

Field Crops

2025 Pest Management Guide

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Keys to the Proper Use of Pesticides

1. Read the label on each pesticide container before each use. Follow the printed instructions to the letter; heed all cautions and warnings; note precautions about residues.
2. Store pesticides in the containers in which you bought them. Put them where children and animals cannot get to them - preferably locked-up and away from food, feed, seed, and other materials that may become harmful if contaminated.
3. Dispose of empty pesticide containers properly.

See your physician if symptoms of illness occur during or after the use of pesticides.

Disclaimer

Commercial products are named in this publication for informational purposes only. Virginia Cooperative Extension does not endorse these products and does not intend discrimination against other products which also may be suitable.

NOTICE:

Because pesticide labels can change rapidly, you should read the label directions carefully before buying and using any pesticides.

Regardless of the information provided here, you should always follow the latest product label when using any pesticide. If you have any doubt, please contact your local Extension agent, VDACS pesticide investigator, or pesticide dealer for the latest information on pesticide label changes.

See Chapter 1 - Regulations and Basic Information for pesticide handling information.

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Safe and Effective Use

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Introduction

The Pest Management Guide Series

The Virginia Pest Management Guide (PMG) series lists options for management of major pests: plant diseases, insects, nematodes, and weeds. These guides are produced by Virginia Cooperative Extension and each guide is revised annually. PMG recommendations are based on research conducted by the Research and Extension Division of Virginia Tech, in cooperation with other land-grant universities, the USDA, and the pest management industry.

These guides are not a comprehensive control plan for all pests in Virginia. However, they do provide management tactics for major pest problems. For specific recommendations beyond the scope of these guides, please contact the Extension specialist(s) associated with the particular commodity or specialty area.

Chemicals listed in the PMG's are registered by the U.S. Environmental Protection Agency (EPA) and the Virginia Department of Agriculture and Consumer Services (VDACS). When used in accordance with label directions, residues should be within tolerance limits set by the EPA. Pesticide users must follow label directions with regard to application site(s), rates of application, number of applications, and minimum time interval between application and harvest. Violation of label directions may result in unsafe residues, fines to the applicator and grower, crop seizure, and loss of public confidence and product marketability.

Use pesticides only on labeled sites, and follow all label directions to the letter!

How To Get Help with a Pest or Pesticide Management Problem

The first rule in solving any problem is to identify the cause before you seek a solution. This is especially true for pest management. You **MUST** identify the pest before you make any attempt to control it. If you need assistance with pest identification, contact your local Extension office. Extension offices are located in local county or city governmental units throughout Virginia. The agents and staff members of these units are dedicated professionals. They are part of a unique alliance between the United States Department of Agriculture, Virginia's land-grant universities, and local government. Local Extension offices are listed in the telephone directory. There is also a complete list of all Virginia Cooperative Extension offices at www.ext.vt.edu/offices/ on the Internet.

If a pest is especially difficult to identify or if you need more information, your agent will send a specimen and/or samples to Virginia Tech. Services available include: the Plant Disease Diagnostic Clinic, the Insect Identification Laboratory, the Weed Identification Laboratory, the Soil Testing Laboratory, and the Forage Testing Laboratory. One or more of these services may help to solve pest—or pesticide—management problems.

Alternative Pest Controls

Pest management includes more than the use of pesticides. Virginia agriculture employs a number of non-chemical methods. Alternative controls are an integral part of any production system. However, where chemical controls are necessary, they must be used in such a way as to provide for a safe food supply, a clean and healthy environment for humans and wildlife, and a productive and profitable agricultural industry.

Integrated Pest Management (IPM)

Integrated Pest Management (IPM) is an ecological approach to pest control, based on the life cycle and habitat of the pest. It combines all appropriate pest management techniques into a single, unified program or plan. The goal of any IPM program is to reduce pest populations to an acceptable level in a way that is practical, cost-effective, and safe for people and the environment.

Virginia Tech has developed a number of specific IPM programs with precise monitoring (scouting) tactics and thresholds. Each is based on scientific studies of local pest populations and the crops/sites these pests damage. Specific IPM protocols take time and resources to generate; as a result, there is not a prescribed program for each and every pest + site combination in the Commonwealth. However, an experienced pest manager can apply IPM principles to any situation by: identifying the

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pest; learning about its life cycle, basic needs, and the environmental conditions that influence its population size and activity; assessing pest population size and distribution by monitoring (scouting); deducing what attracted or brought the pest to the site; acquiring accurate information about management tactics, both chemical and non-chemical; and making long-term plans to prevent or suppress this pest in years to come. For more information about IPM, contact your local Extension agent.

Pesticide Management in Virginia

Virginia Cooperative Extension offers educational programs for the public in pest management and pesticide safety. Examples are commodity production meetings and pesticide safety workshops, including pesticide applicator training and recertification.

Issues and programs such as farmworker protection, recordkeeping, endangered species protection, food and water quality, and re-registration of pesticides often result in additional state and federal regulations affecting pesticide users. In Virginia, the Virginia Pesticide Control Act and regulations drafted under the act affect growers and commercial pesticide applicators. State and federal pesticide laws and regulations are enforced by the VDACS, Office of Pesticide Services (VDACS-OPS).

Growers and applicators are responsible for meeting all requirements imposed by state and federal agencies. For more information about programs, laws, and regulations, contact your local Extension office and/or VDACS-OPS.

Pesticide Applicator Certification

In Virginia, most commercial pesticide users, all aerial applicators, and growers who use restricted-use pesticides must be certified. The Virginia Pesticide Control Act and regulations drafted under the act define “pesticide use” as the application or supervision of an application of a pesticide. This includes the routine activities that are part of a pesticide application, such as mixing, loading, clean-up, storage, and disposal. Handling, transfer, or transport after the manufacturer’s original seal is broken is also considered “use.” (Pesticide handling typically managed by persons other than the mixer/loader/applicator, such as long-distance transport, long-term storage, or ultimate disposal, is not considered part of routine use.)

Pesticide Applicator Training Manuals

Pesticide applicator training manuals are sold by Virginia Tech. Orders can be placed online: <https://resources.ext.vt.edu/>. Alternatively, government purchase orders can be arranged by email: vcedistributioncenter@vt.edu

Certification procedures differ for Private Pesticide Applicators, Commercial Pesticide Applicators, and Registered Technicians. For the most up-to-date information about certification requirements, categories, initial certification procedures, and how to keep a certificate in force, contact your local Extension office, Virginia Tech Pesticide Programs, or VDACS-OPS.

The Virginia Pesticide Control Act

The Virginia Pesticide Control Act is enforced by the VDACS. The act and regulations which support it affect pesticide use in Virginia. Information concerning regulatory changes affecting pesticide use is available from VDACS-OPS, Virginia Tech Pesticide Programs, and your local Extension office.

Responsibilities of Pesticide Applicators in Virginia

I. Follow the Pesticide Label

The pesticide label is a legal agreement between the Environmental Protection Agency (EPA), the product manufacturer, and the user. Pesticide product labels provide instructions for all stages/phases of use. Applicators must read, understand, and follow label directions carefully. Pesticides may not be applied to any site not listed on the product label. Materials may not be applied more often, or at rates higher than the label directs. Pesticide applicators must follow all label directions for transport, mixing, loading, application, storage, and disposal of pesticide products and containers. State and federal laws prohibit the use of any pesticide in a way that is not consistent with its label. There are state and federal penalties for violations.

II. Adhere to Certification Requirements

Private Pesticide Applicators:

- In Virginia, a private pesticide applicator is a person who uses or supervises the use of any restricted use pesticide (RUP)

for purposes of producing an agricultural commodity on property owned or leased by the applicator, or their employer. A private pesticide applicator may also apply a RUP to the property of another agricultural producer so long as they receive no compensation except for trading of personal services between them.

Commercial Pesticide Applicators:

- The Virginia Pesticide Control Act defines a person who, as part of his or her job duties, uses or supervises the use of any pesticide for any purpose (other than production of agricultural commodities on private property) as a commercial pesticide applicator.
- Certification options for commercial pesticide applicators include:
 - registered technician
 - commercial pesticide applicator
- Certification requirements depend on the commercial pesticide applicator class and scope of pesticide use. In addition, The Virginia Business License Regulation requires that people who make pesticide recommendations for-hire be certified as a commercial pesticide applicator. There are four classes of commercial pesticide applicator:
 - *Government employees* must be certified to use any pesticide for any purpose.
 - *For-hire* commercial pesticide applicators must be certified to use any pesticide for any purpose, and to make pesticide recommendations for hire (ex. as a crop consultant). Certified commercial applicators working *for hire* must have a pesticide business license or work for someone who does. Registered technicians working *for hire* must work for a licensed pesticide business.
 - *Not-for-hire* commercial pesticide applicator certification requirements vary. People who do not work for hire but do use pesticides on the job must be certified if:
 - Using restricted-use pesticides, or
 - Using any pesticides on the sites in the following list:
 - on any area open to the public at the following establishments:
 - * Educational institutions,
 - * Health-care facilities,
 - * Day-care centers, or
 - * Convalescent facilities;
 - where open food is stored, processed or sold; or
 - on any recreational land over five acres.
 - *Inactive* status is a way to maintain certified pesticide applicator status while not employed as a pesticide user.

VDACS-OPS is responsible for the certification of applicators and for all enforcement aspects of the Virginia Pesticide Control Act and its regulations. The most current information on how to obtain and maintain pesticide certification can be found at the VDACS website: <https://www.vdacs.virginia.gov/pesticides.shtml>

III. Recertification

Private and commercial pesticide applicators and registered technicians must participate in an ongoing pesticide education program. At a minimum, commercial pesticide applicators and registered technicians must attend at least one fully approved recertification session, per category, every two years before their certificate expires. Private pesticide applicators must accumulate three credits per category every two years before their certificate expires. Pesticide applicators may accumulate up to four years of recertification credit. Persons who fail to recertify will not be able to renew their certificates.

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Virginia Cooperative Extension (VCE), pesticide-related trade and professional organizations, and others offer pesticide recertification courses. A listing of all Virginia-approved courses may be obtained from the following:

Virginia Cooperative Extension offices

Virginia Tech Pesticide Programs (VTPP):

www.vtpp.ext.vt.edu/ (private applicator courses; searchable database)

VDACS-OPS/Certification, Licensing, Registration, and Training Unit:

<http://www.vdacs.virginia.gov/pesticide-applicator-training.shtml>

Program availability varies by time of year and by category. Most courses are offered between September and March. Applicators are advised to keep in touch with Virginia Cooperative Extension and/or professional organizations to avoid missing recertification opportunities.

Certified applicators based out of state may be able to become certified and recertify in Virginia by reciprocity. Contact the VDACS-OPS for more information.

Failure to maintain a certificate, either due to failure to respond to the renewal notice or failure to recertify, will result in expiration. Persons who allow their certificate(s) to lapse (for more than 60 days) must retest.

Applicators must inform VDACS-OPS if their address changes.

IV. Supervise Employees

A. Registered Technicians by Commercial Pesticide Applicators

Certified commercial pesticide applicators must provide on-the-job training, instruction, and supervision of registered technicians employed by them or assigned to them by their employer. Registered technicians may use certain restricted-use pesticides only under the direct supervision of a commercial pesticide applicator. Read the pesticide label for any restrictions on applications by registered technicians. Certified pesticide applicators are responsible for the work of registered technicians under their supervision and must provide the registered technicians with clear, specific instructions on all aspects of pesticide use. A registered technician may apply general-use pesticides unsupervised.

Uncertified persons may apply pesticides commercially while in training to become registered technicians *only* when under the direct, *on-site* supervision of a properly certified commercial pesticide applicator.

B. Uncertified Handlers by Private Pesticide Applicators

Uncertified but competent persons may apply certain restricted-use pesticides in the production of agricultural commodities on private property when under the direct supervision of a certified private pesticide applicator. The certified private pesticide applicator is responsible for the actions of the uncertified person. Read the pesticide label for any restrictions on applications by uncertified persons in agriculture settings.

Direct supervision means the act or process by which the application of a pesticide is made by a competent person acting under the instructions and control of a certified pesticide applicator who is responsible for the actions of that person. The supervising certified pesticide applicator must be accessible to the applicator by either being physically present nearby or within reach by telephone or radio.

V. Handle Pesticides Safely

Although there are no specific storage and disposal regulations in Virginia, unsafe use/handling/storage/disposal practices can be cited under the enforcement regulation: 2 VAC 20-20-10 through 20-220 (VAC is the Virginia Administrative Code).

Provisions to Note:

Handling and Storage:

“No person shall handle, transport, store, display, or distribute pesticides in a manner which may endanger humans or the environment, or food or feed or other products...”

Disposal:

“No person shall dispose of, discard, or store any pesticide or pesticide containers in a manner that may cause injury...or pollute...”

Application Equipment:

“...must...be in good working order...dispense the proper amount of material...be leakproof...have cutoff valves and backflow prevention...”

Service Container Labeling:

Containers other than the original registrant’s or manufacturer’s containers used for the temporary storage or transportation of pesticide concentrates or end-use dilutions must have abbreviated labeling for identification.

A. Pesticide Concentrate:

1. If the pesticide to be temporarily stored or transported is a concentrate to be further diluted, the container shall bear a securely attached label with the following information:
 - a. Product name or brand name from product label;
 - b. EPA registration number from the product label;
 - c. Name and percentage of active ingredient(s) from the product label; and
 - d. Appropriate signal word; i.e., Poison, Danger, Warning, Caution (from the product label).
2. The above labeling is required for concentrate service containers, regardless of container type, size, or capacity. (Note: If possible, keep pesticides in their original container.)

B. Pesticide End-Use Dilutions or End-Use Concentrates:

1. If the pesticide to be temporarily stored or transported will be applied without further dilution, its container must bear a securely attached label with the following information:
 - a. Product name (brand name from product label) preceded by the word “Diluted” or “End-Use Concentrate”;
 - b. EPA registration number from the concentrate product label;
 - c. Name of active ingredient(s) and percentage(s) of end-use dilution; and
 - d. Appropriate signal word; i.e., Poison, Danger, Warning, Caution (from the product label).
2. Exemptions: abbreviated service container labeling is not required for:
 - a. End-use dilution containers not exceeding 3 gallons liquid or 3 pounds dry capacity, when such containers are used as application devices; i.e., hand-held sprayers, dusters, puffers, etc.
 - b. Containers used by farm-supply dealers for the temporary storage or transportation of pesticide concentrate or end-use dilution, provided that sales invoices or delivery tickets adequately identifying the pesticide(s) accompany each shipment or delivery.
 - c. Farm concentrate or end-use dilution containers or application equipment used for the temporary storage or transportation of such pesticides for agricultural use.
 - d. Aircraft-mounted containers used for temporary storage or transportation of concentrate or end-use dilution pesticides, provided that aircraft logs or other documents on board adequately identify the pesticide(s).

VI. Keep Accurate Records

A. Commercial Pesticide Applicators

Virginia regulations require all commercial pesticide applicators to keep records of all pesticide applications. These records must be maintained for two years following the pesticide use. Commercial pesticide applicator records must contain the following information:

1. Name, address, and telephone number (if applicable) of the treatment site property owner, and address/location of the application site, if different;

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2. Name and certification number of the person making or supervising the application;
3. Date of application (day, month, year);
4. Type of plants, crops, animals, or sites treated;
5. Principal pest(s) to be controlled;
6. Acreage, area, number of plants or animals treated, or size of structure treated;
7. Identification of pesticide used:
 - Brand name or common name of pesticide used, and
 - EPA product registration number;
8. Amount of pesticide concentrate and amount of diluent (water, etc.) used, by weight or volume, or the volume and concentration applied to a structure as defined in #6; and
9. Type of application equipment used.

Commercial Pesticide Applicators and WPS Compliance:

Commercial pesticide applicators who apply pesticides to agricultural commodities on farms, forests, nurseries, and greenhouses should be sure their record data elements conform to those required by both the **Worker Protection Standard (WPS)** and the **Food, Agriculture, Conservation, and Trade (FACT) Act**, also known as the 1990 Farm Bill.

- If a grower hires a commercial pesticide applicator to apply a restricted-use pesticide, the applicator is responsible for making and maintaining all appropriate pesticide application records.
- If a grower with farm-worker or pesticide-handler employees hires a commercial pesticide applicator to apply any pesticide, the commercial pesticide applicator must provide the grower with information about the application in advance. This is necessary so that the grower can comply with WPS notification, restricted-entry, and record-keeping requirements.

A sample commercial pesticide applicator record-keeping form follows at the end of this section.

B. Private Pesticide Applicators

The Food, Agriculture, Conservation and Trade (FACT) Act, also known as the 1990 Farm Bill, requires certified private pesticide applicators to record applications of restricted-use pesticides (RUPs). RUP applications made by a private pesticide applicator must be recorded within 14 days and maintained for a period of two years. Private pesticide applicator records must contain the following nine data elements:

1. The restricted-use pesticide brand or product name;
2. The EPA registration number;
3. The total amount of the restricted-use pesticide product applied;
4. The month, day, and year of application;
5. The location of the treated area;
6. The crop, commodity, stored product, or site to which the restricted-use pesticide was applied;
7. The size of area treated;
8. The name of the certified applicator who applied or supervised the application of the restricted-use pesticide; and
9. The certificate number of the person named in number 8, who made or supervised the application.

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Records of spot-treatments may require less information. A spot application is a treatment of an area totalling less than one-tenth of an acre made on the same day. For spot applications record:

1. Brand or product name;
2. EPA registration number;
3. Total amount applied;
4. Month, day, and year of application; and
5. Location of treated area, designated as a “spot application” (with a brief but concise description of the site).

Recording the name and certificate number of the certified private pesticide applicator who made or supervised the RUP spot treatments is recommended, although it is not required by federal law.

(Note: Nursery and greenhouse RUP applications do NOT qualify as spot treatments. Greenhouses and nurseries must record all required recordkeeping data elements.)

Certified pesticide applicators are required to make records available, upon request, to any Federal or State agency that deals with pesticide use or any health or environmental issue related to the use of RUPs. In addition, medical professionals may require access to records in the event of an exposure.

The FACT Act requires commercial pesticide applicators to provide a copy of a restricted-use pesticide application record to the person for whom the application was made within 30 days of the application. However, if a grower has employees, he/she should obtain the record information prior to any for-hire application — RUP or not — to ensure compliance with WPS posting and notification requirements.

The Federal Worker Protection Standard (WPS) also involves some recordkeeping. Growers who employ field workers or pesticide handlers must display pesticide use and safety information at a central location. WPS requires growers who employ agricultural workers to make, maintain, and post pesticide application records. WPS application records must be kept for every pesticide used on the farm, not just for those that are restricted-use. Growers must post information about each application for 30 days after the expiration of the restricted-entry interval (REI). In addition, this information must be kept on file for two years. A WPS application list must record:

1. Brand or product name;
2. EPA registration number;
3. Active ingredient(s) of the product used;
4. Location of the treated area;
5. Time and date of the application; and
6. Restricted entry interval for the pesticide (duration and expiration).

WPS application information and safety data sheets (SDSs) must be displayed at a central location within 24 hours of the end of an application, and before workers enter the treated area. Application information and SDSs must be posted for 30 days after the restricted-entry interval (REI) expires—and kept on file for two years following. On-file application information and SDSs must be available to workers, handlers, designated/authorized representatives (identified in writing), or treating medical personnel upon request.

Additionally, employers will be required to keep records of WPS training. Please keep in touch with your local Extension agent for the latest information on record-keeping. Your agent will also know about WPS and other pesticide laws and regulations affecting agricultural producers. A sample record-keeping form for producers follows at the end of this section.

Table 1.1 - Private/Grower Pesticide Application Record for

USDA records of restricted-use pesticide applications must be kept for two years. WPS requires pesticide application information and Safety Data Sheets for all pesticides to be posted in a central area no later than 24 hours after an application is completed. Application and hazard information must be displayed continuously until 30 days after the last applicable restricted-entry interval or until workers or handlers are no longer on the establishment, whichever is earlier. WPS information must be retained for two years after expiration of the REI.

Application Date(s) (day/month/year) and ¹ Time	³ Crop/ Commodity or Site Treated	³ Location and Description of Treated Area	³ Brand or Product Name	¹ Active Ingredient Common Name	³ EPA Registration Number	² # of Units or Acres Treated	² Total Amount of Product Used (oz., lb., pt., qt., gal.)	² Applicator Information: (Name & Certificate No.)	¹ Restricted-entry Interval (REI)	
									Duration (# of hours)	Expiration (date/ time)

¹Required for Worker Protection Standard
²Required for Federal Pesticide Recordkeeping Requirements, USDA
³Required for Worker Protection Standard and Federal Pesticide Recordkeeping Requirements
 Prepared by Virginia Cooperative Extension and VDACS (Virginia Department of Agriculture and Consumer Services), Office of Pesticide Services, 2016.

Table 1.2 - Commercial Applicator Pesticide Application Record										
Note: The Commonwealth of Virginia requires commercial applicator records of pesticide applications to be kept for two years.										
Name, Address, Telephone Number of Property Owner	Address and Location of the Application Site (if different than recorded in left column)	Certified Applicator's Name and Certificate Number	Date: (Month, Day, Year)	Type of Plants, Crops, Animals, or Sites Treated	Principal Pest to be Controlled	Acreage, Area, or Number of Plants or Animals Treated	Brand or Common Name of Pesticide	EPA Product Registration Number	Total Amount of Product and Diluent (if used)	Type of Application Equipment

Prepared by Virginia Cooperative Extension and VDACS (Virginia Department of Agriculture and Consumer Services) Office of Pesticide Services, 2006.

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VII. Report Pesticide Accidents

Pesticide accidents or incidents that constitute a threat to any person, to public health or safety, and/or to the environment must be reported. Telephone notification is required within 48 hours. A written report describing the accident or incident must be filed within 10 days of the initial notification.

Telephone contacts and written reports should be directed to:

Virginia Department of Agriculture and Consumer Services
Office of Pesticide Services/Enforcement and Field Operations
P. O. Box 1163, Richmond, VA 23218
(804) 371-6560

In the event of an emergency release, notify local authorities immediately, and contact the Virginia Department of Emergency Management (VDEM) Operations Center at 1-800-468-8892 or (804) 674-2400.

If the accident or incident involves a spill which may pose a threat to people and/or the environment, the applicator should contact VDACS-OPS to determine whether the release is governed under SARA Title III (the Community Right-to-Know Law). The chemical hazard and the volume of the released chemical determine reporting under SARA Title III, which involves notifying the National Response Center at 1-800-424-8802.

Sources of Information

Questions regarding federal and state pesticide regulations, the legal responsibilities of pesticide users, and certificate/license status:

Virginia Department of Agriculture and Consumer Services (VDACS)
Office of Pesticide Services (OPS)
P.O. Box 1163
Richmond, VA 23218

(804) 786-3798

<https://www.vdacs.virginia.gov/pesticides.shtml>

Questions regarding federal and state pesticide regulations, legal responsibilities of pesticide users, pesticide management techniques, and sources of approved preparatory training sessions and recertification workshops:

Virginia Cooperative Extension (VCE)
Virginia Tech Pesticide Programs (MC 0409)
302 Agnew Hall
460 West Campus Drive
Virginia Tech
Blacksburg, VA 24061

(540) 231-6543

<https://vtpp.ento.vt.edu/>

Other questions regarding pesticide safety or pest management can be directed to your local Virginia Cooperative Extension office:

Local Offices: <https://ext.vt.edu/offices.html>

The Hazard Communication Standard

As of May 23, 1988, all employers must adhere to restrictions under the OSHA Hazard Communication Standard. This standard is a worker right-to-know law, which requires employers to train and inform all workers who may be exposed to hazardous chemicals in the workplace. The new law especially targets operations, including agricultural operators, with 10 or more employees. These employers must file a Hazard Communication Plan in their offices and inform their employees of the content of this plan. These employers must obtain and file Safety Data Sheets (SDS) for all chemicals used by their employees. In addition, employers must provide training on the information in the plan, the SDS, and chemical labeling to each employee who may be potentially exposed to a chemical hazard. This training is very specific to each operation and therefore must be

conducted by the employer. Also, when new chemical hazards are introduced into the workplace, the employer must provide new training to protect the employee.

For agricultural operators with fewer than 10 employees, it is not necessary to develop and file a Hazard Communication Plan. However, SDS and Labeling should be maintained, and employees must be informed of proper use and safe handling according to the SDS and labeling information. For more information on the standard, contact your local Extension office or the Virginia Department of Labor and Industry.

Community Right To Know (SARA Title III)

The Superfund Amendments and Reauthorization Act of 1986 (SARA Title III) was drafted to require industries and others producing or storing hazardous chemicals to provide communities with the identity and amounts of chemicals located in their vicinity. The law also addresses the need for communities to establish emergency response plans to follow in the event of an emergency.

Section 302 requires a facility to send a one-time written notification to the Virginia Emergency Response Council (VERC) and its jurisdictional local Emergency Planning Committee (LEPC) if the presence of an Extreme Hazardous Substance (EHS) at the facility, at any time, exceeds or equals the threshold planning quantity (TPQ) for that material. For more information, visit this section of the Virginia Department of Environmental Quality website: <https://www.deq.virginia.gov/land-waste/superfund-amendments-and-reauthorization-act-sara>.

Worker Protection Standard for Agricultural Pesticides

The EPA's Worker Protection Standard for Agricultural Pesticides (WPS) was developed to protect workers and pesticide handlers from exposures to agricultural pesticides, thus reducing the risks of pesticide poisonings and injuries. The WPS targets workers who perform hand-labor operations in agricultural fields, nurseries, greenhouses, and forests treated with pesticides. It also affects employees who handle pesticides (mix, load, apply, etc.) for use in those locations. Labels of pesticides used in agricultural plant production, nursery/greenhouse operations, and forestry refer to WPS requirements.

WPS has requirements referenced (*but NOT explained in detail*) on pesticide labels. You will find general information about WPS in the Virginia Core Manual: *Applying Pesticides Correctly*. For comprehensive information, consult the EPA manual: *How to Comply with the Worker Protection Standard for Agricultural Pesticides*. If you have questions about the WPS, please contact your local Extension agent or call the VDACS-OPS at (804) 786-4845.

Groundwater Restrictions

The EPA and Congress have placed special emphasis on protection of water resources. Water quality programs are being implemented in education and research programs throughout the country. Federal and state efforts to protect groundwater are resulting in revised pesticide product label instructions and new use restrictions. Applicators should expect a continued emphasis on protection of water supplies.

As an applicator and landowner, you must adhere to label restrictions and should follow the best management practices in handling pesticides. Particular attention should be given to prevention of spills, backsiphoning, and disposal of pesticides. Applicators can do much to prevent contamination by following label directions and maintaining and calibrating application equipment. In Virginia, it is against the law to use equipment in poor repair or to fill tanks directly from a water source without an anti-siphon device in use on the spray equipment.

For more information on anti-siphon devices, sometimes referred to as back-flow preventers, contact your local water authority. (*Note: most check valves do not qualify as "anti-siphon" devices because they do not break the siphon.*)

Endangered Species Pesticide Use Restrictions

Under the authority of the Endangered Species Act and FIFRA, the U.S. Fish and Wildlife Service and the EPA may restrict pesticide use where such use jeopardizes a federally listed threatened or endangered species.

The EPA's Endangered Species Protection Program (ESPP) is designed to protect federally listed endangered and threatened species from exposure to pesticides. The program's goal is to ensure that pesticide use does not adversely affect the survival, reproduction, and/or food supply of listed species.

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The agency will inform users of enforceable use limitations by means of ESPP Bulletins. Bulletins will provide product users with information about geographically-specific pesticide use restrictions. Bulletins will be referenced on pesticide product labels and available on the internet at www.epa.gov/espp. (Internet search tip: At the main ESPP page, click on “Bulletins Live! Two” to view pesticide use limitations for a specific county or active ingredient.)

Applicators using a product with an ESPP reference on the label must check for—and access—a bulletin no more than 6 months prior to applying this pesticide. Failure to follow label-referenced bulletin instructions and provisions, whether or not that failure results in harm to a listed species, is subject to enforcement under the misuse provisions of FIFRA and state law.

Note that not all pesticide active ingredients will have restrictions, and not all pesticide uses are banned in restricted areas.

Please observe pesticide labeling for changes and keep up to date on this topic. Information is available through your local Extension office or VDACS.

Guidelines for Disposal of Pesticides and Empty Containers

Always dispose of pesticides and empty containers so they pose no hazard to humans or the environment. Follow label directions and consult your local Extension agent if you have questions. The best solution to the problem of what to do with excess pesticide is to avoid having any. Waste minimization strategies include:

- Buy only the amount needed for a year or a growing season.
- Minimize the amount of product kept in storage.
- Calculate how much diluted pesticide you will need for a job, and mix only that amount.
- Apply pesticide with properly calibrated equipment.
- Use all pesticides in accordance with label instructions.
- Purchase pesticide products packaged in such a way as to minimize disposal problems, or packaged in containers that have legal disposal operations available in your area.

The best disposal option for excess usable pesticide is to find a way to apply the material as directed by the label. Please note that the total amount of active ingredient applied to a site, including all previous applications, must not exceed the rate and frequency allowed by the labeling.

Other pesticide waste disposal options include:

- Follow valid label disposal directions.
- Return product to the dealer, formulator, or manufacturer.
- Participate in a federal indemnification program for canceled/suspended products.
- Employ a professional waste-disposal firm.
- Participate in a state or local “clean day,” such as the Virginia Pesticide Control Board-sponsored Pesticide Disposal Program.

Pesticide wastes that cannot be disposed of right away should be marked to indicate the contents and then stored safely and correctly until legal disposal is possible.

EPA container and containment regulations require registrants to place instructions for container cleaning on product labels. In addition, users should read the label to learn if a container is refillable or non-refillable. One-way, non-refillable containers will have guidelines for proper cleaning and disposal.

Federal law (FIFRA) requires pesticide applicators to rinse “empty” pesticide containers before discarding them. Pesticide containers that have been properly rinsed can be handled and disposed of as non-hazardous solid waste. However, the containers of some commonly used pesticides are classified as hazardous waste if not properly rinsed. Proper disposal of hazardous waste is highly regulated. Improper disposal of a hazardous waste can result in high fines and/or criminal penalties.

A “drip-drained” pesticide container contains product. Immediate and proper rinsing generally removes more than 99 percent of container residues. Properly rinsed pesticide containers pose minimal risk to people and their environment.

There are two methods for proper rinsing:

- Triple Rinsing, and
- Pressure Rinsing.

Pesticide containers should be rinsed as soon as they are emptied. So, the time to rinse is during mixing/loading. If containers are rinsed as soon as they are emptied, the rinse water (rinsate) can be added to the spray tank. This avoids the problem of rinsate disposal and makes sure that nothing is wasted. If containers are rinsed immediately, residues do not have time to dry inside. Dried residues are difficult (or impossible!) to remove. Never postpone container rinsing!

Be sure to wear protective clothing when rinsing pesticide containers. See the product label for information on what to wear.

Pesticide Internet/Phone Sales – Buyers Beware

As a general rule, applicators should be wary about buying pesticide products “sight unseen.” Here is a general description of problems often associated with sales offers:

1. The product actually contains a very low percentage of pesticide active ingredient per unit volume. So, it is actually quite expensive to use on a per-area basis.
2. Weed control products containing a small proportion of herbicide formulated with diesel fuel or some other petroleum product. These are generally not recommended and not usable in many situations.
3. The product name is similar to the trade name of another well-known pesticide product or sounds like one from a major pesticide manufacturer’s line.
4. The solicitor gives an EPA establishment number but not an EPA registration number. In many cases, this is because the product is not registered with EPA.
5. The product is not registered with VDACS, despite being offered for sale in the commonwealth. This is an illegal practice.

If the potential buyer wishes to follow up on a sales solicitation, he/she should ask for the following information: company name, address, and telephone number; name of salesperson; product name; product registration number; percent active ingredient(s) per unit volume; use site(s); and use rate(s). It is wise to ask for a copy of the label and product MSDS before making a commitment to purchase. If a salesperson does not provide the information you request, the “bargain” is better passed.

Information given over the internet/telephone can be verified, and the claims for the product can be compared to industry standards or known performance data for the product’s active ingredient(s). To check federal and state product registrations, call:

VDACS-OPS (804) 786-3798 or your local Virginia Cooperative Extension office.

If you receive what you suspect to be an improper sales offer, you’re encouraged to get as much information as possible and make a complaint to VDACS-OPS by calling (804) 786-3798.

Based on the difficulties associated with internet/telephone solicitations, pesticide users are advised to buy from established dealers and from sellers they know.

Pesticide Use Precautions

Efficient and economical control of insects, plant diseases, and weeds is a factor in the production of all crops. Both management costs and losses resulting from inadequate control can reach tremendous proportions. The use of today’s pesticides requires a great degree of precision. In some instances, rates are given in ounces per acre. This requires that pesticide users know how to calibrate equipment and follow detailed directions on product labels.

All pesticides should be used with care. The following suggestions will help minimize the likelihood of injury (from exposure to such chemicals) to people, animals, and the environment.

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Read the Label: Before buying and applying pesticides, always read all label directions. Follow them exactly when you handle and apply the product. Notice warnings and cautions before opening the container. Repeat the process every time, no matter how often you use a pesticide. The label directions for pesticides often change. Apply materials only on crops specified, at the rate(s) and times indicated on the product label.

Store Pesticides Properly: A suitable storage site for pesticides protects:

- People and animals from accidental exposure.
- The environment from accidental contamination.
- Stored products from damage (from temperature extremes and excess moisture).
- The pesticides from theft, vandalism, and unauthorized use.

All pesticides should be stored under lock and key, outside the home. Storage facilities should be well-ventilated and well-lit. Pesticide storage areas should be located away from water sources such as ponds or wells. However, a supply of clean water for decontamination is recommended. Use non-porous materials for flooring and shelving. It is important to arrange materials in the storage site so cross-contamination does not occur. Do not store pesticides with food, feed, seed, or fertilizer. An emergency plan should be worked out with local authorities, notifying them of the contents of pesticide storage facilities. If substantial quantities of highly toxic pesticides are stored, you must notify (according to law) your local Emergency Response Council. Proper records should be maintained to provide an up-to-date list of contents at all times. Always store pesticides in their original containers and keep them tightly closed. Never keep pesticides in unmarked containers.

Avoid Physical Contact with Pesticides: Never smoke, eat, chew tobacco, or use snuff while handling or applying pesticides. Use the protective clothing and equipment the label requires. Protect your eyes from pesticides at all times. Avoid inhaling sprays or dusts. Do not spill pesticides on skin or clothing. If they are accidentally spilled, remove contaminated clothing immediately and wash exposed skin thoroughly. Wash hands and face and change to clean clothing after applying pesticides. Wash protective clothing, separate from the family laundry, each day, before re-use. Do not spray with leaking hoses or connections. Do not use the mouth to siphon liquids from containers or to blow out clogged lines, nozzles, etc. **See a doctor if symptoms of illness occur during or after the use of pesticides.** A list of Poison Control Centers located in and around Virginia is included in this guide.

Apply Pesticides Carefully: Successful pest control requires application of the correct amount of pesticide uniformly over a targeted area. Pesticide application is a precise operation requiring reliable, properly calibrated equipment. For example, many herbicides have narrow ranges of selectivity. At the suggested rates of application, they will generally control weeds without damaging the crop, but at a slightly higher rate they may damage or kill the crop.

Dispose of Pesticides Correctly: All pesticides should be disposed of according to container directions. All empty containers should be triple rinsed (or equivalent), crushed/punctured (to make the container unusable), and disposed of as directed by the product label. Rinsate should be placed in the spray tank at the time of mixing. Leftover diluted pesticides should be used according to label directions. Leftover concentrates should be disposed of according to EPA guidelines only after exhausting other options. Amounts of chemicals that do not qualify for disposal under these guidelines must be disposed of by an approved hazardous-waste handler.

Protect Pets, Fish, and Wildlife: To protect fish and other wildlife, do not apply pesticides to streams or areas where drainage may be expected to enter waterways unless the product is labeled for use in such areas. Incorporate all granular pesticides into the soil to prevent birds and other animals from eating particles. Scout fields for dead animals and birds before and after application. Remove any carcasses to prevent poisoning of birds-of-prey and scavengers. Report any wildlife poisonings to the Virginia Department of Wildlife Resources. Be aware of bee cautions; see section to follow on protecting honeybees from pesticides.

Cover food and water containers when treating around livestock or pet areas. Do not discard leftover materials into drainage channels. Confine chemicals to the property and crop being treated.

Prevent Drift: Drift can be a problem with any pesticide. However, herbicide drift is the most commonly encountered cause of pesticide damage to susceptible crops. No pesticide can be applied by either aerial or ground equipment without some drift. Spray drift is influenced by a number of factors, including, droplet size, environmental conditions, and equipment configuration and operation.

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To minimize particle drift, application should be made as close to the ground as possible using spray nozzles which produce large droplets and eliminate “fines.” In some instances, spray additives may be used to reduce drift.

Some highly volatile herbicide products are capable of causing injury to off-target plants by movement in the vapor phase after the spray has dried. Use low-volatility formulations and avoid making spray applications when the temperature is high and humidity is low to reduce the possibility of vapor drift.

The farmer and the applicator are liable for damages caused by particle drift or volatility.

Select Pesticide Products Wisely: Two or more pesticides may be equally effective in a given situation. Also, the same active ingredient may be available in a variety of formulations. Your selection of a pesticide and its formulation will be determined by the:

1. Site/crop to be treated.
2. Pest species involved.
3. Product availability.
4. Equipment availability.
5. Hazards to humans, domestic animals, wildlife, and desirable plants.
6. Time of application.
7. Relative total costs of materials and application.

All recommended rates of application are based on the amount of active ingredient in a given product. Many commercial products vary in the percentage of active ingredient. The label will give the exact amount of active ingredient in the container and the amount of product to be used in a given area.

To make an accurate cost comparison, it is wise to calculate the cost per area. In general, concentrated products are more economical. However, they may require more handling (measuring, mixing, and loading) than ready-to-use products.

Poisonings

The procedure to be followed *in case of suspected poisoning*:

- (1) Call a physician immediately. If a doctor is not available, take the exposed person to the nearest hospital emergency room along with the product label and safety data sheet. (If you take a label affixed to a product container, do not carry it in the passenger compartment of a vehicle.)
- (2) If necessary, the attending physician will call the nearest poison control center for further information on toxicity of the suspected agent, treatment, and prognosis. The EPA publication *Recognition and Management of Pesticide Poisonings* is an invaluable resource and can be viewed, downloaded here: <https://www.epa.gov/pesticide-worker-safety/recognition-and-management-pesticide-poisonings>, or ordered online.
- (3) You may call a poison control center for information. However, don't delay seeking medical attention.

NOTE: This information is correct to the best of our knowledge. Listings below were checked for this revision. Please note that this information is subject to change. You should confirm locations and phone numbers of nearby emergency contacts now rather than at the time of a poisoning incident.

Poison Information and Treatment Resources For Virginians

National Poison Control Center

Toll-Free Number for all U.S.: (800) 222-1222

Calls to this number will be routed to the closest Regional/Area Poison Control Center.

Website for the American Association of Poison Control Centers is: www.aapcc.org/

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Regional Poison Control Center

Provides 24-hour information and consultation services by Poison Information Specialists and board-certified Medical Toxicologists. Located in a hospital equipped for all toxicologic (poison) emergencies.

CHARLOTTESVILLE, VA.

Blue Ridge Poison Center

University of Virginia Health Systems

Jefferson Park Place

1222 Jefferson Park Avenue

Charlottesville, VA 22908

(800) 222-1222 or (800) 451-1428

<https://med.virginia.edu/brpc/>

Area Poison Control Centers

Hospitals with staff who will provide poison information by telephone. Hospitals equipped for most toxicologic emergencies.

WASHINGTON, D.C.

National Capital Poison Center

3201 New Mexico Ave., NW, Suite 310

Washington, DC 20016

(800) 222-1222

<https://www.poison.org/>

CHARLESTON, W.V.

West Virginia Poison Center

3110 MacCorkle Ave., SE

Charleston, WV 25304

(800) 222-1222

<http://www.wvpoisoncenter.org/>

RICHMOND, VA.

Virginia Poison Center

Virginia Commonwealth University Medical Center, VCU Health System

1250 East Marshall Street

PO Box 980522 - Richmond, VA - 23298-0522

(800) 222-1222 or (804) 828-9123

(Calls from Central and Eastern Va. only)

<https://poison.vcu.edu/>

A complete list of Poison Control Centers is available on the World Wide Web at www.aapcc.org/

Pesticide Information Directory

This directory is intended for use by persons who need assistance with general and emergency pesticide-related information. We hope that it will save time and money by directing you to the proper government and industry sources.

The pages that follow include **Emergency Information, General Information, and Industry Associations**. In the blank lines provided, please take time to list your local phone numbers for these sources. In the case of an emergency, it might save a life, as well as possible added expense and inconvenience. Keep a copy of this guide, with this directory section marked, near your phone and/or in your service vehicle for future reference.

Emergency Information

Poisonings For Treatment: If poisoned, have someone take you immediately to your nearest emergency room with the label of the container.

My Nearest Poison Control Center Is Located At: The blanks below are supplied for recording the name and telephone number of the nearest poison control center. Please refer to the Regional and Area Poison Control Centers listed previously in this section.

Phone number

Spills accidents and other related emergencies	CHEMTREC (for assistance) Chemical Transportation Emergency Center Industry assistance with clean-up procedures, etc.	(800) 262-8200 chemtrec.com/
Accidents or Incidents that constitute a threat to any person, public safety and health, or the environment must be reported to:	Virginia Department of Agriculture and Consumer Services Office of Pesticide Services Field Operations	(804) 371-6560
For Assistance with Spills and Emergencies Take time to write your local emergency numbers in the space provided.	State Police Fire Department Ambulance	<hr/> <hr/> <hr/>
	Virginia Department of Emergency Management (VDEM) Emergency Operations Center pio@vdem.virginia.gov - E-mail monitored during regular business hours. https://www.vaemergency.gov/contact-us/	(804) 897-6500 (Mon-Fri) 8:15am-5pm (804) 674-2400 (800) 468-8892 24 hours / day
	Local Emergency Services Coordinator	<hr/>
	Local Emergency Response Council	<hr/>

General Information

General Information about pest identification and management and about pesticide safety and use patterns	Virginia Tech Your Local Extension Office https://ext.vt.edu/offices.html Virginia Tech Pesticide Programs (0409) Blacksburg, VA 24061 https://vtpp.ento.vt.edu/	<hr/> (540) 231-6543
Regulatory Information including certificate or license status	Virginia Dept. of Agriculture and Consumer Services Office of Pesticide Services 102 Governor Street P.O. Box 1163 Richmond, VA 23218 https://www.vdacs.virginia.gov/pesticides.shtml	(804) 786-3798

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Community Right-to-know Environmental Programs	Department of Environmental Quality 629 East Main Street P.O. Box 1105 Richmond, VA 23218 https://www.deq.virginia.gov/	(804) 698-4000 (800) 592-5482
EPA Cooperator for general pesticide information	National Pesticide Information Center (NPIC) Ag. Chemistry Extension Oregon State University 310 Weniger Hall Corvallis, OR 97331-6502 http://npic.orst.edu/	(800) 858-7378 M-F 11:00 am – 3:00 pm ET
Animal Poisonings Assistance	Va.-Md. Regional College of Veterinary Medicine 265 Duck Pond Drive Virginia Tech (0442) Blacksburg, VA 24061 https://vetmed.vt.edu/	(540) 231-4621 (hospital) Ask your veterinarian to call on your behalf
	ASPCA Animal Poison Control Center University of Illinois at Urbana-Champaign College of Veterinary Medicine 2001 S. Lincoln Ave. Urbana, IL 61802 https://www.aspca.org/pet-care/animal-poison-control	(888) 426-4435
Toxicology Information	Virginia Dept. of Health Division of Environmental Epidemiology/Toxicology Program 109 Governor Street P.O. Box 2448 Richmond, VA 23218 https://www.vdh.virginia.gov/	(804) 864-8127 (toxic substance information)
EPA Safe Drinking Water Hotline	For information on drinking water regulations and pesticides in drinking water. https://www.epa.gov/ground-water-and-drinking-water	(800) 426-4791 M-F 10:00 am-4:00 pm
Hazard Communication/OSHA Compliance Information	Virginia Dept. of Labor & Industry 600 East Main Street Suite 207 Richmond, VA 23219 https://www.doli.virginia.gov/	(804) 371-2327 M-F 8:15 am – 5:00 pm

Industry Associations

Croplife America 4201 Wilson Boulevard, Suite 700 Arlington, VA 22203	(202) 296-1585 www.croplifeamerica.org/
Virginia Crop Production Association, Inc. (VCPA) 6442 Cross Keys Road Mt. Crawford, VA 22841	(540) 234-9408 www.vacropproduction.com
Responsible Industry for a Sound Environment (RISE) 4201 Wilson Boulevard, Suite 700 Arlington, VA 22203	(202) 872-3860 www.pestfacts.org/

This directory neither endorses the groups listed nor intends to exclude those not listed. To be included in future revisions contact Virginia Tech Pesticide Programs, 302 Agnew Hall (0409) Virginia Tech, Blacksburg, VA 24061, telephone: (540) 231-6543.

Protective Clothing and Equipment

Dermal exposures account for most of all handler exposures that occur during liquid spray applications. Wearing protective clothing will prevent pesticides from coming into contact with the skin. Any body covering will provide some protection, because dermal absorption is reduced to some degree by a fabric barrier. Protective clothing may be classified according to the part of the body it protects; i.e., feet (boots and shoes), hands (gloves), eyes (goggles and faceshields), head (hats and hoods), trunk (apron), and arms and/or legs (jackets, shirts, pants, coveralls, overalls, and raincoats).

Because of its comfort, conventional work clothing is worn most often. Wearing cotton clothing with a stain-repellent finish provides some protection from dusts and spray mists. However, cotton fabric will provide little or no protection from accidental spills of concentrated pesticides.

Use chemical-resistant garments when handling pesticide concentrates and applying liquids. Adjust work habits and take precautions to prevent heat exhaustion.

Cleaning/Laundering Recommendations

Before laundering pesticide-contaminated clothing, read the pesticide label. Key words on all pesticide labels identify the toxicity of the product: **DANGER POISON** (highly toxic), **WARNING** (moderately toxic), and **CAUTION** (slightly toxic). Wear chemical-resistant gloves when handling pesticide-contaminated clothing and equipment.

1. **Cotton or Denim Fabric** - Hold and wash contaminated clothing separately from the family wash. Pesticide residues may be transferred from contaminated clothing to other clothing in a hamper, and clothing worn when handling pesticides requires extra washing steps.

Note: Regular laundering will not clean fabric contaminated with highly toxic and/or concentrated pesticide. Clothing saturated with either should be discarded after slashing/cutting to make the item unusable.

Pre-treating contaminated clothing before washing will help remove pesticide particles from the fabric. This can be done by:

1. Pre-soaking in a suitable container.
2. Pre-rinsing with agitation in an automatic washing machine.
3. Spraying/hosing garments outdoors.
4. Pretreating soiled areas with heavy-duty liquid detergent or a stain-removal product.

Clothing worn while using slightly toxic pesticides may be effectively laundered in one machine washing. It is strongly recommended that multiple washings be used on clothing worn while applying more toxic pesticides. Also, multiple wash cycles are recommended for protective clothing treated with starch or water/stain repellents.

When machine-washing, use a full tank of hot water. Choose heavy-duty liquid detergent. Heavy-duty detergents are particularly effective in removing oily soils (the kind emulsifiable concentrate formulations make). In addition, their performance is not affected by water hardness. Increasing the amount of detergent used is recommended, especially if the fabric has been treated with a stain/water repellent finish.

If several garments are contaminated, wash only one or two garments in a single load. Wash garments contaminated by the same pesticide(s) together. Use a full water level to allow the water to thoroughly flush the fabric.

Clothing exposed to pesticides should be laundered daily. It is much easier to remove pesticides from clothing by daily laundering than attempting to remove residues that have accumulated over a period of time.

Pesticide carry-over to subsequent laundry loads is possible because the washing machine may retain residues, which are then released in following loads. Rinse the washing machine with an "empty load," using hot water, the same detergent, and machine settings and cycles used for laundering contaminated clothing.

Line drying is recommended for these items. Many pesticides break down when exposed to heat and sunlight. Line drying eliminates the possibility of residues collecting in the dryer.

When dry, apply fabric starch or stain repellent on clothing.

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2. **Vinyl-coated fabric, neoprene, or rubber** - This type of outer protective clothing should be pan-washed in warm water using a good detergent. Double or triple washing of heavily contaminated outer protective clothing is desirable. Rinse through two water changes and hang up to air dry. Wash after each use.
3. **Chemical-resistant gloves and boots** should be rinsed before taking them off, then pan-washed inside and out using a good detergent with several rinses. Remember, gloves must be clean inside because the inner surface will be in contact with your skin. Wash boots the same as gloves.
4. **Respirators** require special care. Wash inside with a cloth, detergent, and warm water. Change filters according to instructions on the original container. Keep the respirator in a plastic bag, original container, or some other suitable container when it is not being used. Keep the respirator properly adjusted to your face. Filters and prefilters should be kept sealed in a plastic bag when not in use.
5. **Goggles** should be washed with a mild detergent so as not to scratch the lens.

Give all of your protective clothing and equipment the best of care. They may save your life.

Chemical Resistance

Many pesticide labels require the use of specific personal protective equipment (PPE) — clothing and devices that protect the body from contact with pesticides or pesticide residues. Some labels call for **chemical-resistant** PPE — items that the pesticide cannot pass through during the time it takes to complete the task. The labels of a few pesticides, such as some fumigants, prohibit the use of chemical-resistant PPE. Please refer to specific product labels for details.

Most chemical-resistant PPE items are plastic or rubber. But not all these materials are equally resistant to all pesticides and under all conditions.

Three factors affect a material's chemical resistance: the exposure time, the exposure situation, and the chemical properties of the pesticide product to which the material is exposed.

Unless the pesticide label directs otherwise, do not use items that are made of — or lined with — absorbent materials such as cotton, leather, or canvas. These materials are not chemical-resistant, and they are difficult or impossible to clean after a pesticide gets on them. Even dry formulations can move quickly through woven materials and may remain in the fibers.

Look for PPE items whose labels state that the materials have been tested using American Society for Testing Materials (ASTM) test methods for chemical resistance, such as test method F739-91. Footwear — and in most cases, gloves — should be at least **14 mils** thick.

Pesticides can leak through stitching holes and gaps in seams. For chemical resistance, PPE should have sealed seams.

Most waterproof materials are resistant to dry and to water-based pesticides.

Dry pesticides include dusts, granules, pellets, wettable powders, dry flowables (water-dispersible granules), microencapsulated products, soluble powders, and some baits. Water-based pesticides include soluble powders and some solutions.

The type of material that is resistant to non-water-based liquid pesticides depends on the contents of the formulation.

Liquid pesticides that are not water-based may be emulsifiable concentrates, ultra-low-volume and low-volume concentrates, flowables, aerosols, dormant oils, and invert emulsions. Common solvents are xylene, fuel oil, petroleum distillates, and alcohol.

Choosing Chemical-Resistant PPE

If PPE Materials or Chemical-Resistance Category are not Listed on Label.

If the pesticide label requires the use of chemical-resistant PPE but does not indicate the types of materials that are resistant to the product, select sturdy barrier-laminate, butyl, or nitrile materials. Then watch for signs that the material is not resistant to the product. If it is not, it may:

- Change color.
- Become soft or spongy.
- Swell or bubble.

- Dissolve or become jelly-like.
- Crack or develop holes.
- Become stiff or brittle.

If any of these changes occur, discard the item and choose another type of material for the task.

If PPE Materials or Chemical-Resistance Category are Listed on Label.

If the pesticide label specifies the PPE materials that **must** be worn when using the product, follow those instructions.

Some labels may list **examples** of PPE materials that are highly resistant to the product. The label may say, for example: “Wear chemical-resistant gloves, such as barrier laminate, butyl, nitrile, or viton.” You may choose PPE items made from any of the listed materials.

Pesticide labels sometimes specify a chemical-resistance category (A through H) for PPE to use when working with the product. This allows you to consult an EPA chemical-resistance chart (see below) for PPE material options.

Table 1.3 - EPA Chemical Resistance Category Selection Chart

For use when PPE section on pesticide label lists chemical resistance category

Selection Category Listed On Pesticide Label	Type Of Personal Protective Material							
	Barrier Laminate ≥ 14 mils	Butyl Rubber ≥ 14 mils	Nitrile Rubber ≥ 14 mils	Neoprene Rubber ≥ 14 mils	Natural Rubber ¹	Polyethylene	Polyvinyl Chloride (PVC) ≥ 14 mils	Viton ≥ 14 mils
A (dry and water-based formulations)	high	high	high	high	high	high	high	high
B	high	high	slight	slight	none	slight	slight	slight
C	high	high	high	high	moderate	moderate	high	high
D	high	high	moderate	moderate	none	none	none	slight
E	high	slight	high	high	slight	none	moderate	high
F	high	high	high	moderate	slight	none	slight	high
G	high	slight	slight	slight	none	none	none	high
H	high	slight	slight	slight	none	none	none	high

¹Includes natural rubber blends and laminates

HIGH: Highly chemical resistant. Clean or replace PPE at end of each day’s work period. Rinse off pesticides at rest breaks.

MODERATE: Moderately chemical resistant. Clean or replace PPE within an hour or two of contact.

SLIGHT: Slightly chemical resistant. Clean or replace PPE within ten minutes of contact.

NONE: No chemical resistance. Do not wear this type of material as PPE when contact is possible.

When choosing an appropriate material, consider the dexterity needed for the task and whether the material will withstand the physical demands of the task. The PPE will protect you if:

- the item is in good condition, and no punctures, tears, or abrasions allow pesticide to penetrate the material, and
- pesticide does not get inside the PPE through careless practices, such as allowing pesticide to run into gloves or footwear or putting the PPE on over already-contaminated hands or feet.

Highly Resistant PPE

A rating of **high** means that the material is highly resistant to pesticides in that category. PPE made of this type of material can be expected to protect you for an 8-hour work period. The outside of the PPE, especially gloves, should be washed at rest breaks — about once every 4 hours. Highly resistant PPE is a good choice when handling pesticides, especially concentrates, for long periods of time.

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Moderately Resistant PPE

A rating of **moderate** means that the material is moderately resistant to pesticides in that category. PPE made of this type of material can be expected to protect you for 1 or 2 hours. After that, replace the PPE with clean chemical-resistant PPE or thoroughly wash the outside of the PPE with soap and water. Moderately resistant PPE may be a good choice for pesticide handling tasks that last only a couple of hours.

Slightly Resistant PPE

A rating of **slight** means that the material is only slightly resistant to pesticides in that category. PPE made of this type of material can be expected to protect you for only a few minutes after exposure to the pesticide product. Slightly resistant PPE is not a good choice for most pesticide handling tasks.

Inexpensive disposable gloves or shoe covers, such as those made from polyethylene, may be useful for such brief tasks as:

- Adjusting contaminated parts of equipment.
- Unclogging or adjusting nozzles.
- Opening pesticide containers.
- Moving open pesticide containers or containers with pesticides on the outside.
- Handling contaminated PPE.
- Climbing in and out of cabs or cockpits where the outside of the equipment is contaminated.
- Operating closed systems.

These disposable PPE items should be used only once, for a very short-term task, and then discarded. At the end of the task, it is a good idea to wash the outside of the gloves or shoe covers first, and then remove them by turning them inside out. Discard them so they cannot be reused.

Table 1.4 - Tables of Weights and Measures

Weights:

28.35 grams = 1 ounce
16 ounces = 1 pound = 453.6 grams
1 pint of water = 1.04 pounds
1 gallon of water = 8.34 pounds
1000 micrograms = 1 milligram
1000 milligrams = 1 gram = 0.035 ounce avoirdupois
1000 grams = 1 kilogram = 2.2 pounds

Volume And Liquid Measure:

3 teaspoons = 1 tablespoon = 14.8 cubic centimeters (cc)
2 tablespoons = 1 fluid ounce = 29.6 cc
8 fluid ounces = 16 tablespoons = 1 cup = 236.6 cc = 1/2 pint
2 cups = 32 tablespoons = 1 pint = 473.1 cc = 16 fluid ounces
2 pints = 64 tablespoons = 1 quart = 946.2 cc = 0.946 liter
4 quarts = 256 tablespoons = 1 gallon = 3785 cc
1 gallon = 128 fluid ounces = 231 cubic inches = 3785 cc
1 milliliter (ml) = 1 cubic centimeter = 0.034 fluid ounces
1000 milliliters = 1 liter = approximately 1 quart, 1 fluid ounce
1 liter of water = 1 kilogram
1 bushel soil = 1.25 cubic feet

Land Measure:

43,560 square feet = 1 acre = 0.404 hectare
1 mile = 5280 feet = 1609.35 meters
10 millimeters = 1 centimeter = 0.3937 inches
100 centimeters = 1 meter = 39.37 inches

Length Of Row Required For One Acre:

Row Spacing	Length or Distance
24 inch	7260 yards = 21,780 feet
30 inch	5808 yards = 17,424 feet
36 inch	4840 yards = 14,520 feet
40 inch	4356 yards = 13,069 feet
42 inch	4149 yards = 12,446 feet
48 inch	3630 yards = 10,890 feet

Table 1.5 - Common Abbreviations For Pesticide Formulations

A	=	Aerosol	M	=	Microencapsulated
B	=	Bait	P	=	Pellet
C	=	Concentrate	RTU	=	Ready to Use
D	=	Dust	S	=	Solution
DF	=	Dry Flowable (see WDG)	SP	=	Soluble Powder
E or EC	=	Emulsifiable Concentrate	ULV	=	Ultra Low Volume
F	=	Flowable	W or WP	=	Wettable Powder
G	=	Granule	WDG	=	Water Dispersible Granule (see DF)
H/A	=	Harvest Aid	WS	=	Water Soluble
IE	=	Invert Emulsion	WSP	=	Water Soluble Packet
LC	=	Liquid Concentrate			

Calibration Tables And Information

Table 1.6 - Travel Speed Chart

Time Required in Seconds to Travel				
Miles per				
Hour	100 ft	200 ft	300 ft	
1	68	136	205	
2	34	68	102	
3	23	46	68	
4	17	34	51	
5	14	27	41	
6	11	23	34	
7	10	20	29	
8	9	17	26	
9	8	15	23	
10	7	14	21	

1 mph = 88 feet per minute

1 mph = 1.466 feet per second

Speed in mph = Number of 35-inch steps per minute/30

Table 1.7 - Equivalent Quantities of Liquid Materials (Emulsifiable Concentrates, Etc.) for Various Quantities of Water

Water	Quantity of Material					
100.0 gal ¹	0.5 pt	1.0 pt	2.0 pt	3.0 pt	4.0 pt ¹	5.0 pt
50.0 gal	4.0 fl oz	8.0 fl oz	1.0 pt	24.0 fl oz	1.0 qt	2.5 pt
5.0 gal	0.4 fl oz (2.5 tsp) ²	0.8 fl oz	1.6 fl oz	2.4 fl oz	3.2 fl oz	4.0 fl oz
1.0 gal ¹	0.08 fl oz (0.5 tsp) ²	0.16 fl oz (1.0 tsp) ²	0.32 fl oz (2.0 tsp) ²	0.48 fl oz (3.0 tsp) ²	0.64 fl oz ¹ (4.0 tsp) ²	0.8 fl oz (5.0 tsp) ²

¹Example: If 4 pints of a liquid concentrate is recommended to 100 gallons of water, approximately 4 teaspoonsful of the chemical to 1 gallon of water will give a mixture of approximately the same strength.

²Approximate figure.

Table 1.8 - Pounds of Active Ingredients per Gallon, Pounds per Pint of Liquid, and the Number of Pints for Various per Acre Rates

Pounds of Active ingredients in one gallon of commercial product	Pounds of active ingredients per pint ¹	Pints of commercial product needed each acre to give the following pounds of active ingredient					
		0.25 lb/A	0.50 lb/A	0.75 lb/A	1.0 lb/A	1.50 lb/A	2.0 lb/A
2.00	0.25	1.00	2.00	3.00	4.00	6.00	8.00
2.64	0.33	0.75	1.50	2.25	3.00	4.50	6.00
3.00	0.375	0.67	1.33	2.00	2.67	4.00	5.33
3.34	0.42	0.60	1.20	1.80	2.40	3.60	4.80
4.00	0.50	0.50	1.00	1.50	2.00	3.00	4.00
6.00	0.75	0.33	0.67	1.00	1.33	2.00	2.67

¹1 pint = 16 liquid ounces.

Table 1.9 - Available Commercial Materials in Pounds Active Ingredients per Gallon Necessary to Make Various Percentage Concentrate Solutions

Pounds of active ingredients in one gallon of commercial product	Pounds of active ingredients per pint ¹	Liquid ounces of commercial product per one gallon of solution to make:				
		1/2%	1%	2%	5%	10%
2.00	0.25	2.68	5.36	10.72	26.80	53.60
2.64	0.33	2.02	4.05	8.10	20.25	40.44
3.00	0.375	1.78	3.56	7.12	17.80	35.58
3.34	0.42	1.59	3.18	6.36	15.90	31.96
4.00	0.50	1.34	2.67	5.33	13.34	26.69
6.00	0.75	0.89	1.78	3.56	8.90	17.79

¹Based on 8.34 pounds per gallon (weight of water).

Table 1.10 - Converting Pounds Active Ingredients per Acre to Smaller Units for Small Plots

Liquid

Cubic centimeters (ml) per 100 square feet necessary to apply the following pounds of active ingredients per acre

lbs/gal	Concentrate lbs/A															
	1/8	1/4	1/2	3/4	1	2	3	4	5	6	7	8	9	10	11	12
8.00	0.14	0.27	0.54	0.81	1.08	2.16	3.24	4.32	5.40	6.48	7.56	8.64	9.72	10.80	11.88	12.96
7.00	0.16	0.31	0.62	0.93	1.24	2.48	3.72	4.96	6.20	7.44	8.68	9.92	11.16	12.40	13.64	14.88
6.66	0.16	0.33	0.65	0.99	1.30	2.60	3.91	5.21	6.51	7.80	9.10	10.40	11.70	13.03	14.30	15.60
6.00	0.18	0.36	0.72	1.10	1.45	2.89	4.34	5.78	7.23	8.70	10.15	11.60	13.05	14.46	15.95	17.40
5.00	0.22	0.44	0.87	1.31	1.74	3.47	5.21	6.94	8.68	10.44	12.18	13.92	15.66	17.35	19.14	20.88
4.00	0.27	0.54	1.09	1.64	2.17	4.34	6.51	8.68	10.85	13.02	15.19	17.36	19.53	21.69	23.87	26.04
3.33	0.33	0.65	1.31	1.97	2.61	5.21	7.82	10.42	13.03	15.66	18.27	20.88	23.49	26.06	28.71	31.32
3.00	0.36	0.72	1.45	2.16	2.89	5.78	8.67	11.56	14.45	17.34	20.23	23.12	26.01	28.90	31.79	34.68
2.50	0.43	0.87	1.74	2.61	3.47	6.94	10.41	13.88	17.36	20.82	24.29	27.76	31.12	34.71	38.17	41.64
2.00	0.54	1.09	2.17	3.25	4.34	8.68	13.01	17.35	21.69	26.04	30.38	34.72	39.06	43.38	47.74	52.08
1.00	1.08	2.17	4.34	6.51	8.68	17.35	26.03	34.71	43.39	52.08	60.76	69.44	78.12	86.76	95.48	104.16

Dry

Grams per 100 square feet necessary to apply the following pounds of active ingredient per acre

% Active ingredients	lbs										
	1/2	3/4	1	2	3	4	5	7.5	10	20	50
100.0	0.52	0.78	1.04	2.08	3.12	4.15	5.19	7.79	10.39	20.77	51.94
90.0	0.58	0.87	1.15	2.31	3.46	4.62	5.77	8.66	11.54	23.08	57.71
80.0	0.65	0.97	1.30	2.60	3.90	5.19	6.49	9.74	12.98	25.97	64.92
75.0	0.69	1.04	1.38	2.77	4.15	5.54	6.92	10.39	13.85	27.70	69.25
50.0	1.04	1.56	2.08	4.15	6.23	8.31	10.39	15.58	20.77	41.55	103.87
25.0	2.08	3.12	4.15	8.31	12.46	16.62	20.77	31.16	41.55	83.10	207.75
22.5	2.31	3.46	4.62	9.23	13.85	18.46	23.08	34.62	46.17	92.33	230.83
20.0	2.60	3.90	5.19	10.39	15.58	20.77	25.97	36.37	51.94	103.87	259.69
18.5	2.81	4.21	5.61	11.23	16.84	22.46	28.07	42.11	56.15	112.30	280.74
12.5	4.15	6.23	8.31	16.62	24.93	33.24	41.55	62.32	83.10	166.20	415.50
10.0	5.19	7.79	10.39	20.77	31.16	41.55	51.94	77.91	103.87	207.75	519.37
7.5	6.92	10.39	13.85	27.70	41.55	55.40	69.25	103.87	138.50	277.00	692.50
5.0	10.39	15.58	20.77	41.55	62.32	83.10	103.87	155.81	207.75	415.50	1038.74
4.0	12.98	19.48	25.97	51.94	77.91	103.87	129.84	194.76	259.69	519.37	1298.43
2.0	25.97	38.95	51.94	103.87	155.81	207.75	259.69	389.53	519.37	1038.74	2596.86
1.0	51.94	77.91	103.87	207.75	311.62	415.50	519.37	779.06	1038.74	2077.49	5193.72

Table 1.11 - Determination of Product Rate per Acre from Active Ingredient Rate

(Liquid Formulations)

Active Ingredient per gallon					
Active Rate lb/A	1.5 lb	2.0 lb	3.0 lb pt/A	4.0 lb	6.0 lb
0.25	1.33	1.0	0.83	0.5	0.33
0.5	2.67	2.0	1.33	1.0	0.67
1.0	5.33	4.0	2.67	2.0	1.33
2.0	10.67	8.0	5.33	4.0	2.67
3.0	16.00	12.0	8.00	6.0	4.00
4.0	21.33	16.0	10.67	8.0	5.50
5.0	27.00	20.0	13.33	10.0	6.67

Table 1.12 - Determination of Product Rate per Acre from Active Ingredient Rate

(Dry Formulations)

Percentage of Active Ingredient in Product										
Active Rate lb/A	5	10	20	25	50	65	70	75	80	90
	lb/A									
0.25	5.0	2.5	1.2	1.0	0.5	0.37	0.36	0.32	0.3	0.28
0.5	10.0	5.0	2.5	2.0	1.0	0.75	0.72	0.65	0.6	0.55
1.0	20.0	10.0	5.0	4.0	2.0	1.50	1.40	1.30	1.2	1.10
2.0	40.0	20.0	10.0	8.0	4.0	3.00	2.90	2.60	2.4	2.20
3.0	60.0	30.0	15.0	12.0	6.0	4.50	4.30	3.90	3.6	3.30
4.0	80.0	40.0	20.0	16.0	8.0	6.00	5.80	5.20	4.8	4.40
5.0	100.0	50.0	25.0	20.0	10.0	7.50	7.20	6.50	6.0	5.50

Calibration of Boom Sprayers

Be sure to calibrate your sprayer properly. NEVER exceed the labeled rate. Using too much pesticide is illegal and may injure your crop. Using too little may result in little or no pest control. Pressure, nozzle orifice size, spacing of nozzles, and speed all affect the application rate. Be sure that all of your spray equipment is in good working order and your sprayer is configured properly.

Large-area Method

1. Measure and stake off one acre (43,560 sq ft) in the field to be treated.
2. Fill sprayer tank with water.
3. Maintain constant pressure and speed while spraying the acre. Mark pressure, throttle, and gear settings.
4. Measure the amount of water used. The amount of water necessary to refill the tank is equal to gallons per acre applied.
5. Make up the spray solution with the correct amount of chemical, based on the amount of water applied per acre.
6. Make the application at pressure, throttle, and gear settings used in calibrating.

“Ounce” Method

1. Mark off a test course, based on the chart below.
(Measure nozzle spacing for booms; row spacing for directed and band rigs.)
2. Fill your tank half full (average weight). Set the throttle for spraying. Get a running start. Drive the test course three times while operating the equipment under field conditions. Record driving times (# of seconds) for each trial.
3. Calculate the average time in seconds required to drive the measured distance.
4. Run the equipment for the average time it took to drive the course, using the same settings (RPMs, pressure). Catch output during that time in a container marked in ounces. (If you are using a boom sprayer, catch the output from one nozzle. If you are using a directed/band rig, catch the spray from all nozzles per row for the prescribed time.)
5. Output in ounces = gallons per acre (GPA) applied.

Table 1.13 - “Ounce” Method Distances

Row Width or Nozzle Spacing (inches)	Distance (feet)	Row Width or Nozzle Spacing (inches)	Distance (feet)
48	85	30	136
46	89	28	146
44	93	24	170
42	97	20	204
40	102	18	227
38	107	15	272
36	113	10	408

This method works because the test course is 1/128th of an acre, and an ounce is 1/128th of a gallon — the proportions are the same.

A word of caution: Be sure to use the right nozzle (and pressure) for the job. Check ALL nozzles (or sets of nozzles, in the case of banding/directed applications) to be sure the pattern and output from each one (or each set) is the same. To check pattern, use a tray designed for this purpose or spray a hard surface and observe how the wetted area dries. Check output with a flow meter, or by catching the output from each for a short time (ex. 10 seconds). Replace any nozzles that do not match the pattern and flow rate of the one(s) you used in the calibration test.

For more information and/or for guidance on calibration methods for other types of equipment, contact your local Extension agent.

Chemical Information Chart

This section contains a chart listing commonly used pesticides (chemical name/trade name), their actions, their chemical resistance group number (FRAC for fungicides, IRAC for insecticides, and WSSA for herbicides), and signal word (based on acute toxicity rating).

This list is for information purposes only and is not meant to endorse or exclude any manufacturers or their products. The names are correct to the best of our knowledge. If mistakes were made, they were unintentional. Please notify the authors if corrections or additions are needed for the next edition.

Names

The common chemical name is the approved name given a pesticide by the American National Standards Committee. An active ingredient may have many trade names, given to a pesticide by the manufacturers/producers.

Action

The specific actions of the pesticides listed are abbreviated as follows:

F	- fungicide	M	- molluscicide
Fum	- fumigant	Mi	- miticide
H	- herbicide	N	- nematocide
HA	- harvest aid (defoliant)	PGR	- plant growth regulator
I	- insecticide	Rep	- repellent
IGR	- insect growth regulator		

Toxicity

Toxicity is the quality, state, or degree of being poisonous. The toxicities listed here are oral. Oral LD₅₀ (mg/kg) is the dosage in milligrams per kilogram of body weight required to kill 50 percent of test animals when given as a single dose by mouth. A milligram/kilogram (mg/kg) is equal to 1 part per million (1 lb in 500 tons). The lower the LD₅₀, the higher the toxicity. Dermal LD₅₀ ratings are in most cases higher (lower in toxicity) than oral ratings.

When registering pesticides, the Environmental Protection Agency (EPA) uses acute LD₅₀ values based on the pesticide formulation as it is sold, to determine the toxicity category, words, and symbols that must be placed on the label. For this purpose the test animals are usually mice, rats, or rabbits. The letters LD stand for lethal dose.

Table 1.14 - Toxicity Categories

Toxicity Category	Signal Words* Required on Label by EPA	Oral LD ₅₀ (mg/kg)	Probable Lethal Adult Human Dose
I Highly Toxic	DANGER and POISON, plus skull and crossbones symbol	0 to 50	A few drops to 1 teaspoon
II Moderately Toxic	WARNING	50 to 500	1 teaspoon to 2 teaspoons
III Slightly Toxic	CAUTION	500 to 5,000	1 ounce to 1 pint (1 pound)
IV Almost non-toxic	CAUTION	more than 5,000	1 pint (1 pound)

***Please note:** certain products may use signal words which do not correlate with LD₅₀ ratings due to some special property of the chemical. For example, chlorothalonil has a very low toxicity (LD₅₀ 10,000 mg/kg) yet has DANGER and WARNING signal words on many of its formulations, due to a possibility of an extreme allergic reaction in some people. Also, toxicity (LD₅₀) is relative to the concentration of active ingredient in question and the body weight of the victim.

To find the LD₅₀ for a specific pesticide product – which takes into account the toxicity of the active ingredients, its concentration, and all other components in the formulation – consult the MSDS. Remember that, if misused, any pesticide can be highly toxic to humans, domestic animals, and wildlife.

Restricted-Use Pesticides

Products that are restricted usually have a higher toxicity, concentration, or other property which makes them more hazardous than products which are designated for general use. Refer to the product label as a guide. Applicators must be certified to use or purchase restricted-use pesticides. Contact your local Extension agent for information on how to become a certified applicator.

Table 1.15 - Chemical Information Chart

Common Name or Designation	Examples of Trade Names (¹=restricted use, ²=premix product with multiple active ingredients)	Action	Resistance Group	Signal Word (may vary depending on formulation and/or concentration of active ingredient)
2,4-D	various	H	WSSA-4	Caution-Danger
2,4-DB	various	H	WSSA-4	Danger
abamectin	Agri-Mek¹, Avid¹	I, Mi, N	IRAC-6	Warning-Danger (Poison)
acephate	Orthene	I	IRAC-1	Caution-Danger

Table 1.15 - Chemical Information Chart (cont.)

Common Name or Designation	Examples of Trade Names (¹ =restricted use, ² =premix product with multiple active ingredients)	Action	Resistance Group	Signal Word (may vary depending on formulation and/or concentration of active ingredient)
acetamiprid	Assail	I	IRAC-4	Caution
acetochlor	Breakfree NXT, Harness, Keystone NXT ^{1,2} , Surpass NXT, SureStart ² , Warrant	H	WSSA-15	Caution-Warning
acifluorfen	Ultra Blazer, Storm ²	H	WSSA-14	Danger
aldicarb	AgLogic ¹	I, Mi, N	IRAC-1	Danger (Poison)
ametryn	Evik	H	WSSA-5	Caution
aminopyralid	Milestone	H	WSSA-4	Caution
atrazine	Atrazine ¹ , Bicep II Magnum ^{1,2} , Keystone NXT ^{1,2} , Lexar ^{1,2} , Lumax ^{1,2}	H	WSSA-5	Caution
avermectin	XP 820	I	IRAC-6	Caution
azadirachtin	Azera ²	I, IGR, Rep	-	Warning
azoxystrobin	Abound, Affiance ² , Custodia ² , Dynasty, Elatus ² , Quadris, Quilt Xcel ² , Trivapro ²	F	FRAC-11	Caution-Warning
<i>Bacillus cereus</i>	Pix Plus ²	PGR	-	Caution
<i>Bacillus firmus</i>	Poncho Votivo ²	I	-	Caution
<i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	DiPel	I	IRAC-11	Caution
benefin (benfluralin)	Balan	H	WSSA-3	Warning
bensulide	Prefar	H	WSSA-8	Caution
bentazon	Basagran	H	WSSA-6	Caution-Danger
benzovindiflupyr	Elatus ² , Trivapro ²	F	FRAC-7	Caution
bifenthrin	Bifenture ¹ , Brigade ¹ , Capture ¹ , Elevest ^{1,2} , Hero ^{1,2} , Steed ^{1,2}	I	IRAC-3	Caution-Warning
boscalid	Endura	F	FRAC-7	Warning
broflanilide	Cimegra, Nurizma, Teraxxa	I	IRAC-30	Caution
bromoxynil	Huskie ² , Maestro	H	WSSA-6	Warning
<i>Burkholderia</i> sp.	BioST	I, N	-	Caution
captan	Captan	F	FRAC-M4	Danger
carbaryl	Sevin	I	IRAC-1A	Caution
carboxin	Rancona ² , Vitavax	F	FRAC-7	Caution
carfentrazone-ethyl	Aim	H	WSSA-14	Caution
chlorantraniliprole	Besiege ^{1,2} , Coragen, Elevest ^{1,2} , Prevathon	I	IRAC-28	Caution-Warning
chlorimuron ethyl	Canopy ² , Classic	H	WSSA-2	Caution
chloropicrin	Pic-Clor ¹ , Tri-Pic ¹	Fum	-	Danger (Poison)
chlorothalonil	Bravo, Echo	F	FRAC-M5	Caution-Danger
chlorsulfuron	Glean	H	WSSA-2	Caution
chlorthal-dimethyl (DCPA)	Dacthal	H	WSSA-3	Caution

Table 1.15 - Chemical Information Chart (cont.)

Common Name or Designation	Examples of Trade Names (¹=restricted use, ²=premix product with multiple active ingredients)	Action	Resistance Group	Signal Word (may vary depending on formulation and/or concentration of active ingredient)
clethodim	Select	H	WSSA-1	Caution
clomazone	Command	H	WSSA-13	Caution
clopyralid	Stinger, SureStart ²	H	WSSA-4	Caution-Warning
clothianidin	Belay, Inovate ² , NipsIt, Poncho 600, Poncho Votivo ²	I	IRAC-4	Caution
coumaphos	Co-Ral, Corathon ²	I	IRAC-1	Caution-Warning
cyclanilide	Finish ² , Stance ² , Terminate ²	PGR	-	Caution-Danger
cycloate	Ro-Neet	H	WSSA-8	Caution
cyfluthrin	Tombstone ¹	I	IRAC-3	Warning-Danger
(beta-) cyfluthrin	Baythroid ¹ , Leverage 360 ¹	I	IRAC-3	Caution-Warning
(gamma-) cyhalothrin	Cobalt ^{1,2}	I	IRAC-3	Danger
(lambda-) cyhalothrin	Besiege ^{1,2} , Cobalt Advanced ^{1,2} , Endigo ^{1,2} , Warrior II ¹	I	IRAC-3	Warning-Danger
cypermethrin	Bite Free ² , Tri-Tec ² , UltraShield Red ²	I	IRAC-3	Caution
(zeta-) cypermethrin	Hero ^{1,2} , Mustang Maxx ¹ , Stallion ^{1,2} , Steed ^{1,2}	I	IRAC-3	Caution-Warning
cyproconazole	Alto, Approach Prima ²	F	FRAC-3	Caution
cyromazine	Flynexx, Flyzine, Larvadex	IGR	-	Caution
DCPA	see chlorthal-dimethyl			
dazomet	Basamid ¹	Fum	-	Danger (Poison)
deltamethrin	DeltaGard	I	IRAC-3	Caution
diazinon	Corathon ² , Optimizer	I	IRAC-1	Caution
dicamba	Banvel, Clarity, Status ²	H	WSSA-4	Caution
dichlobenil	Casoron	H	WSSA-20	Caution
(1,3-) dichloropropene	Telone II ¹	Fum	-	Warning
dichlorvos	Vapona	I	IRAC-1	Caution-Danger (Poison)
diclofop-methyl	Hoelon ¹	H	WSSA-1	Danger
diclosulam	Strongarm	H	WSSA-2	Caution
dicrotophos	Bidrin ¹	I	IRAC-1	Danger (Poison)
difenoconazole	Quadris Top ² , Warden ²	F	FRAC-3	Caution
diflubenzuron	various	IGR	IRAC-15	Caution
diflufenzopyr-sodium	Status ²	H	WSSA-19	Caution
dimethenamid-P	Outlook	H	WSSA-15	Warning
dimethoate	Dimethoate	I, Mi	IRAC-1	Caution-Warning
dinotefuran	Venom	I	IRAC-4	Caution
diquat dibromide	Reglone	H	WSSA-22	Caution
diuron	Direx, Karmex	H	WSSA-7	Caution
endothall	Aquathol	H	-	Danger
EPTC	Eptam	H	WSSA-8	Warning
esfenvalerate	Asana ¹	I	IRAC-3	Warning

Table 1.15 - Chemical Information Chart (cont.)

Common Name or Designation	Examples of Trade Names (¹=restricted use, ²=premix product with multiple active ingredients)	Action	Resistance Group	Signal Word (may vary depending on formulation and/or concentration of active ingredient)
ethaboxam	Intego	F	FRAC-22	Caution
ethalfluralin	Curbit, Sonalan	H	WSSA-3	Danger
ethephon	CottonQuick ² , Ethephon, Finish, Super Boll	PGR	-	Danger
etoxazole	Zeal	I, Mi	IRAC-10	Caution
fenoxaprop-p-ethyl	Tacoma	H	WSSA-1	Warning
fenpropathrin	Danitol ¹	I, Mi	IRAC-3	Warning
florasulam	Orion ² , Quelex ²	H	WSSA-2	Caution
fluazifop-p-butyl	Fusilade	H	WSSA-1	Caution
fluazinam	Omega	F	FRAC-29	Warning
flucarbazone-sodium	Everest	H	WSSA-2	Caution
fludioxonil	Apron Maxx ² , Cruiser Maxx ² , Maxim, Warden ²	F	FRAC-12	Caution
flufenacet	Axiom ²	H	WSSA-15	Caution
flumetsulam	SureStart ²	H	WSSA-2	Caution-Warning
flumiclorac-pentyl	Resource	H	WSSA-14	Warning
flumioxazin	Chateau, Valor	H	WSSA-14	Caution
fluometuron	Cotoran	H	WSSA-13	Caution
fluopyram	Ilevo, Propulse ² , Velum	F	FRAC-7	Caution
fluoxastrobin	Aftershock, Evito, Fortix ² , Preemptor ²	F	FRAC-11	Caution-Warning
flupyradifurone	Sivanto	I	IRAC-4	Caution
fluridone	Brake	H	WSSA-12	Danger
fluroxypyr	Stranixa Ultra, Vista	H	WSSA-4	Warning
fluthiacet-methyl	Cadet	H	WSSA-14	Warning
flutolanil	Artisan ²	F	FRAC-7	Caution
flutriafol	Fortix ² , Preemptor ² , TopGuard	F	FRAC-3	Caution
fluxapyroxad	Acceleron, Nexicor ² , Priaxor ²	F	FRAC-7	Caution
fomesafen-sodium	Flexstar, Prefix ² , Reflex	H	WSSA-14	Warning-Danger
fosamine-ammonium	Krenite	H	WSSA-27	Caution
gardona	see tetrachlorvinphos			
glufosinate-ammonium	Finale, Liberty, Rely	H	WSSA-10	Warning
glyphosate	Extreme ² , Halex ² , Roundup	H	WSSA-9	Caution-Warning
halauxifen-methyl	Elevore, Quelex ²	H	WSSA-4	Caution
halosulfuron-methyl	Permit, Sandea	H	WSSA-2	Caution-Warning
hexazinone	Velpar	H	WSSA-5	Danger
imazamox	Beyond, Raptor	H	WSSA-2	Caution
imazapic	Plateau	H	WSSA-2	Caution
imazapyr	Arsenal	H	WSSA-2	Caution
imazaquin	Scepter	H	WSSA-2	Caution

Table 1.15 - Chemical Information Chart (cont.)

Common Name or Designation	Examples of Trade Names (¹ =restricted use, ² =premix product with multiple active ingredients)	Action	Resistance Group	Signal Word (may vary depending on formulation and/or concentration of active ingredient)
imazethapyr	Extreme ² , Pursuit	H	WSSA-2	Caution-Warning
imazosulfuron	League	H	WSSA-2	Caution
imidacloprid	Admire Pro, Gaucho 600, Leverage 360 ^{1,2} , Velum Total ²	I	IRAC-4	Caution
indaziflam	Alion	H	WSSA-29	Caution
indoxacarb	Steward	I	IRAC-22	Caution
iodosulfuron	Autumn	H	WSSA-2	Caution
ipconazole	Inovate ² , Rancona	F	FRAC-3	Caution
isoxaben	Gallery	H	WSSA-21	Caution
isoxaflutole	Balance ¹ , Corvus ^{1,2}	H	WSSA-27	Caution
lactofen	Cobra, Phoenix	H	WSSA-14	Caution-Danger
linuron	Lorox	H	WSSA-7	Caution
malathion	Malathion	I	IRAC-1	Caution-Warning
mancozeb	Koverall	F	FRAC-M3	Caution
MCPA	MCPA, Orion ²	H	WSSA-4	Caution-Danger
mefenoxam	see metalaxyl-M			
mepiquat chloride	Mepex, Pix, Stance ²	PGR	-	Caution
mepiquat pentaborate	Pentia	PGR	-	Caution
mesosulfuron-methyl	Osprey	H	WSSA-2	Caution
mesotrione	Callisto, Halex ² , Lexar ^{1,2} , Lumax ^{1,2}	H	WSSA-27	Caution
metalaxyl-M (mefenoxam)	Apron, Allegiance, Cruiser Maxx ² , EverGol Energy ² , Inovate ² , Rancona ² , Ridomil Gold, Warden ²	F	FRAC-4	Caution-Warning
metaldehyde	Deadline	M	-	Caution
metam-sodium	Metam ¹ , Sectagon ¹ , Vapam ¹	Fum	-	Danger (Poison)
metconazole	Caramba, Headline AMP ² , Quash, TwinLine ²	F	FRAC-3	Caution-Warning
methomyl	Lannate ¹ , Nudrin ¹	I	IRAC-1	Danger (Poison)
(S-) methoprene	Extinguish	IGR	IRAC-7	Caution
methoxyfenozide	Intrepid	I	IRAC-18	Caution
(S-) metolachlor	Bicep II Magnum ^{1,2} , Boundary ² , Cinch, Dual Magnum, Halex ² , Lexar ^{1,2} , Lumax ^{1,2} , Prefix ²	H	WSSA-15	Caution-Warning
metribuzin	Axiom ² , Boundary ² , Canopy ² , Glory, Metribuzin, Tricor	H	WSSA-5	Caution-Warning
metsulfuron-methyl	Cimarron (Max Part A)	H	WSSA-2	Caution
MSMA	Drexel, Target	H	WSSA-17	Caution
myclobutanil	Laredo	F	FRAC-3	Caution
naled	Dibrom ¹	I	IRAC-1	Danger
napropamide	Devrinol	H	WSSA-15	Caution
nicosulfuron	Accent, Primero, Steadfast ²	H	WSSA-2	Caution

Table 1.15 - Chemical Information Chart (cont.)

Common Name or Designation	Examples of Trade Names (¹ =restricted use, ² =premix product with multiple active ingredients)	Action	Resistance Group	Signal Word (may vary depending on formulation and/or concentration of active ingredient)
norflurazon	Solicam	H	WSSA-12	Caution
oryzalin	Surflan	H	WSSA-3	Caution
oxadiazon	Ronstar	H	WSSA-14	Caution-Warning
oxamyl	Vydate ¹	I, N	IRAC-1	Danger (Poison)
oxyfluorfen	Goal, GoalTender	H	WSSA-14	Caution- Warning
paraquat	Gramoxone ¹	H	WSSA-22	Danger (Poison)
Pasteuria nishizawae	Clariva	N	-	Caution
pendimethalin	Pendulum, Prowl	H	WSSA-3	Caution
penflufen	EverGol	F	FRAC-7	Caution
penthiopyrad	Fontelis	F	FRAC-7	Caution
permethrin	Perm-Up ¹	I	IRAC-3	Caution
phenmedipham	Spin-Aid ¹	H	WSSA-5	Danger
phorate	Thimet ¹	I	IRAC-1	Danger (Poison)
phosmet	Imidan	I	IRAC-1	Warning
picloram	Tordon ¹	H	WSSA-4	Caution
picoxystrobin	Approach	F	FRAC-11	Caution
pinoxaden	Axial, Pina	H	WSSA-1	Caution-Warning
piperonyl butoxide	(used as a pesticide synergist)			
pirimiphos-methyl	Dominator, Double Barrel	I	IRAC-1	Danger
potassium salts of phosphorous acid	various	F	FRAC-P7	Caution
primisulfuron-methyl	Beacon	H	WSSA-2	Caution
prodiamine	Barricade	H	WSSA-3	Caution
prometon	Pramitol	H	WSSA-5	Caution-Warning
prometryn	Caparol	H	WSSA-5	Caution
pronamide	Kerb ¹	H	WSSA-3	Caution
propargite	Comite ¹ , Omite ¹	Mi	IRAC-12	Danger
propiconazole	Artisan ² , Nexicor ² , QuiltXcel ² , Stratego ² , Tilt, Trivapro ²	F	FRAC-3	Caution-Warning
prosulfuron	Peak	H	WSSA-2	Caution
prothioconazole	Delaro ² , EverGol Energy ² , Proline, Propulse ² , Prosaro ² , Provost ² , Stratego ²	F	FRAC-3	Caution
pydiflumetofen	Miravis	F	FRAC-7	Caution-Warning
pyraclostrobin	Headline AMP ² , Nexicor ² , Priaxor ² , TwinLine ²	F	FRAC-11	Caution-Warning
pyraflufen-ethyl	ET, Venue	H, HA	WSSA-14	Caution-Danger
pyrasulfotole	Huskie ²	H	WSSA-27	Warning
pyrethrins	Azera ² , Bite Free ² , Tri-Tec ² , UltraShield Red ²	I	IRAC-3	Caution-Warning
pyrithiobac-sodium	Staple	H	WSSA-2	Caution

Table 1.15 - Chemical Information Chart (cont.)

Common Name or Designation	Examples of Trade Names (¹=restricted use, ²=premix product with multiple active ingredients)	Action	Resistance Group	Signal Word (may vary depending on formulation and/or concentration of active ingredient)
pyroxasulfone	Anthem, Zidua	H	WSSA-15	Caution
pyroxsulam	PowerFlex	H	WSSA-2	Caution
quinclorac	Facet L	H	WSSA-4, WSSA-26	Caution
quizalofop-p-ethyl	Assure II, Targa	H	WSSA-1	Danger
rimsulfuron	Matrix, Resolve, Steadfast ²	H	WSSA-2	Caution
saflufenacil	Kixor, Sharpen	H	WSSA-14	Caution
sedaxane	Cruiser Maxx Vibrance ² , Vibrance, Warden ²	F	WSSA-7	Caution
sethoxydim	Poast	H	WSSA-1	Caution-Warning
simazine	Princep	H	WSSA-5	Caution
sodium bentazon	Basagran, Storm ²	H	WSSA-6	Caution-Danger
sodium chlorate	Defol	H	-	Caution
spinetoram	Intrepid Edge ² , Radiant	I	IRAC-5	Caution
spinosad	Blackhawk, Tracer	I	IRAC-5	Caution
spiromesifen	Oberon	I, Mi	IRAC-23	Caution
sulfentrazone	Authority ² , Spartan	H	WSSA-14	Caution
sulfosulfuron	Cryder	H	WSSA-2	Caution
sulfoxaflor	Transform	I	IRAC-4	Danger
tebuconazole	Absolute ² , Custodia ² , Prosaro ² , Provost ²	F	FRAC-3	Caution-Warning
tebuthiuron	Spike	H	WSSA-7	Caution
tefluthrin	Force ¹	I	IRAC-3	Caution-Danger
tembotrione	Capreno ² , Laudis	H	WSSA-27	Caution
terbufos	Counter ¹	I, N	IRAC-1	Danger (Poison)
tetrachlorvinphos (gardona)	Rabon	I	IRAC-1	Caution
tetraconazole	Affiance ² , Eminent, Priaxor D ²	F	FRAC-3	Caution
tetramethrin	UltraShield Red ²	I	IRAC-3	Caution
thiabendazole	Mertect	F	FRAC-1	Caution
thiamethoxam	Avicta Duo ^{1,2} , Centric, Cruiser Maxx ² , Endigo ^{1,2} , Warden ²	I	IRAC-4	Caution-Warning
thiencarbazone-methyl	Autumn Super ² , Capreno ² , Corvus ^{1,2}	H	WSSA-2	Caution
thidiazuron	Adios ² , Cutout ² , Detach Ultra	HA	-	Caution-Danger
thifensulfuron-methyl	Harmony, Resolve Q ²	H	WSSA-2	Caution
thiodicarb	Aeris ^{1,2}	I, N	IRAC-1	Caution
thiophanate-methyl	Topsin-M	F	FRAC-1	Caution
thiram	Spotrete, Thiram	F	FRAC-M3	Caution
topramezone	Armezon, Impact	H	WSSA-27	Caution
tribenuron-methyl	Canopy ² , Express	H	WSSA-2	Caution
triclopyr	Crossbow, Garlon, Remedy Ultra	H	WSSA-4	Caution-Danger

Table 1.15 - Chemical Information Chart (cont.)

Common Name or Designation	Examples of Trade Names (¹=restricted use, ²=premix product with multiple active ingredients)	Action	Resistance Group	Signal Word (may vary depending on formulation and/or concentration of active ingredient)
trifloxystrobin	Absolute ² , Delaro ² , EverGol Xtend ² , Stratego ² , Trilex	F	FRAC-11	Caution-Warning
trifloxysulfuron-sodium	Envoke	H	WSSA-2	Caution
trifluralin	Treflan	H	WSSA-3	Caution
triflusulfuron	Upbeet	H	WSSA-2	Caution
triticonazole	Teraxxa F4 ²	F	FRAC-3	Caution

Protecting Honey Bees

James Wilson, Extension Apiculturist, Virginia Tech Department of Entomology

Honey bees are a valuable service to apiculture and agriculture not only because they produce honey and beeswax, but they are the most important pollinators of cultivated crops. Pesticide poisoning of honey bees, and other beneficial insects, can be a serious problem. Every effort should be made to minimize the exposure of honey bees to pesticides in treated areas.

Bees in Field Crops

The United States Department of Agriculture has developed a list of agricultural crops attractive to bees. If you are unsure of the risk that your crop system might have to bees, please use this USDA guide to help you determine how likely bees will be in your crops. Exposure is one of the two main components of risk, the other being toxicity of the compound in question. Additionally, while we list pesticides by toxicity and relative harm to honey bees below, the University of California IPM Center houses a searchable database with precautionary rankings. Virginia Cooperative Extension is proud to announce that we have become members of the Honey Bee Health Coalition (HBHC after this). The HBHC is “to collaboratively implement solutions that will help to achieve a healthy population of honey bees and other pollinators in the context of productive agricultural systems and thriving ecosystems.” We believe that being members of this organization will help to protect our pollinators in Virginia through access to, and continued development of, critical resources like those developed with commodity and stakeholder groups. Specifically, users of this guide may benefit from the soybean, corn, and canola best management guides. These focus on pollinator management in production systems and were developed with their respective commodity boards. The guides are free for download and distribution. Please see the below table for links to each of the resources mentioned above.

Online resources for pollinator protection information.

Best Management Practices in order of acreage in VA from greatest to least.

Resource	Web Link
USDA “Attractiveness of Agricultural Crops to Pollinating Bees for the Collection of Nectar and/or Pollen”	https://www.usda.gov/sites/default/files/documents/Attractiveness-of-Agriculture-Crops-to-Pollinating-Bees-Report-FINAL-Web-Version-Jan-3-2018.pdf
University of California IPM Program’s Bee Precaution Pesticide Ratings	https://ipm.ucanr.edu/bee-precaution-pesticide-ratings/
The Honey Bee Health Coalition (HBHC) Resources	https://honeybeehealthcoalition.org/resource_category/best-management-practices/
HBHC Soybean Best Management Practices	https://honeybeehealthcoalition.org/resources/soybean-best-management-practices/
HBHC Corn Best Management Practices	https://honeybeehealthcoalition.org/resources/corn-best-management-practices/
HBHC Canola Best Management Practices	https://honeybeehealthcoalition.org/resources/canola-best-management-practices/

An Updated Note on Protecting Pollinators in Virginia

Federal guidelines mandate that each state develop a plan for the mitigation of pesticide exposure to managed pollinators in their own state. The plan is known as the “Voluntary Plan to Mitigate the Risk of Pesticides to Managed Pollinators” and was finalized in May of 2017.

This voluntary plan encourages an increase in communication between pesticide applicators and the managers of pollinators to reduce the potential for damaging pesticide exposure. Since this plan is voluntary there are additional guiding documents for most involved stakeholders, see table below for links. This plan has been adopted by the Commonwealth of Virginia and can be found in its entirety at the 1st link provided below. Virginia is using the Bee Check tool for beekeepers, and the Field Check tool for applicators to help reduce pesticide exposure risk (the respective sign-up links are below). Questions and comments should be directed to VDACS with the contact information given below.

Virginia’s Voluntary Plan to Mitigate the Risk of Pesticides to Managed Pollinators

Link: <http://www.vdacs.virginia.gov/pdf/BMP-plan.pdf>

Beekeepers can sign up for the Bee Check Program at: <https://beecheck.org/signup#beekeeper>

Applicators can sign up for the Field Program at: <https://driftwatch.org/signup#applicator>

Best Management Practices:

Stake Holder Category	VDACS Recommended Best Management Practices
Beekeepers	https://www.vdacs.virginia.gov/pdf/BMP-Beekeeper.pdf
Commercial Ag. Applicators	https://www.vdacs.virginia.gov/pdf/BMP-Ag-Commercial-Applicator.pdf
Agricultural Producers	https://www.vdacs.virginia.gov/pdf/BMP-Ag-Producer.pdf
Structural Pest Management	https://www.vdacs.virginia.gov/pdf/BMP-Structural-Pest-Management.pdf
Horticultural Production	https://www.vdacs.virginia.gov/pdf/BMP-Horticultural-Industry.pdf

VDACS Contact Point:

Liza Fleeson Trossbach, Program Manager
Office of Pesticide Services
liza.fleeson@vdacs.virginia.gov
804.371.6559

Keith Tignor, State Apiarist
Office of Plant Industry Services
keith.tignor@vdacs.virginia.gov
804.786.3515

Causes of Honey Bee Poisoning

1. The majority of honey bee poisoning occurs when pesticides are applied to crops in bloom. This includes crop plants such as sweet corn, which is routinely sprayed when in tassel. Honey bees do not pollinate corn; however, they will collect pollen from corn tassels and transport it back to the honey bee hive.
2. The application of pesticides to fields with weeds in bloom. The spring application of pesticides to alfalfa fields with flowering weeds is a particular problem in Virginia.
3. The drift of toxic sprays or dusts to adjoining crops or weeds in bloom.
4. The contamination of flowering ground-cover crops in orchards treated with pesticides.
5. The contamination of water or dew on foliage and flowers. This includes the water collected by honey bees for drinking and cooling the honey bee hive.
6. The application of systemic pesticides and the potential contamination of nectar and pollen collected by foraging honey bees. The use of neonicotinoid pesticides (e.g., clothianidin, imidacloprid, and thiamethoxam) is a concern for honey bee poisoning; although, there is a need for more research evidence.

The most serious poisonings result with honey bees that collect pesticide-contaminated pollen or nectar and transport these materials to the honey bee hive. Pesticide dusts (e.g., Sevin) and encapsulated pesticides are especially dangerous. These pesticides can adhere to foraging honey bees, be transported to the hive, and stored for long periods of time. Such pesticides may cause honey bee mortality in the hive for several months.


Ways to Reduce Honey Bee Poisoning

1. Contact beekeepers with honey bee hives near areas to be treated with pesticides that are hazardous to honey bees.
2. Do not apply pesticides that are toxic to honey bees on crops in bloom.
3. Use pesticides that are less toxic to honey bees when such choices are consistent with pest control recommendations (e.g., see table of relative pesticide toxicities).
4. Choose the least hazardous pesticide formulations when possible. Pesticide dusts and encapsulations are more toxic than sprays of the same material. Pesticides applied as wettable powder sprays tend to have longer residual effects (and are more toxic) than the emulsifiable concentrate sprays. Granular applications of pesticides are typically the safest method of treatment in areas with honey bee hives.
5. Avoid drift of toxic pesticide sprays onto ground-cover plants, weeds, and crops in nearby fields.
6. Control weeds in fields and avoid direct pesticide applications to flowering weeds when possible. Mow before pesticide application, if orchards have ground-cover plants in bloom.
7. Apply pesticides in the late evening or early morning when honey bees are not actively foraging. This is important with crops such as corn, since pollen is released in the morning. The evening application of pesticides to such crops are less hazardous and will reduce the unintentional poisoning of honey bees..
8. Do not apply pesticides if temperatures are expected to be unusually low following pesticide treatment. Pesticide residues can remain toxic to honey bees for longer periods of time under low temperature conditions.
9. Avoid the direct application of pesticides over honey bee hives.
10. Allow beekeepers an option to move or confine honey bee hives that are near areas to be treated with pesticides, if there is a potential for honey bee loss.




PROTECT POLLINATORS READ PESTICIDE LABELS



Four steps to reading a pesticide label to reduce risk to pollinating insects



1. OPEN THE LABEL.
STEP 1 - See if product is toxic and has more than 8 hour residual contact toxicity in the **ENVIRONMENTAL HAZARDS** statement.
STEP 2 - Look for general and crop-specific directions under **DIRECTIONS FOR USE.**



2. BEE TOXIC PESTICIDES will be indicated by the phrase **"TOXIC"** or **"HIGHLY TOXIC TO BEES"**. If toxic:


→


don't spray when in bloom wait until over 80% of petals fall

ENVIRONMENTAL HAZARDS

This pesticide is toxic to mammals, birds, fish and aquatic invertebrates.

This product is **highly toxic** to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops if bees are **actively foraging** the treatment area.

DIRECTIONS FOR USE

Protection of Pollinators
APPLICATION RESTRICTIONS EXIST FOR THIS PRODUCT BECAUSE OF RISK TO BEES AND OTHER POLLINATING INSECTS.

Tree Nuts (Crop Group 14-12)	
Post	10(a)(c)(v)
Apply:	0.75 - 1.5 (0.023 - 0.047 lb/a/cv)
Can-Rate Scale:	2.75 - 10.00 lb/a/cv

Advisory Pollinator Statement: Foraging honeybees collect 1 min of the treatment and 48 hours before the product is applied. The RT25 for this product is less than or equal to 0 hours.

Restrictions:
Do not apply this product any time between 3 days after to bloom and until petals fall.

3. Some bee-toxic pesticides BREAK DOWN IN A FEW HOURS. Learn if these pesticides can be applied at bloom in the evening:

1. "FORAGING" or "VISITING" = remains toxic for more than 8 hours. **DON'T APPLY TO FLOWERING PLANTS!**

2. "ACTIVELY FORAGING" or "ACTIVELY VISITING" = remains toxic for less than 8 hours **ONLY APPLY IN THE EVENING WHEN BEES ARE NOT ACTIVE!**

4. GENERAL AND CROP-SPECIFIC USE DIRECTIONS
Newer labels have **additional precautions** for using products around honey bees. Here you will find what practices to follow to keep bees safe and/or **restrictions around whether a pesticide can be applied around crop bloom time.** Instructions **may apply to all crops, or include crop-specific restrictions.** The label may also specify a value **RT25**, a measure of the time that field weathered residues remain toxic to bees on contact with foliage.

www.pollinator.org/pesticide-education

Graphic by Iris Korminn and Andony Melathopoulos - Oregon State University; Rose Kachadoorian and Gilbert Uribe - Oregon Department of Agriculture
Text on reverse of card by the NAPPC Pollinator Health Task Force

MINIMIZING PESTICIDE EXPOSURE TO BEES

Understanding pesticide label information on the hazard and risks of bees is an important first step to protecting bees. Insecticides and some fungicides are of concern for bees. Here are a few actions to help minimize pesticide exposure to bees while managing pests and diseases.

- 1. Avoid sprays during bloom when possible.** Bees face the highest exposure when pesticides are applied to the bloom of bee-attractive crops and weeds. When possible, use sprays before bloom to control pests and diseases to reduce the need for treatments at bloom.
- 2. If you must treat during bloom, choose products carefully and apply in the evening.** Choose insecticides that are not labeled as 'Toxic' or 'Highly Toxic' to bees (front of card, Point 2). Avoid insecticides where residues remain toxic to bees for longer than 8 hours (Point 3). Always look to the Directions for Use for more specific information on when a product can be applied at reduced risk to bees (Point 4)
- 3. Cooperate and communicate with beekeepers in a timely manner.** Contact beekeepers at least 48 hours prior to applying insecticides or fungicides to blooming bee-attractive crops. The beekeeper may choose to cover or move colonies, or may leave colonies in place depending on the toxicity of the product being sprayed.
- 4. Avoid spraying bee colonies and bee habitat.** Avoid placing bees directly in the crop. In cases where colonies can only be set in the crop, turn sprayers off as you pass over the colonies. Reduce drift onto adjacent flowering habitat by using coarser droplet sizes, drift reducing agent, or intelligent sprayer technology.
- 5. Mow blooming weeds.** If there are bee-attractive blooming weeds (e.g., mustard, clover or dandelion), mow them before spraying.
- 6. Review Pollinator Protection Plans and use IPM.** Many states and industries provide information on how to protect bees and other pollinators. Contact your Department of Agriculture to obtain these plans. Integrated Pest Management (IPM) can also reduce bee pesticide exposure. Contact your regional IPM Center for details.
- 7. Report pesticide incidents with bees.** Let EPA know as soon as you think bees have been killed by a pesticide (beekill@epa.gov). Also reach out to your state or tribal pesticide regulatory agency - contact information can be found at: <http://npic.orst.edu/incidents>.



HELPFUL LINKS

The **North American Pollinator Protection Campaign (NAPPC)** is a growing collaborative body of more than 170 diverse partners, including respected scientists, researchers, conservationists, government officials and dedicated volunteers. NAPPC's mission is to encourage the health of resident and migratory pollinating animals in North America.



Relative Toxicity of Pesticides to Honey Bees by Laboratory and Field Tests

Group I. Highly Toxic

Severe losses may be expected if these pesticides are used when honey bees are present at treatment time or within a day *thereafter*.

Abamectin	(cyfluthrin)	Denim	Lannate D	Pounce	Supracide
Acramite	Bidrin	(emamectin	(methomyl)	(permethrin)	(methidathion)
(bifenazate)	(dicrotophos)	benzoate)	Lindane	Prallethrin	Swat
Actara, Centric,	Capture, Annex,	Dibrom	Lorsban	Proaxis	(bonyl)
Platinum, Helix,	Brigade	(naled)	(chlorpyrifos)	(gamma-cyhalo-	Synthrin
Cruiser, Adage	(bifenthrin)	Diazinon	Malathion	thrin)	(resmethrin)
(thiamethoxam)	Carzol	(spectracide)	Matacil	Proclaim	Talstar
Acephate	Clutch	Dimecron	(aminocarb)	(emamectin)	Tameron
Admire,	(clothianidin)	(phosphamidon)	Mesuroil	Provado	(methamidophos)
Advantage,	Commodore	Dinotefuran	(methiocarb)	(imidacloprid)	Tefluthrin
Gaucho, Merit,	(lambda-cyhalo-	Dursban, Eradex	Monitor	Pydrin	(Force)
Premise,	thrin)	(chlorpyrifos)	(methamidophos)	(fenvalerate 0.1	Temik
Touchstone	Comply	Endigo	Nexter	lb/A) ²	(aldicarb)
(imidacloprid)	(fenoxycarb)	Envidor	(pyridaben)	Pylon, Phantom	TEPP
Advantage	Curacron	(spirodiclofen)	Nudrin	(chlorfenapyr)	Tralomethrin
Ambush	(profenofos)	Ethyl guthion	(methomyl)	Pyramite	(Saga)
(permethrin)	Cygon	(azinphos-ethyl)	Orthene	Rebelate	Trimax
Ammo (Fury)	(dimethoate)	Flagship	(acephate)	(dimethoate)	Vapona
(>.025 lb/A)	Cymbush	(thiamethoxam)	Parathion	Resmethrin	(dichlorvos)
(cypermethrin)	Danitol	Fipronil	Pay Off	Scout	Venom
Apollo, Ovation	(fenopropathin)	Furadan F	(flucythrinate)	(tralomethrin)	(dinotefuran)
(clofentezine)	Dasanit	(carbofuran)	Phosphamidon	Sevin	Warrior
Asana	(fensulfothion)	Gardstar	Pirimiphos-methyl	(carbaryl) ³	(lambda-cyhalo-
(esfenvalerate)	DDVP	(permethrin) ¹	(Execute, Actellic)	Sniper	thrin)
Avaunt (Advion)	(dichlorvos)	Guthion	Poncho,	Spectracide	Zectran
(indoxacarb)	Decis	(azinphos-methyl)	Titan, Clutch,	Steward	(mexacarbate)
Avid	(decamethrin)	Imidan	Acceleron, Arena,	(indoxacarb)	Zephyr (Agri-Mek)
(avermectin)	Delegate, Radiant	(phosmet)	Belay, Celero	Sumithion	(abamectin)
Baygon	(spinetoram)	Karate	(clothianidin)	(fenitrothion)	Zeta-cypermethrin
(propoxur)					
Baythroid					

¹Can be applied to ground in front of honey bee hives for the control of small hive beetles.

²Can be applied in the late evening at rate of 0.1 lb/A or less.

³Some formulations of Sevin XLR are rated as moderately toxic to honey bees.

1-42 Regulations and Basic Information: *Protecting Honey Bees*

Group II. Moderately Toxic

These can be used around honey bees if dosage, timing, and method of application are correct, but should not be applied directly on honey bees in the field or at the honey bee hive.

Abate (temophos)	Calypso (thiacloprid)	Decis, Battalion (deltamethrin)	Ethodan (Ethion)	Oil sprays (superior type)	Systox (demeton)
Acramite, Floramite (bifenazate)	Carzol (formetanate)	Di-Syston (disulfoton)	Larvin (thiocarb)	Rimon, Pedestal (novaluron)	Trigard (cyromazine)
Assail (acetamiprid)	Chlordane	Dyfonate (fonofos)	Metasystox (demeton-s- methyl)	SpinTor, Conserve SC, Entrust, Success (spinosad)	Thimet (phorate) ²
Banol (carbanolate)	Ciodrin (crotoxyphos)	Elgetol (dinitrocresol)	Metasystox R (oxydemeton- methyl)	Spirotetramet (Movento)	Thionex (endosulfan)
Bolstar (sulprofos)	Coumaphos ¹ (Agridip, Asunthol)	endrin	Mocap (ethoprop)		Trithion, Thiodan (carbophenothion)
	Counter (terbufos)	Esteem (pyriproxyfen)			Vydate (oxamyl)

¹Checkmite (coumaphos) strips can be used in honey bee hives to treat for varroa mites and small hive beetles.

²Thimet EC should only be applied during late evening.

Group III. Relatively Nontoxic

These can be used around honey bees with a minimum of injury; safest if applied in the evening or early morning.

Acaraben (chlorobenzilate)	Calypso (thiacloprid)	Ethrel (ethephon)	(halofenozide)	Pyrellin (rotenone/ pyrithrin)	Talus (buprofezin)
Acarol (bromopropylate)	Chlorantraniliprole	Esteem (pyriproxyfen)	Mavrik (tau-fluvalinate) ¹	Pyrethrum (natural)	Tedion (tetradifon)
Agri-Mek (avermectin)	Chlorparacide (chlorbenside)	Fonicamid	Methoxychlor (Marlate)	Rotenone	Tetram
Allethrin	Confirm, Mimic (tebufenozide)	Fujimite, Akari (fenpyroximate)	Mitac (amitraz)	Ryania	Tetrasan
Altosid (methoprene)	Cyd-X (CM granulovirus)	Fulfill (pymetrozine)	Morocide (binapacryl)	Sabadilla	Torak (dialifor)
Amitraz	Cyrolite	Fundal, Galecron (chlordimeform)	Murvesco (fenson)	Saphos (menazon)	Trigard (cyromazine)
Apollo, Ovation (clofentezine)	Delnav (dioxathion)	<i>Heliothis polyhe- drosis</i> virus	Neemix, Align (azadirachtin)	Savey, Onager (hexythiazox)	Vendex (fenbutatin oxide)
Applaud, Centaur (buprofezin)	Demize (D-Limonene)	Herculex	Neotran	Shuttle	Yieldgard
Aza-direct (azadirachtin)	Dessin (dinobuton)	Hexygon	Nicotine	Smite (sodium azide)	Zeal, Secure (etoxazole)
Baam (amitraz)	Dimilin (diflubenzuron)	Intrepid (methoxyfenozide)	Omite (propargite)	Spiromesifen (Oberon, Forbid)	
<i>Bacillus thuringiensis</i> (Accoate, Biotrol, Dipel, Thuricide)	Dinocap (Karathane)	Isomate	Ovotran (ovex)	Spur (fluvalinale)	
Birlane (chlorfenvinphos)	Dylox (trichlorfon)	Kanemite (acequinocyl)	Pentac (dienochlor)	Sucroicide (sucrose octano- ate esters)	
	Endeavor (Pymetrozine)	Kelthane (dicofol)	Plictran [mitacid] (cyhexatin)	Surround (kaolin)	
		Mach 2	Pynamin		

¹tau-Fluvalinate is used in Apistan strips to treat honey bee hives for varroa mites. It is illegal to use Mavrik in honey bee hives.

Fungicides

As a general rule, fungicides are safe to use around honey bees.

Afugan (pyrazophos)	Polyphase) Copper oxides	(captafol) Dithane D-14 (nabam)	Indar (butrizol) Iprodoine ² Karathane	Phygon (dichlone) Plantvax (oxycarboxin)	Sulfur Syllit (dodine) Terraguard ¹ , Procure (triflumizole)
Arasan (thiram)	Copper oxychloride sulfate	Dithane M (maneb, manzeb)	Lesan (fenaminosulf)	Polyram (metriam)	Tetraconazole (Domark, Eminent)
Bayleton (triadimefon)	Copper sulfate	Dithane Z (zineb)	Maneb Mancozeb	Propiconazole ¹ (Alamo, Banner)	Thiram Thylate
Benlate (benomyl)	Cupric hydroxide (Kocide)	Du-Ter (fentin hydroxide)	Morestan (oxythioquinox)	Pyraclostrobin ²	Vinclozolin ²
Bordeaux mixture	Cyprix (dodine)	Dyrene (anilazine)	Morocide (binapaeryl)	Pyrimethanil ¹ (Philabuster, Penbotec)	Vitavax (carboxin)
Boscalid (emerald, endura, pristine)	Daconil (chlorothalonil)	Ferbam	Myclobutanil	Ridomil	Zineb
Bravo (chlorothalonil)	Dessin (dinobuton)	Fluoxastrobin	Mylone (dazomet)	Rovral (iprodione) ²	
Captan	Difenoconazole	Glyodin			
Carbendazim (Fungisol,	Difolatan	Hinosan (edifenphos)			

¹ May increase the toxicity of neonicotinoid pesticides to honey bees if used together.

² May cause loss of honey bee larvae. Use with caution where honey bees are foraging.

Herbicides, Defoliants and Desiccants


2,4-D	Basagran (bentazon)	Dual (metolachlor)	Hyvar (bromacil)	Nortron (ethofumesate)	Ronstar (oxadiazon)
2,4-DB	Betanal AM (bentanex)	Endothall (endothall)	IPC (propham)	Oxyfluorfen ¹	Sancap (dipropetryn)
2,4-DP (dichlorprop)	Bladex (cyanazine)	Eptam	Karmex (diuron)	Paarlan (isopropalin)	Sencor (metribuzin)
Alachlor	Blazer (acifluorfen)	Evik (ametryn)	Kerb (proamide)	Paraquat	Sinbar (terbacil)
Alanap (naptalam)	Blazer (acifluorfen)	Evital (norflurazon)	Lasso (alachlor)	Pendimethalin ¹ (Prowl)	Surflan (oryzalin)
Alopex (clofop-isobutyl)	cacodylic acid	Exhalt 800	Lorox (linuron)	Phenmedipham (Betanal)	Sutan (butylate)
Amiben (chloramben)	Cambilene (2,3,6-TBA)	Folex (desmedipham)	MCPA	Pramitol (prometone)	Telvar (monuran)
Amitrol	Caparol (prometryn)	Garlon (triclopyr)	Methar, DSMA	Princep (simazine)	Tolban (profluralin)
Ammate	Chloro-IPC (chlorpropham)	Glyphosate	Milogard (propazine)	Probe (methazole)	Tordon (picloram)
Atrex (atrazine)	Cotoran (fluometuron)	Gramoxone (paraquat)	Modown (bitenox)	Propanil ¹	Treflan (trifluralin) ¹
Avenge (difenzoquat)	Daconate (MSMA)	Herbisan (EXD)	MSMA	Pyramin (chloridazon)	Vegadex
Balan (benefin)	Dalapon	Hoelon (diclofop-methyl)	Mylone (dazomet)	Ramrod (propachlor)	Zorial (norflurazon)
Banvel (dicamba)	Diquat			Randox	
	DSMA				


¹ Slightly toxic to honey bees

THE NEW EPA BEE ADVISORY BOX

On EPA's new and strengthened pesticide label to protect pollinators

PROTECTION OF POLLINATORS

 **APPLICATION RESTRICTIONS** EXIST FOR THIS PRODUCT BECAUSE OF RISK TO BEES AND OTHER INSECT POLLINATORS. FOLLOW APPLICATION RESTRICTIONS FOUND IN THE DIRECTIONS FOR USE TO PROTECT POLLINATORS.

Look for the bee hazard icon  in the Directions for Use for each application site for specific use restrictions and instructions to protect bees and other insect pollinators.

This product can kill bees and other insect pollinators. Bees and other insect pollinators will forage on plants when they flower, shed pollen, or produce nectar.

Bees and other insect pollinators can be exposed to this pesticide from:

- Direct contact during foliar applications, or contact with residues on plant surfaces after foliar applications
- Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, soil, tree injection, as well as foliar applications.

When Using This Product Take Steps To:

- Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site.
- Minimize drift of this product on to beehives or to off-site pollinator attractive habitat. Drift of this product onto beehives can result in bee kills.

Information on protecting bees and other insect pollinators may be found at the Pesticide Environmental Stewardship website at:
<http://pesticidestewardship.org/pollinatorprotection/Pages/default.aspx>

Pesticide incidents (for example, bee kills) should immediately be reported to the state/tribal lead agency. For contact information for your state/tribe, go to: www.aapco.org. Pesticide incidents can also be reported to the National Pesticide Information Center at: www.npic.orst.edu or directly to EPA at: beekill@epa.gov

Alerts users to separate restrictions on the label. These prohibit certain pesticide use when bees are present.

 The new bee icon helps signal the pesticide's potential hazard to bees.

Makes clear that pesticide products can kill bees and pollinators.

Bees are often present and foraging when plants and trees flower. EPA's new label makes it clear that pesticides cannot be applied until all petals have fallen.

Warns users that direct contact and ingestion could harm pollinators. EPA is working with beekeepers, growers, pesticide companies, and others to advance pesticide management practices.

Highlights the importance of avoiding drift. Sometimes, wind can cause pesticides to drift to new areas and can cause bee kills.

The science says that there are many causes for a decline in pollinator health, including pesticide exposure. EPA's new label will help protect pollinators.



Read EPA's new and strengthened label requirements: <http://go.usa.gov/jHH4>

Livestock Area Fly Control

Eric R. Day, Extension Entomologist, Virginia Tech

Fly Control in Milk Rooms

Warning: Extremely small amounts of pesticide residues can be detected in milk. For all practical purposes, the tolerance level for pesticide residues in milk is ZERO. Moreover, the presence of such residues in milk is virtually always illegal. To avoid pesticide residues in milk, dairy producers are cautioned to use **ONLY** those pesticides that are labeled for use in dairy operations. The following steps are suggested for managing flies in milk rooms:

- (a) Use good sanitation and only labeled insecticides in dairy barns to reduce the number of flies entering the milk room.
- (b) Use tight screens (14-16 mesh per inch) in good repair on milk room doors and windows. Screens made of copper, aluminum, bronze, plastic, or rust-resisting materials are best.
- (c) Use sticky flypaper, sex pheromone sticky paper (Fly Stik with Muscalure), or sticky foil flypaper with flies printed on it to attract other flies.
- (d) Dichlorvos (Vapona) resin strips work best in controlling flies if windows and doors are kept closed. Replace strips when they become ineffective.
- (e) **Use only labeled** space spray treatments in milk rooms when the above strips do not give adequate fly control. Avoid contaminating milking utensils, cans, bulk tanks, and containers. Remove these items from the milk room or completely cover them before spraying. Follow all instructions on the label.

General Fly Control Methods for Livestock

Sanitation

Good sanitation practices are the basis for all fly control programs and can account for as much as 75% toward the prevention of fly breeding. **Sanitation should be the first line of defense against house flies and other filth-breeding fly species.** Under optimum conditions, house flies can complete their life cycle (egg to adult) in as few as 9 days. By adhering to a strict manure management program throughout the period of greatest fly activity (i.e., the spring and summer months) it is possible to disrupt the life cycles of these pests. Remember, a clean livestock barn has fewer fly problems.

- (a) Remove all manure from livestock pens as frequently as possible. Pens with calves or bulls require special attention and should be cleaned once or twice a week.
- (b) Manure that has been removed should be spread thinly on fields or other large outside areas to facilitate rapid drying. This will help kill developing fly eggs and larvae. Another option is to stack the manure and cover **completely** with black plastic.
- (c) Eliminate silage seepage areas, wet litter, manure stacks, old wet hay or straw bales, and other organic matter accumulations that may attract flies on the farm. Wet feed remaining at the ends of mangers also will breed flies.
- (d) Provide proper drainage in barnyards. Use clean gravel and other fill to eliminate low spots in livestock yards. Proper tiling can reduce wet barnyards.
- (e) Drag pastures with wire mesh to break up large piles of droppings.

To be successful in controlling flies it is important that producers implement a control program that best fits their particular operation. Reliance on a single practice or pesticide product is not the best approach to achieving effective and economical pest control. A better approach is to combine routine sanitation with a variety of pesticide strategies such as baits, residual sprays, space sprays, and larvicides whenever flies are a problem. Do not wait for heavy fly populations to build up. It is much easier and less expensive to prevent fly populations from increasing at the beginning of the season than to attempt to control them after they have reached unacceptable density levels. As fly populations begin to increase, take time and treat as needed.

2-2 Livestock: *Livestock Area Fly Control*

Residual Sprays

The next line of defense is residual sprays applied to the outside and inside of buildings. Other practices such as the application of larvicides, space sprays, and baits should be considered supplementary to sanitation and residual sprays. Residual sprays are applied to walls, ceilings, partitions, stanchions, posts, and other fly resting places. These sprays are much more effective in stanchion barns than in loose-housing, open barns where landing and resting surfaces are minimal. Also, barn surfaces vary in the amount of spray that should be applied to them. Smooth surfaces require less spray than rough, porous surfaces. Thoroughly wet the surface to the point of runoff at low pressures of 80-100 pounds per square inch. Avoid contaminating feed, drinking water, milk, milking utensils, and milk rooms. The importance of *following directions exactly according to the label* cannot be stressed enough when using any pesticide.

Long-Term Residual Treatments

- (a) Fenvalerate [10%]. This product is labeled for use only in swine or horse buildings as a premise spray. Mix 1 quart product in 10 gal water and apply at the rate of 1 gal of spray per 750 sq ft. Remove animals before spraying. Keep animals out of treated buildings for at least 4 hours. **Do not** allow feed or drinking water to become contaminated.
- (b) Permethrin [25%]. **This product is not labeled for use in milk rooms.** Mix 6.67 oz product in 10 gal water and apply at the rate of 1 gal of spray per 1,000 sq ft. **Do not** make direct applications to animals, feed, or drinking water.
- (c) Permethrin [10%]. Mix 1 qt product in 25 gal water and apply at the rate of 1 gal of spray per 750 sq ft. Can be used in barns, dairies, feedlots, stables, and poultry houses.
- (e) Tetrachlorvinphos [50%]. Follow directions according to label. Remove calves and lactating animals before spraying. Keep them out of treated buildings for at least 4 hours. **Do not** allow feed or drinking water to become contaminated. Can be used in dairy barns, poultry houses, swine buildings, and other animal buildings.
- (f) Lambda-cyhalothrin
- (g) Malathion, various formulations. See label for directions.
- (h) Beta-cyfluthrin, various formulations. See label for directions.
- (i) Gardona, various formulations. See label for directions.
- (j) Pyrethrins
- (k) Spinosad
- (l) Bifenthrin

Medium-Term Residual Treatments

- (a) Deltamethrin [0.02%]. Controls stable flies, horn and face flies, house flies, deer flies, mosquitoes, and gnats in livestock and horse facilities. Apply thoroughly to surfaces until wet. Apply as needed, but not more than once per week. Do not spray animals or humans. Do not contaminate feed or drinking water. **Do not use in milk room or milking parlor.**

Short-Term Residual Treatments

- (a) Dichlorvos [43.2%]. Make up a 0.5% solution by mixing 1 gal product in 100 gal water and apply diluted spray as an overall premise application. Particular attention should be given to areas where flies congregate. Animals may be present during treatment. **Do not** allow feed, water or foodstuffs, milk or milking utensils to become contaminated. Apply to cattle feedlots, stockyards, holding pens, and corrals.
- (b) Naled [58%]. Follow directions according to label.
- (c) Pyrethrins [0.1%] and piperonyl butoxide [1.0%]. Follow directions according to label. Apply as a space spray for quick knockdown and kill of house flies, stable flies, and horn flies in barns, milk rooms, and dairies.
- (d) Pyrethrins [0.5%] and piperonyl butoxide [4.0%]. Controls stable flies and other flies, mosquitoes, fleas, and wasps in

livestock, dairy, hog, and poultry facilities. Close all windows and doors and apply at a rate of 2 to 3 seconds/1,000 cubic feet of area. Do not remain in treated area. Thoroughly vent treated area after 15 minutes.

Bait Treatments

Although fresh baits will help control flies, results may be poor if fly breeding is excessive. It is suggested that baits be applied following the removal of all floor litter and manure. For best control, use baits liberally and repeat as needed. It may be necessary to increase amounts when flies are breeding heavily, but check label for proper use directions for any bait product. Baits are most effective when used in conjunction with other control measures. Do not use bait in areas where animals can slip and fall or where children may come in contact with the bait.

- (a) Methomyl [1%]. No mixing required. Bait can be used only around the outside of feed lots, broiler houses, livestock barns, and on walkways in caged layer houses. Scatter bait (do not put in piles) at rate of approximately 0.25 lb per 500 sq ft of fly feeding area, keeping 1- to 2-inch intervals between particles. **Do not** allow food-producing animals to have access to treated areas. **Do not** allow contamination of feed or drinking water.
- (b) Methomyl [1%] and (Z)-9-Tricosene [0.025%]. See label for use directions.

Space Treatments

Space sprays or aerosols can be effective for rapid knockdown and kill of adult flies. It is important to reduce air movement as much as possible. Follow directions according to label.

- (a) Pyrethrins [0.1%] and piperonyl butoxide [1.0%]. Before spraying, close doors and windows. Apply as a fog or fine mist, directing spray toward ceiling and upper corners until area is filled with mist. Use about 0.5 oz solution per 1,000 cu ft. Allow mist to settle on animals. Leave room closed for 5 minutes after treatment, remembering to ventilate area before reoccupying. Repeat as needed. Wash teats of dairy animals before milking. Avoid breathing fumes by wearing mask or respirator of a type recommended by the U.S. Bureau of Mines.
- (b) Dichlorvos [23.4%]. Apply by fogging or misting at rate of 1 quart of 0.5% solution per 8,000 cu ft. Reduce air movement as much as possible before applying. **Do not** use in areas where animals have received a direct application within 8 hours. **Do not** allow feed, water, milk, or milking utensils to become contaminated.
- (c) Dichlorvos resin strips. Suspend from ceiling as directed on label. Use 1 strip per 1,000 cu ft. These strips work best in closed rooms. **Do not** place over water or feed. Keep strips away from animals and children.
- (d) Spinosad [2.46%]. Dilutable spray for control of stable and house flies on animal premises, including in and around poultry, beef, dairy, horse, swine, and sheep premises. **Do not** apply product in milking parlor or milk room. Mix 20 oz product per 5 gal water and apply at a rate of 1 gal solution per 500-1,000 sq ft. **Do not** use in overhead sprinkler system. Refer to label for more directions.

Larvicides

Oral Treatments

The use of oral larvicides such as cyromazine, tetrachlorvinphos, and diflubenzuron [9.7%], is not legal in all states. These feed additives and boluses often are not the answer to fly control unless used very extensively. All manure must be treated within an area in order to effectively reduce the fly population. In many cases the area must be very large because flies rapidly move from one herd to the next over large geographic regions.

Oral larvicides work by preventing the development of flies in manure. They are not effective against existing adult flies, and should be used in conjunction with a regular manure sanitation practice. Supplemental fly control often is needed where flies breed in manure from untreated animals or other organic sources.

- (a) Cyromazine [1%]: See Poultry section.
- (b) Diflubenzuron [9.7%]. This product is a controlled-release bolus for beef and dairy cattle that aids in the suppression of house and stable flies. Administer 1/2 bolus to cattle weighing 300-550 lb, and 1 bolus to cattle weighing 550-1,100 lb or more. **Do not** administer to cattle weighing less than 300 lbs. NEVER administer more than 1 bolus to any animal.

2-4 Livestock: *Livestock Area Fly Control*

- (c) Tetrachlorvinphos [97.3%]. Follow directions according to label. For beef cattle and lactating dairy cattle, feed at the rate of 70 mg product/100 lb of body weight. Start feeding in early spring before flies begin to appear, and continue through the summer and fall until cold weather restricts fly activity.

Manure Treatments

- (a) Tetrachlorvinphos [23%] and dichlorvos [5.3%]. Mix 1 gal product in 25 gal water and apply at the rate of 1 gal of spray per 100 sq ft of droppings. Repeat at 7- to 10-day intervals until droppings begin to cone up, then treat only “hot spots” (small areas found to have large numbers of maggots). Can be used in poultry and livestock facilities. **Do not** spray animals directly. **Do not** contaminate feed or drinking water.
- (b) Tetrachlorvinphos [50%]. Apply at the rate of 1 gal of 1% solution per 100 sq ft of poultry droppings, manure piles, etc. Repeat every 7-10 days until control is achieved. **Do not** spray animals directly. **Do not** contaminate feed or drinking water.

Mineral Mixtures and Feed Additives

- (a) S-Methoprene [10.5% and other formulations]. The AI in Altosid Cattle Custom Blending Premix is an insect growth regulator (IGR) that interrupts the development of the horn fly (and possibly other species of filth-breeding flies) in the manure of treated cattle. Begin use in the spring before horn flies appear on cattle and continue feeding until cold weather restricts horn fly activity. Product is safe for beef and dairy cattle, including breeding cattle, lactating cattle, and calves. Product can be fed up to slaughter and to lactating dairy cows without withholding milk. Refer to label for details on proper feed to weight blending ratios.

Perimeter Area Treatments

- (a) Citric Acid and crystalized propanetricarboxylic acid [100%]. Apply 1/8 cup per sq ft of treatment area. Treatment area should have a moderately salted appearance after application. Apply every 7 days during fly season. See label for specific area applications.

Poultry Area Fly Control

Eric R. Day, Extension Entomologist, Virginia Tech

There are several species of flies commonly found around caged layer poultry houses. The most common species are the house fly and the lesser house fly. Other annoying flies are blow flies (which breed on bird carcasses, broken eggs, and other garbage), soldier flies, fruit flies, gnats, and rat tailed maggots.

The house fly is by far the most important problem in caged layer operations. Not only are they a nuisance but they also are carriers of diseases. With the spread of non-farm residences into rural areas near poultry operations, egg producers are faced with increasing pressures from non-farm residents and health officials to control house flies. Also, the shift to large poultry operations has resulted in heavy concentrations of manure, a major source of fly breeding. According to workers in Georgia, as many as 1000 flies can develop in one pound of suitable breeding media. They are difficult to control, especially when the population becomes extremely high. A dedicated effort involving integrated pest management (IPM) will be needed to maintain house flies at a low level.

Fly Biology

All flies pass through four life stages: egg, larva (maggot), pupa, and adult. During its life cycle, which is about 30 days, a house fly female can lay up to 1000 eggs. These eggs are deposited on moist manure or any type of moist rotten or decaying organic matter. The eggs hatch in 10-12 hours and the maggots move into the wet manure. Fly maggots mature in 4-5 days under warm moist conditions. Pupation occurs in the drier parts of manure with the adult flies emerging in 3-5 days. Under ideal conditions a house fly can complete its life cycle in 9-14 days. The life cycle can be much longer in cooler temperatures. Although capable of movement up to several miles, house flies normally move no more than one half to three quarters of a mile from their breeding sites.

An IPM Program to Control House Flies

Step 1. Population Monitoring

It is essential to know as early as possible which houses are the major sources of fly breeding. The simplest and quickest method of taking quantitative fly counts is the moving tape method. A roll of ordinary sticky fly tape is carefully extended full length and held by the top loop so that the cardboard carton is almost touching the floor. The operator then walks at a normal pace up and down a standardized number of rows (at least 2 full rows) holding the tape by his or her side and slightly in front. At the end of the circuit, the number of flies that have stuck on the tapes is counted and recorded on a chart. These counts should be made in each house twice a week. Population increases and decreases can then be seen and compared from each house. The problem houses can thus be determined early enough to begin supplemental control measures before the fly population gets out of control. The producer also has quantitative evidence of the progress of his or her IPM program to present to interested neighbors or health officials.

The producer has to judge, based on the population dynamics in each house, when to apply supplementary control measures (**treatment threshold**). This decision is based on application costs and the nuisance situation to the surrounding residents.

Step 2. Sanitation and Manure Management

Inside: Manure is usually removed once a year in high-rise egg houses. It is allowed to cone up under the cages and kept as dry as possible. If at all possible, this manure should be removed during the cooler months of the year. Do not disturb the manure during the summer months. When it is spread on fields it is important to scatter the manure thinly so that the eggs and larvae are killed by drying. It is best to plow or disk it under immediately after spreading. In shallow pit houses, frequent removal of manure once or twice a week reduces fly breeding. It is important to make sure that spilled manure is not left in wet piles around the disposal equipment and in areas that the disposal equipment does not reach. If manure has to be stored, be sure to cover it completely with a heavy grade of black plastic. Cover the edges of the plastic with soil to prevent house flies from entering. House fly eggs need relative humidity levels of 90% or higher to develop successfully.

Flies normally breed in wet manure (above 40% moisture). **Leaking waterers are a major source of wet manure.** Thousands of house flies can breed in just one leaking water spot. Daily inspection and repair of all leaking waterers is essential. Provide abundant cross ventilation by the use of fans above the cages and in the manure pits, especially in hot weather.

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Outside: All garbage, leaking feed, spilled manure, bird carcasses, eggs, and miscellaneous trash should be removed regularly. Vegetation, weeds, and grass should be kept trimmed around the houses. Junk, trash, and rusting equipment which provide resting sites for flies should be removed. Install proper eave troughs and down spouts on houses to carry rain water away from buildings. Provide proper drainage in poultry yards and roadways.

Step 3. Biological Control

Natural fly predators (insects and mites that actively feed on fly eggs and larvae) and parasites (small, stingless wasps that lay their eggs in and kill the pupae of house flies) can build up in manure accumulations. They can significantly reduce house fly breeding. Biological control is more effective if the sanitation and manure management as listed in Step 2 is conscientiously applied. In high-rise houses, never clean out a house completely of manure. Leave at least a fourth of the manure undisturbed so that the natural enemies can survive and move into the new manure. Biological control is not as effective in shallow-pit houses; however, if manure is kept dry, the natural enemies are more effective.

Several commercial companies sell parasites for release in poultry houses. These parasites are supposed to be self-propagating in the process of controlling flies; however, quality control of these commercially available parasites is quite variable. Often, only a small percentage of the parasites are actually alive by the time the producer receives them. Producers intending to use these parasites are advised to set aside a small sample of them to check for emergence before releasing them in the houses.

A specific biological control program for house flies in high-rise poultry houses has been developed for Virginia. A predaceous fly larva, *Hydrotaea aeneascens*, is mass-reared and released, resulting in a low house fly population with a reduced need for chemical control.

Step 4. Chemical Control

Insecticides should be used to supplement steps 2 (sanitation) and 3 (biological control). Insecticides can be used to attract and kill those flies that survived the larval stages. They should be applied so that they will not contact and kill house fly predators and parasites. Other insecticides can be used as an emergency control measure when fly populations threaten to overwhelm IPM control measures.

Fly Baits: These are designed to kill flies that have escaped the natural enemies in the manure and should be a regular part of the house fly IPM program. They are inexpensive and simple to use. They should be put out at the beginning of the fly season and renewed at least once a week through warm weather. Baits should be placed in containers (i.e., egg cartons) or glued onto cardboard panels so they will not fall into the manure pits.

Contact Sprays: If the moving tape counts indicate that the fly population in a house is threatening to overwhelm the natural controls, contact sprays can be used. As the name implies, these sprays kill flies on contact and are effective as a quick knock down treatment. Contact spray insecticides have a short residual life and will not prevent a later reinfestation. Do not spray in the manure pits or directly on the birds, eggs, feed, or water.

Residual Sprays: These insecticides have a longer residual life and can be used both inside and outside where flies congregate. In darkness, flies tend to “roost” on the upper walls and ceilings of layer houses, so residual insecticides should be concentrated in these areas. Because insecticide resistance is possible, residual sprays should be applied only to problem houses and areas where the moving tape counts indicate that the population growth is becoming serious.

Step 5. Feed-Through Larvicides

When the moving tape counts indicate that the fly population is about to explode, or when equipment failure has caused a temporary build up of wet spots in the manure, application of larvicides in the feed is a practical option. It should be applied until the tape counts indicate that the flies have been significantly reduced.

These syrphid fly larvae live in highly polluted water such as livestock lagoons, polluted abandoned fish pools, foul pools, and streams associated with barnyards. The maggots are able to live in the water if sufficient solids are present as food. The adult flies resemble honey bees and are often seen “hovering” near the ground in the barnyard vicinity. Because the rattailed maggot breeds and feeds in highly polluted water, an effort must be made to keep the lagoon in optimum condition. Usually, the lagoon becomes “out-of-balance” when the water level is not in proper relationship with the solids. Never allow accumulations of manure above the water line, either floating or sticking to the sides, because these conditions promote fly development. Keep the banks steep and the weeds under control.

Use loose soil and construct a soil barrier between the milk house and the rattailed maggot source. As maggots migrate to the soil barrier, they will dig into it to pupate rather than move into the milk house.

Try to agitate the pit contents frequently during the spring and summer by pumping the pits routinely (at least once a week) to disrupt maggot development. Always maintain a waterline above the manure solids. Clean out the pit contents on a routine basis, if possible.

Usually the occurrence of rattailed maggots is a management problem directly related to improper care of the lagoon or a poorly constructed lagoon. The Environmental Protection Agency (EPA) is very concerned with run-off and over-flow leading to pollution. It is very important to coordinate with agricultural designers and Health Department officials before constructing new liquid manure tanks and lagoons. Plans are available from these agencies for constructing tanks to prevent manure seepage and polluted waters, thereby avoiding a rattailed maggot problem.

Table 2.1 - Some Commercial Insecticides Registered for Control of House Flies in Poultry Houses

Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information
Fly Baits	
Methomyl [1%]	Ready-to-use bait.
Contact Sprays	
Pyrethrins [0.1% - 0.6%] + Piperonyl Butoxide [1% 6%]	Ready-to-use oil spray; apply as mist or fog. Spray at a rate of 1-2 seconds per 1,000 cubic feet. Close windows and doors for 15 min. or double dosage if area can't be closed.
Dichlorvos [43.2%]	Mix with water as instructed on label, apply as mist or fog.
Tetrachlorvinphos [50%] walls and ceilings	Mix with water as instructed on label, apply to inside or outside
Permethrin [5.7% to 25%]	Check label for specific application instructions.
Tetrachlorvinphos [23%] and Dichlorvos [5.3%]	Check label for specific application instructions.
Dibrom 37% EC	Check label for specific application instructions.
Stirophos	Check label for specific application instructions.
Imidacloprid	Check label for specific application instructions.
Sevin	Check label for specific application instructions.
Feed-Through Larvicides	
Cyromazine [1%] ton of feed. Follow directions according to label.	feed to egg-laying hens only. Mix 1 lb product per

Rattailed Maggots (Syrphid Fly Larvae)

Frequently during the warm summer months, rattailed maggots are reported as a nuisance pest migrating from livestock lagoons and manure pits. These insects are not a problem as long as they remain in the liquid manure pit. However, they have been known to move out of the pit or lagoon in large numbers contaminating livestock feed, accumulating in electrical boxes causing short circuits, and congregating in stacks of egg cartons and other unwanted places. The maggots migrate in search of drier places in which to pupate.

Rattailed maggots, known as the larval or immature stage of syrphid flies, are about 1 1/4 inches long. The body portion is about 3/4 inch long and the tail portion (breathing tube) is about 1/2 inch long. These maggots are white in color and semi-transparent with the body portion being an elongated, oval, cylindrical shape. What appears to be a long tail is actually a breathing tube. The adult rattailed maggots resemble bumble bees but are actually flies that cannot sting.

These syrphid fly larvae live in highly polluted water such as livestock lagoons, polluted abandoned fish pools, foul pools, and streams associated with barnyards. The maggots are able to live in the water if sufficient solids are present as food. The adult flies resemble honey bees and are often seen “hovering” near the ground in the barnyard vicinity. Because the rattailed maggot breeds and feeds in highly polluted water, an effort must be made to keep the lagoon in optimum condition. Usually, the lagoon becomes “out-of-balance” when the water level is not in proper relationship with the solids. Never allow

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accumulations of manure above the water line, either floating or sticking to the sides, because these conditions promote fly development. Keep the banks steep and the weeds under control.

Use loose soil and construct a soil barrier between the milk house and the rattailed maggot source. As maggots migrate to the soil barrier, they will dig into it to pupate rather than move into the milk house.

Try to agitate the pit contents frequently during the spring and summer by pumping the pits routinely (at least once a week) to disrupt maggot development. Always maintain a waterline above the manure solids. Clean out the pit contents on a routine basis, if possible.

Usually the occurrence of rattailed maggots is a management problem directly related to improper care of the lagoon or a poorly constructed lagoon. The Environmental Protection Agency (EPA) is very concerned with run-off and over-flow leading to pollution. It is very important to coordinate with agricultural designers and Health Department officials before constructing new liquid manure tanks and lagoons. Plans are available from these agencies for constructing tanks to prevent manure seepage and polluted waters, thereby avoiding a rattailed maggot problem.

Asian Longhorned Tick

The Asian Longhorned Tick, *Haemaphysalis longicornis*, is a recently recognized tick in Virginia and other states in the eastern United States. If you suspect that you have this tick please submit a sample to the Insect Identification Lab or a State Veterinarian to have it confirmed. ALT can reproduce without mating, aiding rapid proliferation, and only female ticks are found in the United States. Populations can build up into extreme numbers and impact animal health. For information see: <https://www.pubs.ext.vt.edu/ENTO/ENTO-282/ENTO-282.html>

Table 2.2 - Special section for Longhorned Tick Control on Poultry

Control Method for Ticks	Active Ingredients <i>Sold under various trade names</i>	Insecticide Mixing and Application Information	Precautions
Dip wash	Permethrin	Wet feathers through to skin and air dry.	Check label, some versions are ready to use and some require dilution.
Emulsifiable concentrate spray	Permethrin	Spray/soak plumage, skin, and vent.	Wear protective clothing when making applications.
Ready to use dust or spray	Permethrin	Spot treat legs, tail, wings & comb. For dust, treat at the rate 1 lb. per 100 birds, make sure vent area is treated.	Wear protective clothing. If using dust, include a NIOSH approved respirator.

Beef External Parasites

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Beef External Parasite Control

Table 2.3 - Dust Bags

Pests	Active Ingredient [Percent A.I. in Product]	Insecticide Mixing and Application Information	Precautions
horn flies, lice (aids in control of face flies)	Coumaphos [1%] Dust Permethrin [0.25%] Dust Gardona (lis-isomir)	No mixing is necessary. Install burlap bags or commercial ready-to-use bags of dust in areas where animals must come in contact. Keep bags in place during winter months to aid in control of lice. DUST BAGS MUST HANG 4-6 INCHES BELOW TOPLINE OF CATTLE.	Do not contaminate feed or water.

Table 2.4 - Hand Dusting

Pests	Active Ingredient [Percent A.I. in Product]	Insecticide Mixing and Application Information	Precautions
horn flies, face flies, lice	Tetrachlorvinphos [3%]	Read label before use. Wear rubber gloves and apply approximately 2.0 oz of dust to the upper portions of the back, neck, and poll, and to the face as an aid in the control of face flies. Rub in lightly to carry the dust beneath the hair.	Do not contaminate feed or water. Wear protective clothing and gloves as recommended on the label.
	Permethrin [0.25%]	Apply 2.0 oz (6.0 tbsp) of dust per animal by shaker can. Repeat as necessary.	Do not contaminate water, food or feed by storage or disposal. Keep container sealed when not in use. Wear protective clothing and gloves as recommended on the label.
	Malathion Dust [4%]	For horn flies: apply 4 tbsp on the back and neck. Repeat at 10-14 day intervals. Dust calves lightly. For lice and ticks: dust animal thoroughly. Repeat treatment after 2-3 weeks if needed.	Do not treat calves under 1 month of age. Do not contaminate water. Wear protective clothing and gloves as recommended on the label.
	Coumaphos [1%]	No mixing is necessary. Apply not more than 2.0 oz per animal. Dust evenly into the hair over the head, neck, shoulders, back, and tailhead. Repeat as necessary but not more than once every 10 days.	Do not contaminate feed or water. Wear protective clothing and gloves as recommended on the label.
	Zeta-Cypermethrin [0.075%] + Piperonyl Butoxide [0.15%]	Check label for specific application instructions.	

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Table 2.5 - Backrubbers¹ and Facerubbers

Pests	Active Ingredient [Percent A.I. in Product]	Insecticide Mixing and Application Information	Precautions
face flies, horn flies, stable flies, house flies, black flies, mosquitoes, eye gnats, mange mites	Permethrin [11%] (Atroban 11% EC) Permethrin [10%] Permethrin [5.7%] and others	Follow directions according to labels. Use only #2 diesel oil or any approved backrubber base oil.	Read and adhere to all precautions on labels. Do not use motor oil or waste oil on backrubbers. Keep rubbing device charged. Results improve daily with forced use.
face flies, horn flies	Coumaphos Dichlorvos [5.3%] Phosmet [11.6%] Permethrin [7.4%] + Piperonyl Butoxide [7.4%] Gardona (cis-isomer)	Follow directions according to label. Use only #2 diesel oil or any approved backrubber base oil.	Read and adhere to all precautions on labels. Do not use motor oil or waste oil on backrubbers.

¹Backrubbers will suppress cattle lice, but usually do not result in complete control.

Table 2.6 - Sprays

Pests	Active Ingredient [Percent A.I. in Product]	Insecticide Mixing and Application Information	Precautions
face flies, horn flies, grubs ¹ , lice, screwworms, ticks	Coumaphos Pyrethrin	Follow directions according to label. Apply spray at high pressure so as to wet the skin. Use only between August 1 and November 1 for grub control. ¹ Do not use after November 1 unless animals are known to be grub-free, because paralysis or suffocation may result.	Do not apply to sick animals or those less than 3 months old. Do not apply in conjunction with oral drenches or internal medications.
horn flies, lice, ticks	Tetrachlorvinphos [50%]	For horn flies and lice, mix 4.0 lbs product in 75.0 gal water. For ticks mix 4 lb product in 50.0 gal of water. Apply as coarse spray. Use 0.5-1.0 gal of spray per animal depending on size and thickness of hair coat.	Do not contaminate feed or water.
horn flies, lice, lone star ticks, face flies (aids in control)	Tetrachlorvinphos [23%] and Dichlorvos [5.3%]	Check label for proper dilution for each pest. Apply as coarse spray. Use between 0.5-1.0 gal of spray/ animal depending on size and hair coat.	Do not treat more often than every 10 days. Do not contaminate feed or water.

¹Cattle grubs - dips and sprays - Do not apply to sick, convalescent, or stressed animals or animals less than three months old. Do not dip or spray animals for 10 days before or after shipping or weaning, or after exposure to contagious or infectious diseases. Do not apply in conjunction with oral drenches, or with internal medications such as phenothiazine, or with natural or synthetic pyrethroids or their synergists, or with other organic phosphates. Do not apply in a confined, non-ventilated area. Destruction of *Hypoderma* larvae (cattle grubs) at the period when these grubs are in vital areas may cause undesirable host-parasite reactions including the possibility of fatalities. Killing *Hypoderma lineatum* when it is in the tissue surrounding the gullet may cause salivation and bloat; killing *H. bovis* when it is in the vertebral canal may cause staggering or paralysis. These reactions are not specific to treatment with Ivomec, but can occur with any successful treatment of grubs. Cattle should be treated either before or after these stages of grub development. Consult your veterinarian or Extension entomologist concerning proper timing of treatment.

Table 2.6 - Sprays (cont.)

face flies, horn flies, stable flies, lice, ticks	Permethrin [11%] Permethrin [10%]	Check labels for specific application instructions.	Do not contaminate feed or water.
Permethrin [5.7%] face flies, horn flies, lice	(Ectiban EC) and others Permethrin [7.4%] + Piperonyl Butoxide [7.4%]	Check label for specific application information.	Can be applied topically to livestock and their premises. Check label for precautions.
horn flies, lice, ticks, sarcoptic mange horn flies, lice	Phosmet [11.6%] (Liquid Insecticide) Spinosad [2.46%]	See label for specific mixing and rate information Refer to label for specific mixing and rate information.	Do not contaminate feed or water. Does not control cattle grubs. Do not make more than 5 consecutive treatments with this product. Do not apply more than once every 7 days. Do not apply within 2 days of slaughter.

¹Cattle grubs - dips and sprays - Do not apply to sick, convalescent, or stressed animals or animals less than three months old. Do not dip or spray animals for 10 days before or after shipping or weaning, or after exposure to contagious or infectious diseases. Do not apply in conjunction with oral drenches, or with internal medications such as phenothiazine, or with natural or synthetic pyrethroids or their synergists, or with other organic phosphates. Do not apply in a confined, non-ventilated area. Destruction of *Hypoderma* larvae (cattle grubs) at the period when these grubs are in vital areas may cause undesirable host-parasite reactions including the possibility of fatalities. Killing *Hypoderma lineatum* when it is in the tissue surrounding the gullet may cause salivation and bloat; killing *H. bovis* when it is in the vertebral canal may cause staggering or paralysis. These reactions are not specific to treatment with Ivomec, but can occur with any successful treatment of grubs. Cattle should be treated either before or after these stages of grub development. Consult your veterinarian or Extension entomologist concerning proper timing of treatment.

Table 2.7 - Pour-ons

Pests	Active Ingredient [Percent A.I. in Product]	Insecticide Mixing and Application Information	Precautions
horn flies, face flies	Lambda-Cyhalothrin [1.0%]	Ready to use. Apply down backline at rate of 0.33 oz/ animal up to 600 lbs of body weight. For animals weighing more than 600 lbs use 0.5 oz/animal.	Do not apply to face of animal. Non-systemic, will not control cattle grubs. Repeat as needed, but not more than once every 2 weeks and not more than 4 times within 6 months. Two treatments at 14- day intervals are recommended for control of sucking lice.
	Permethrin [10.0 %]	Ready to use. Apply from poll down neck to shoulders and along midline of back. Use 0.125 oz/250 lbs of body weight.	Non-systemic, will not control cattle grubs. Repeat as needed, but not more often than once every 2 weeks.
lice	Permethrin [1.0%]	Ready to use. Apply along back and down face. Use 0.5 oz/100 lbs of body weight, up to 5 oz/animal.	Repeat as needed, but not more than once every 2 weeks.

Refrain from smoking or eating when handling. Wash hands after using. Keep this and all drugs out of reach of children.

Table 2.7 - Pour-ons¹ (cont.)

Pests	Active Ingredient [Percent A.I. in Product]	Insecticide Mixing and Application Information	Precautions
lice (continued)	Cyfluthrin [1.0%]	Rates for horn flies and face flies: 4 oz < 400 lb body wt 8 oz 400 to 800 lb body wt 12 oz > 800 lb body wt Rates for biting and sucking lice: 8 oz < 400 lb body wt 16 oz 400 to 800 lb body wt 24 oz > 800 lb body wt	Does not control cattle grubs.
	Permethrin [1.0%] + Piperonyl Butoxide [1.0%]	Apply at rate of 0.5 oz/100 lb of body wt up to maximum dosage of 5 oz/animal.	Repeat as needed, but not more often than once every 2 weeks. Check label for additional precautions.
	Spinosad [2.46%]	Ready to use. Apply along back and down face. See label for complete use directions.	Repeat as needed, but not more than once every 2 weeks. Do not make more than 5 consecutive treatments with this product. Do not apply more than once every 7 days. Do not apply within 2 days of slaughter.
	L-cyhalothrin	See label.	0 days to slaughter.

Avoid using products with grubicidal activity in Virginia from Nov. 1 to Feb. 1.

grubs, horn flies, lice, sarcopic mange, chorioptic mange See footnote ²	Eprinomectrin, Ivermectin, Doramectin, Moxidectin	Use 1.0 ml of product for each 22.0 lb of body weight. Apply along backline in a narrow strip extending from the withers to tailhead.	When used according to label, no pre-slaughter withdrawal period is required.
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Refrain from smoking or eating when handling. Wash hands after using. Keep this and all drugs out of reach of children.

Table 2.8 - Spot-ons

Pests	Active Ingredient [Percent A.I. in Product]	Insecticide Mixing and Application Information	Precautions
ear ticks, screwworm	Coumaphos [5%]	Shake well. Squeeze container to release dust in short bursts of light clouds. Hold nozzle 2-4 inches from area to be treated and apply a light, even coat around the area.	For screwworm, treat infested wounds with light but thorough coverage. For ear ticks, dust into the area and also treat adjacent head area.

Table 2.9 - Mineral Mixtures and Feed Additives

Pests	Active Ingredient [Percent A.I. in Product]	Insecticide Mixing and Application Information	Precautions
face flies, horn flies, house flies, stable flies	Tetrachlorvinphos [7.6%] Gardona (cis-isomer) Diflubenzuron	Follow directions according to label. Start feeding in early spring before flies begin to appear, and continue throughout the summer and fall until cold weather restricts fly activity.	Check label for precautions.
horn flies (and possibly other species of filth-breeding flies)	s-Methoprene [10.5%]	Refer to label for details on proper feed to weight blending ratios.	S-Methoprene is an insect growth regulator (IGR) that interrupts the development of the horn fly (and possibly other species of filth-breeding flies) in the manure of treated cattle. Begin use in spring before horn flies appear on cattle and continue feeding until cold weather restricts horn fly activity. Product is safe for beef and dairy cattle, including breeding cattle, lactating cattle, and calves. Product can be fed up to slaughter and to lactating dairy cows without withholding milk.

Table 2.10 - Ear Tags

Pests	Active Ingredient [Percent A.I. in Product]	Insecticide Mixing and Application Information	Precautions
face flies, horn flies	Pyrethroid Class Tags Beta-Cyfluthrin insecticide, Cyfluthrin insecticide, Cypermethrin insecticide & Piperonyl Butoxide synergist, Permethrin insecticide, Permethrin insecticide & Piperonyl Butoxide synergist, Lambda-Cyhalothrin insecticide & Piperonyl Butoxide synergist	Follow directions according to labels. Apply with recommended applicator.	Carefully read instructions to avoid ear damage. Remove tags before slaughter.
	Organophosphate Class Tags Diazinon, Coumaphos	Follow directions according to labels. Apply with recommended applicator.	Carefully read instructions to avoid ear damage. Remove tags before slaughter.

Table 2.10 - Ear Tags (cont.)

Pests	Active Ingredient [Percent A.I. in Product]	Insecticide Mixing and Application Information	Precautions
face flies, horn flies (continued)	Pyrethroid & Organophosphate Class Tags Cypermethrin & Chlorpyrifos insecticide & Piperonyl Butoxide synergist, Lambda-Cyhalothrin & Pirimiphos-methyl insecticide, Permethrin and Chlorpyrifos insecticide & Piperonyl Butoxide synergist	Follow directions according to labels. Apply with recommended applicator.	Carefully read instructions to avoid ear damage. Remove tags before slaughter.
	Avermectin Class Tags Abamectin (xp-820)	Follow directions according to label. Apply with recommended applicator.	Carefully read instructions to avoid ear damage. Remove tags before slaughter.

Table 2.11 - Injectables¹

Pests	Active Ingredient [Percent A.I. in Product]	Insecticide Mixing and Application Information	Precautions
lice (sucking): (<i>Linognathus vituli</i>), (<i>Haematopinus eurysternus</i>), (<i>Solenopotes capillatus</i>) grubs: (<i>Hypoderma bovis</i>), (<i>H. lineatum</i>) mange mites: (<i>Psoroptes ovis</i>), (<i>Sarcoptes scabiei</i>) See footnote ¹	Ivermectin [1%] Doramectin [1%] Moxidectin [1%]	Ivermectin should be given only by subcutaneous injection at the recommended dose level of 200 mcg ivermectin/kg of body weight. Each 10 mg of ivermectin is sufficient to treat 110 lb (50 kg) of body weight. Use of a 16 gauge, 1/2 to 3/4" needle is suggested. Inject under the loose skin in front of or behind the shoulders.	Do not treat cattle within 35 days of slaughter. This product is not for intravenous or intra-muscular use. Animals should be appropriately restrained to achieve the proper route of administration. Use sterile equipment and sanitize the injection site by applying a suitable disinfectant. Clean, properly disinfected needles should be used to reduce potential injection-site infections.

¹Observe cattle for injection site reactions. Reactions may be due to clostridial infection and should be aggressively treated with appropriate antibiotics.

Ivermectin is highly effective against all stages of cattle grubs. However, proper timing of treatment is important. For most effective results, cattle should be treated as soon as possible after the end of the heel fly (warble fly) season.

Destruction of *Hypoderma* larvae (cattle grubs) at the period when these grubs are in vital areas may cause undesirable host-parasite reactions including the possibility of fatalities. Killing *Hypoderma lineatum* when it is in the tissue surrounding the gullet may cause salivation and bloat; killing *H. bovis* when it is in the vertebral canal may cause staggering or paralysis. These reactions are not specific to treatment with ivermectin, but can occur with any successful treatment of grubs. Cattle should be treated either before or after these stages of grub development. Consult your veterinarian or Extension entomologist concerning proper timing of treatment.

Cattle treated with ivermectin after the end of the heel fly season may be retreated with ivermectin during the winter for internal parasites, mange mites, or lice without danger of grub-related reactions. **A planned parasite control program is recommended.**

Transitory discomfort has been observed in some cattle following subcutaneous administration. A low incidence of soft-tissue swelling at the injection site has been observed. These reactions have disappeared without treatment. Divide doses greater than 10 ml between two injection sites to reduce occasional discomfort or site reaction. Protect from light.

CAUTION: Ivermectin injection for cattle has been developed specifically for use in cattle and reindeer only. This product should not be used in other animal species because severe adverse reactions, including fatalities in dogs, may result.

Refrain from smoking or eating when handling. Wash hands after using. Keep this and all drugs out of reach of children.

Table 2.12 - Bolus

Pests	Active Ingredient [Percent A.I. in Product]	Insecticide Mixing and Application Information	Precautions
face flies, horn flies, house flies, stable flies	Diflubenzuron [9.7%]	This product is a controlled-release bolus for beef and dairy cattle that aids in the suppression of house and stable flies. Administer 1/2 bolus to cattle weighing 300-550 lb, and 1 bolus to cattle weighing 550-1,100 lb or greater.	Do not administer to cattle weighing less than 300 lb. Never administer more than 1 bolus to any animal.

When to Treat for Cattle Grubs

Proper timing of treatment is important when using systemic grubicide pour-ons and spot-ons on beef and non-lactating dairy cattle. For most effective results, cattle should be treated for grubs after the end of heel fly activity in September. Host-parasite reactions such as bloat, salivation, staggering and paralysis may sometimes occur when cattle are treated while the common cattle grub, *Hypoderma lineatum*, is in the gullet, or while the northern cattle grub, *H. bovis*, is in the area of the spinal cord. Therefore, avoid using products with grubicidal activity on cattle in Virginia from Nov. 1-Feb. 1.

Follow Instructions on the Label

If it is impossible to determine the origin of the cattle, and thus the exact stage of the grubs is unknown, it is recommended that the cattle receive only dry hay or a maintenance ration of low energy feed a couple of days before and during the treatment period. This lessens the likelihood of severe bloat, which may occur in cattle on full feed when the common grub is killed in the gullet.

When to Treat for Cattle Lice

Systemic pour-ons and spot-ons for lice control on beef and non-lactating dairy cattle are convenient. Grub treatment before the November cutoff date often will not take care of cattle lice problems. Louse eggs are not as susceptible to insecticides as the lice themselves and therefore animals should be re-examined about three weeks after treatment to determine if viable lice eggs have hatched and reinfested the herd.

Do not use grubicides such as coumaphos (Co-Ral), famphur (Warbex - registration cancelled), fenthion (Tiguvon or Spotton – registration cancelled) or phosmet (Prolate) from November through January on cattle not previously treated for grubs due to possible host-parasite reactions. After February 1, grub larvae have migrated from the spinal canal, or esophagus, and usually encyst in the back; cattle may then be treated safely with grubicides. It is then safer to treat for lice to minimize the host-parasite reaction.

For cattle previously treated for grubs, a second treatment later in the season may become necessary should lice become a problem. The second treatment usually should not be applied sooner than 35 days after the first treatment. Be sure to follow instructions on the label for any safety precautions.

Systemic spot-ons and pour-ons that kill lice but not grubs can be applied anytime throughout the fall and winter months. Be sure to follow instructions on the label for any safety precautions.

Longhorned Tick Control for Cattle

The Asian Longhorned Tick, *Haemaphysalis longicornis*, is a recently recognized tick in Virginia and other states in the eastern United States. If you suspect that you have this tick please submit a sample to the Insect Identification Lab or a State Veterinarian to have it confirmed. Populations can build up into extreme numbers and impact animal health. For information see: Managing the Asian Longhorned Tick: Checklist for Best Management Practices for Cattle Producers (<https://www.pubs.ext.vt.edu/ENTO/ENTO-382/ENTO-382.html>). For information on the biology of the Asian Longhorned Tick, see; Asian Longhorned Tick (<https://www.pubs.ext.vt.edu/ENTO/ENTO-282/ENTO-282.html>).

Managing the Asian Longhorned Tick

Checklist for Best Tick Management Practices for Cattle Producers

Large numbers of the Asian longhorned tick (ALT) on cattle can reduce herd health and possibly spread disease. Managing the ALT can reproduce without mating, aiding rapid proliferation, and only female ticks are found in the United States. Following this checklist can reduce its impact and spread.

The following recommendations are suggested to help protect your herd.

Inspection

- Regularly inspect cattle for ticks. The ALT is small and may go unnoticed with only a cursory glance. Focus on the head and the neck, but also check the flanks and back, the armpits and groin, and under the tail. Tick larvae, nymphs, and adults may all be found at the same time on a single animal.
- Cattle with low weight gain, that are lethargic, have patchy hair, anemia, or generally look unthrifty should always be inspected for ticks.
- Several ticks on an animal may not be of concern, but large numbers of ticks should be addressed as soon as possible. Submit tick samples to your local extension agent for species confirmation.
- Once ALT is confirmed on your animals, you should assume it is established in the area and that management for this tick will be an on-going process.
- Check fields for ticks before moving cattle into a new pasture.

Chemical Control

- A single insecticide application method may not be fully effective. Consider using insecticide-impregnated ear-tags in conjunction with backrubbers and bullets.
- Ear tags: Use abamectin eartags for low numbers of ticks. Follow all label instructions for insecticide-impregnated eartags. Use the number of insecticide-impregnated eartags per animal specified on the label. Tag both adults and calves. Check labels for any limitations for beef or dairy cattle. Replace eartags following the label recommendations. Keep records of when eartags were placed so you know when to replace them
- Use backrubbers and siderubbers (“bullets”) or similar devices charged with phosmet or permethrin. Hang rubs in such a way that cattle must contact the rub as they move past, spreading the insecticide along the top of their bodies. Vertical strips hung from a backrubber help apply material to the head and flanks as the cattle move past. Bullets also distribute insecticide along the head and flanks.
- Pinch points: Place backrubbers, bullets, and similar devices in a pinch point (e.g., gateways, between posts, entry to creep feeders, etc.) where cattle are forced to walk under or past on a daily basis, such as to visit a water source. Rubs hung in front of mineral feeders are helpful, but cattle do not visit these feeders every day and may not receive the appropriate amount of insecticide for tick control on a daily basis.
- Recharge devices regularly following the insecticide label. ALT management may require recharging devices every 2-3 weeks.
- Pour-ons: Use for heavy or extreme tick numbers. Use ivermectin at the rate of 1 ml per 22 pounds of body weight. Apply along the topline of the animal in a narrow strip. Be aware that heavy rain may temporarily wash insecticides off the animal. Check for the presence of flies on the animal several days after a heavy rain. Increased numbers of flies at several days after a heavy rain may indicate the need to retreat the animal.
- Injectable ivermectin can provide up 90 days of tick control.
- Treat all animals in a herd for ticks at the same time. Apply formulations specifically labeled for tick control. Follow all label recommendations for any pesticide used on an animal.
- Chemical treatment of pastures is not recommended except under severe conditions. Carbaryl (Sevin) labeled for use on

pastures should be restricted to sections of the pasture with the highest number of ticks. Pasture treatments should be used in conjunction with other treatments.

Herd Management

- Inspect purchased cattle for ticks before adding to the herd. Treat animals if ticks are found before adding to the established herd.
- Consider having animals tested by a vet for tick-borne disease if ticks are found on them, especially if the cattle are not gaining weight, have patchy hair, appear lethargic, or otherwise show symptoms of anemia.
- Mow and keep pastures short as long grass and brush enhance tick survival. Leaving pastures ungrazed will not control ticks as they can survive about a year without feeding. Wildlife in the ungrazed pastures will support tick survival in the absence of cattle, too.
- Keep cattle out of wooded areas. If possible, fence cattle 20 feet away from wooded areas.
- Mow pastures short before rotating stock back into them, even if the cattle have been treated for ticks.
- Wildlife, such as deer, small mammals, and birds, can serve as alternative hosts for ticks and assist their spread throughout pastures. Contact the Virginia Department of Game and Inland Fisheries (VDGIF, <https://www.dgif.virginia.gov/>) or the Virginia Tech Center for Human-Wildlife Conflict Resolution (<https://www.humanwildlife.cmi.vt.edu/Species/Deer.htm>) for any questions regarding white-tail deer management on your property. Whitetail deer are a managed game species in Virginia with specific regulations on trapping, poisoning, capturing, and killing deer.
- Other domesticated animals (e.g., small livestock, poultry, pets) on the property should be examined for ticks.
- People working with livestock, especially tick-infested animals, should inspect themselves for any ticks after working with the animals. Follow all label recommendations for personal protection when handling any pesticides.

Dairy External Parasites

Eric R. Day, Extension Entomologist, Virginia Tech
John F. Currin, DVM, VMRCVM

Insecticides should be applied with extreme caution to cows or calves in poor health. This means light applications of safer materials. Extremely small amounts of pesticide residues can be detected in milk. For all practical purposes, the tolerance level for pesticide residues in milk is ZERO. Moreover, the presence of such residues in milk is virtually always illegal. To avoid pesticide residues in milk, dairy producers are cautioned to use ONLY those pesticides that are labeled for use in dairy operations.

Table 2.13 - Dust Bags¹

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
horn flies, lice (aids in control of face flies)	Coumaphos [1%] Dust Gardona Permethrin Rabon	No mixing is necessary. Install burlap bags of dust in doorway where cattle leave milking barn or enter loafing barn. Keep in place during winter months to aid in control of lice.	Do not contaminate feed or water. Wear protective clothing and gloves as recommended on the label.

¹Closed-mesh bags must be used to prevent waste of dust.

Table 2.14 - Backrubbers¹ - Lactating Cows

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
face flies, horn flies, stable flies	Permethrin [11%]	Dilute 1.0 pt product/10.0 gal #2 diesel oil.	Use only #2 diesel oil or any other approved backrubber base oil. Do not use motor oil or waste oil. Keep rubbing device charged. Results improve with daily forced use. Install backrubbers where cattle leave the milking barn.
	Permethrin [10%]	Mix 1.0 qt product/20.0 gal #2 diesel oil.	
	Permethrin [5.7%]	Mix 1.0 qt product/10.0 gal #2 diesel oil.	
	Cumophos	1.25 cups/gal #2 diesel oil	
face flies, horn flies, lice	Permethrin [7.4%] + Piperonyl Butoxide [7.4%]	Mix 2.1 oz/gal mineral oil. Results improve with daily forced use.	

¹Backrubbers will suppress cattle lice, but usually do not result in complete control.

Table 2.15 - Hand Dusting - Lactating Cows

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
face flies, horn flies, lice	Tetrachlorvinphos [3%] Dust	Follow directions according to label. Wear rubber gloves to apply. Apply approximately 2 oz dust to the upper portions of the back, neck and poll, and to the face as an aid in the control of face flies. Rub in lightly to carry the dust beneath the hair.	Do not contaminate feed or water.
	Permethrin [0.25%]	Apply 2 oz (6.0 tbsp) of dust/animal by shaker can. Repeat as necessary.	Do not contaminate water, food or feed by storage or disposal. Keep container sealed when not in use.
horn flies, lice	Coumaphos [1%] Dust	No mixing is necessary. Apply not more than 2.0 oz/ animal. Dust evenly into the hair over the head, neck, shoulders, back, and tail-head. Repeat as necessary.	Do not contaminate feed or water.
	Zeta-Cypermethrin [0.075%] + Piperonyl Butoxide [0.15%]	See label for specific application instructions.	

Table 2.16 - Wetting Sprays - Lactating Cows

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
face flies, horn flies, horse flies, house flies, stable flies, lice, mites, ticks	Permethrin [11%]	Mix 1.0 pt product in 25.0 gal water. Apply 1-2 qts of coarse spray/ animal over entire body surface.	Spray lactating dairy animals only after milking is completed. Do not contaminate feed or drinking water.
face flies, horn flies, stable flies, ticks	Permethrin [5.7%]	Mix 1.0 qt product in 25.0 gal water. Apply 1-2 qts spray/ animal over entire body surface.	
lice	Permethrin [5.7%]	Mix 1.0 quart product in 100 gal water.	A second application is recommended 2-3 weeks later.
	Coumaphos [25%]	Mix 1.0 lb product in 100 gal water. Apply spray to run-off.	
face flies, horn flies, horse flies, stable flies, lice, mites, ticks, etc.	Permethrin [10%]	Mix 1.0 quart product in 200 gal water. Apply spray to thoroughly cover animal.	For lice and mites a second application is recommended 2-3 weeks later.
face flies, horn flies, lice	Permethrin [7.4%] + Piperonyl Butoxide [7.4%] Pyrethrin	Check label for specific application instructions.	Can be applied topically to lactating dairy animals and their premises. Check label for precautions.
horn flies, lice	Spinosad [2.46%]	For lactating and non-lactating beef and dairy cows. Refer to label for specific mixing and rate information.	Do not make more than 5 consecutive treatments with this product. Do not apply more than once every 7 days. Do not apply within 2 days of slaughter.

Table 2.17 - Mist Sprays - Lactating Cows

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
horn flies, stable flies	Synergized pyrethrins	Apply 1.0-2.0 oz of product directly to animal once daily, preferably in morning.	If other mist sprays are used on lactating dairy cattle, please read label carefully.
face flies, horn flies, stable flies	Dichlorvos [40.2%]	Dilute 5.0 oz product in 2.0 gal water. Apply 1.0- 2.0 oz of diluted solution/animal daily as a fine mist. Thoroughly cover all parts of the animal, including the legs, but do not wet the skin.	Do not contaminate feed or drinking water. Do not apply in combination with trichlorfon. Do not apply to calves under 6 months.

Table 2.18 - Injectables - Males and Females Not of Breeding Age¹

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
lice (sucking): <i>Linognathus vituli</i> , <i>Haematopinus eurysternus</i> , <i>Solenopotes capillatus</i>	Ivermectin [1%] doramectin moxidectin	Ivermectin should be given only by subcutaneous injection at the recommended dose level of 200 mcg ivermectin/kilogram of body weight. Each 10 mg of ivermectin is sufficient to treat 110 lb (50 kg) of body weight. A 16 gauge, 1/2 to 3/4" needle is suggested. Inject under the loose skin in front of or behind the shoulders.	Do not treat cattle within 35 days of slaughter. Because a withdrawal time in milk has not been established, do not use in female dairy cattle of breeding age. This product is not for intravenous or intramuscular use. Animals should be appropriately restrained to achieve the proper route of administration. Use sterile equipment and sanitize the injection site by applying a suitable disinfectant. Clean, properly disinfected needles should be used to reduce the potential for injection-site infections.
grubs: <i>Hypoderma bovis</i> , <i>H. lineatum</i>			

Table 2.18 - Injectables - Males and Females Not of Breeding Age¹ (cont.)

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
¹ Ivermectin - Observe cattle for injection-site reactions. Reactions may be due to clostridial infection and should be aggressively treated with appropriate antibiotics.			
Ivermectin is highly effective against all stages of cattle grubs. However, proper timing of treatment is important. For most effective results, cattle should be treated as soon as possible after the end of the heelfly (warble fly) season.			
Destruction of <i>Hypoderma</i> species larvae (cattle grubs) at the period when these grubs are in vital areas may cause undesirable host-parasite reactions including the possibility of fatalities. Killing <i>Hypoderma lineatum</i> when it is in the tissue surrounding the gullet may cause salivation and bloat; killing <i>H. bovis</i> when it is in the vertebral canal may cause staggering or paralysis. These reactions are not specific to treatment with ivermectin, but can occur with any successful treatment of grubs. Cattle should be treated either before or after these stages of grub development. Consult your veterinarian or Extension entomologist concerning proper timing of treatment.			
Cattle treated with ivermectin after the end of the heelfly season may be retreated with ivermectin during the winter for internal parasites, mange mites, or lice without danger of grub-related reactions. A planned parasite control program is recommended.			
Transitory discomfort has been observed in some cattle following subcutaneous administration. A low incidence of soft-tissue swelling at the injection site has been observed. These reactions have disappeared without treatment. Divide doses greater than 10 ml between two injection sites to reduce occasional discomfort or site reaction.			
Protect from light.			
CAUTION: Ivermectin injection for cattle has been developed specifically for use in cattle and reindeer only. This product should not be used in other animal species because severe adverse reactions, including fatalities in dogs, may result.			
Refrain from smoking or eating when handling. Wash hands after using. Keep this and all drugs out of reach of children.			

Table 2.19 - Bolus

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
face flies, horn flies, house flies, stable flies	Diflubenzuron [9.7%]	Administer 0.5 bolus to cattle weighing 300-550 lb, and 1 bolus to cattle weighing 550- 1,100 lb or more. Follow directions according to label.	Do not administer to cattle weighing less than 300 lb. Never administer more than 1 bolus to any animal.

Table 2.20 - Pour-ons - Lactating Cows¹

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
horn flies, lice	Permethrin [10.0%]	Ready to use. Apply from poll down neck to shoulders and along midline of back. Use 0.125 oz/250 lbs of body weight.	Non-systemic, will not control cattle grubs. Repeat as needed, but not more often than once every 2 weeks.
face flies, horn flies, lice	Permethrin [5.0%]	Apply 0.10 oz/100 lbs of body weight, up to a maximum of 1.01 oz/animal.	Non-systemic, will not control cattle grubs. Repeat as needed, but not more often than once every 2 weeks.
	Permethrin [1.0%]	Ready to use. Apply along back and down face. Use 0.5 oz/100 lbs of body weight, up to 5 oz/animal.	Repeat as needed, but not more than once every 2 weeks.
	Permethrin [1.0%] + Piperonyl Butoxide [1.0%]	Apply at rate of 0.5 oz/100 lb body weight up to a maximum dosage of 5 oz/animal.	Repeat as needed, but not more than once every 2 weeks. Check label for additional precautions.
	Cyfluthrin [1.0%]	Rates for horn flies and face flies: 4 oz <400 lb body wt 8 oz 400 to 800 lb body wt 12 oz >800 lb body wt Rates for biting and sucking lice: 8 oz <400 lb body wt 16 oz 400 to 800 lb body wt 24 oz >800 lb body wt	Does not control cattle grubs.
	Diflubenzuron + Permethrin	See label.	
grubs, horn flies, lice sarcopic mange, chorioptic mange	Ivomec® (ivermectin) Eprinex® (eprinomectin) moxidectin	Use 1.0 ml of product for each 22.0 lb body wt. Apply along backline in a narrow strip extending from the withers to tailhead.	When used according to label, neither a pre-slaughter withdrawal period nor a milk discard time is required.

¹Avoid using products with grubicidal activity in Virginia from Nov. 1 to Feb. 1.

Table 2.21 - Pour-ons - Non-lactating Cows¹

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
face flies, horn flies, lice	Permethrin [1.0%] + Piperonyl Butoxide [1.0%]	Pour along back at rate of 0.5 oz/100 lbs body wt up to a maximum of 5 oz/animal.	Repeat as needed, but not more than once every 2 weeks. Check label for additional precautions.
grubs ² , horn flies, lice sarcopic mange, chorioptic mange	Eprinomectrin (Ivomec Eprinex)	Use 1.0 ml of product for each 22.0 lb body wt. Apply along backline in a narrow strip extending from the withers to tailhead.	When used according to label, neither a pre-slaughter withdrawal period nor a milk discard time is required.

¹Please read label carefully if other pour-ons for grub control are used on non-lactating dairy cattle.

²Avoid using products with grubicidal activity in Virginia from Nov. 1 to Feb. 1.

Table 2.22 - Ear Tags

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
face flies, horn flies	<p>Pyrethroid Class Tags Beta-Cyfluthrin insecticide, Cyfluthrin insecticide, Cypermethrin insecticide & Piperonyl Butoxide synergist, Permethrin insecticide, Permethrin insecticide & Piperonyl Butoxide synergist, Fenvalerate insecticide</p> <hr/> <p>Organophosphate Class Tags Pirimiphos-Methyl, Coumaphos, Diazinon Chlorpyrifos insecticide & Piperonyl Butoxide synergist</p> <p>Pyrethroid & Organophosphate Class Tags Cypermethrin insecticide & Chlorpyrifos insecticide & Lambda-cyhalothrin, Piperonyl Butoxide synergist, Permethrin insecticide & Chlorpyrifos insecticide & Piperonyl Butoxide synergist</p> <p>Tags From Other Classes Avermectin B1</p>	Follow directions according to labels and apply with recommended applicator.	Carefully read instructions to avoid ear damage. Remove tags before slaughter. Only tags approved for lactating dairy cows be used for lactating dairy cows, dry cows, and heifers over 20 months of age.

Table 2.23 - Mineral Mixtures and Feed Additives

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
face flies, horn flies, house flies, stable flies	Tetrachlorvinphos [7.6%] Diflubenzuron	Follow directions according to label. Start feeding in early spring before flies begin to appear, and continue throughout the summer and fall until cold weather restricts fly activity.	Check label for precautions.
horn flies (and possibly other species of filth-breeding flies)	s-Methoprene [10.5%]	Refer to label for details on proper feed to weight blending ratios.	The Ai in Altosid Cattle Custom Blending Premix is an insect growth regulator (IGR) interrupts the development of the horn fly (and possibly other species of filth-breeding flies) in the manure of treated cattle. Begin use in spring before horn flies appear on cattle and continue feeding until cold weather restricts horn fly activity. Product is safe for beef and dairy cattle, including breeding cattle, lactating cattle, and calves. Product can be fed up to slaughter and to lactating dairy cows without withholding milk.

Longhorned Tick Control for Cattle

The Longhorned Tick, *Haemaphysalis longicornis*, is a recently recognized tick in Virginia and other states in the eastern United States. If you suspect that you have this tick please submit a sample to the Insect Identification Lab or a State Veterinarian to have it confirmed. ALT can reproduce without mating, aiding rapid proliferation, and only female ticks are found in the United States. Populations can build up into extreme numbers and impact animal health. For information see:

Asian Longhorned Tick (<https://www.pubs.ext.vt.edu/ENTO/ENTO-282/ENTO-282.html>) and Managing the Asian Longhorned Tick: Checklist for Best Management Practices for Cattle Producers (<https://www.pubs.ext.vt.edu/ENTO/ENTO-382/ENTO-382.html>)

Table 2.24 - Special section for Longhorned Tick Control on Dairy Cattle

Pest	Active Ingredients <i>Sold under various trade names</i>	Insecticide Mixing and Application Information	Precautions
Longhorned Tick	Permethrin	Ready to use version. Apply from poll down neck and along midline of back. Use as a Pour on, Ready to Use, wipe on, or Back Rubber: based on label instructions.	Check label some versions are ready to use and some require dilution. Repeat as needed, but not more than once every 2 weeks.
Longhorned Tick	Permethrin	EC Spray for Beef and non-lactating dairy cattle.	Beef & non-lactating dairy cattle.

Swine External Parasites

Eric R. Day, Extension Entomologist, Virginia Tech

Table 2.25 - Sprays

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
lice	Coumaphos [25%]	Mix 2.0 lbs product in 100 gal water. Apply to point of run-off.	Check label for details.
	Tetrachlorvinphos [50%]	Dilute 4.0 lbs in 50.0 gal water. Apply as a coarse spray, using 1-2 qts/animal.	Repeat in 2 weeks if necessary.
lice, mange mites, ticks	Amitraz [12.5%]	Mix 1 can (760-ml = 25.7 oz) in 50.0 gal water (equivalent to 0.5 oz product/gal spray solution). Use solution within 6 hr of mixing. Spray entire pen area at 70-150 psi. Spray all animals to run-off and thoroughly treat jowl, legs, inside the ears, and underside of body. If necessary, make second application in 7-10 days for mites and 10-14 days for lice.	Remove feed from pen and cover drinking bowls. Remove and destroy bedding. Hose out feces and excess feed. Do not apply to swine within 3 days of slaughter. Do not treat animals more than 4 times per year.
lice, mange mites	Fenvalerate [10%]	Mix 1.0 qt product in 50.0 gal water. Wet entire animal with up to 8.0 oz of spray.	Do not apply within 1 day of slaughter.
	Phosmet [11.6%] ¹	Mix 1.0 qt product in 25.0 gal water. Apply to run-off. Repeat if necessary after 14 days.	Check label for details. Do not apply within 1 day of slaughter. Do not apply to sick, convalescent or stressed animals. Do not apply to suckling pigs.
	Permethrin [11%] Stirofos Piperonyl Butoxide + Pyrethrins s-Methoprene	Follow directions according to labels.	Check labels for precautions.

¹Do not use this product in conjunction with other cholinesterase-inhibiting drugs, pesticides, or chemicals.

Table 2.26 - Dusts

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
lice	Coumaphos [1%]	No mixing is necessary. Ready-to-use. Do not use more than 1.0 oz of product/ animal.	Do not use more frequently than once every 10 days. Wear protective clothing and gloves as recommended on the label.
	Tetrachlorvinphos [3%] ¹	Use 3-4 oz/animal. Repeat as necessary, but not more often than once every 14 days. In severe infestations, both animals and bedding should be treated. Use 1.0 lb/150.0 sq ft of bedding.	Check label for details. Wear protective clothing and gloves as recommended on the label.
	Permethrin [0.25%]	Apply up to 1.0 oz (3.0 tbsp) of dust to the head, shoulders, and neck. Repeat as necessary, but not more than once every 10 days.	Do not contaminate water, food or feed by storage or disposal. Keep container sealed when not in use.

¹Do not use this product in conjunction with other cholinesterase-inhibiting drugs, pesticides, or chemicals.

Table 2.27 - Pour-ons

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
lice, mange mites	Amitraz [2%] Fenualerate Fenthion Permethrin	Requires specially designed dosing gun. Apply proper dosage (consult chart on label) to the inside of each ear and along the midline of the back.	Restrain animals. Do not treat within 7 days of slaughter. Retreat in 7 to 10 days, if necessary. Check label for details.

Table 2.28 - Injectables

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
sucking lice (<i>Haematopinus suis</i>), mange mites (<i>Sarcoptes scabiei</i> var. <i>suis</i>)	Ivermectin [1%] (Ivomec)	Ivomec should be given only by subcutaneous injection at the recommended dose level of 300 mcg ivermectin/kgm of body wt. Each ml of Ivomec contains 10 mg of ivermectin, sufficient to treat 75 lb (33 kg) of body weight. Use of a 16- or 18-gauge 1/2 to 3/4" needle is suggested. The recommended route of administration is by subcutaneous injection in the neck, behind the ear. Use aseptic technique.	This product has been developed for use in swine only. Do not treat swine within 18 days of slaughter. This product is not for intravenous or intra-muscular use. Restrain animal to achieve the proper route of administration. Use sterile equipment and sanitize the injection site by applying a suitable disinfectant. Clean, properly disinfected needles should be used to reduce potential injection-site infection. Protect product from light. Keep this and all drugs out of reach of children.

Table 2.29 - Oral Treatments

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
lice	Gardonia Tetrachlorvinphos	See label.	See label.

Longhorned Tick Control for Swine

The Longhorned Tick, *Haemaphysalis longicornis*, is a recently recognized tick in Virginia and other states in the eastern United States. If you suspect that you have this tick please submit a sample to the Insect Identification Lab or a State Veterinarian to have it confirmed. ALT can reproduce without mating, aiding rapid proliferation, and only female ticks are found in the United States. Populations can build up into extreme numbers and impact animal health. For information see:

Asian Longhorned Tick (<https://www.pubs.ext.vt.edu/ENTO/ENTO-282/ENTO-282.html>)

Table 2.30 - Special section for Tick Control on Swine

Control Method for Ticks	Active Ingredients Sold under various trade names	Insecticide Mixing and Application Information	Precautions
Dip, Sponge, or Spray	Permethrin	Back and shoulders.	No treatments 1 week before shipping.

Sheep External Parasites

Eric R. Day, Extension Entomologist, Virginia Tech

Table 2.31 - Sprays or Dips¹

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
lice, sheep keds	Permethrin [7.4%] + Piperonyl Butoxide [7.4%], Cumaphos, Diazinon	Check label for specific application instructions.	Can be applied topically to sheep and their premises. Check label for precautions.
	Fenvalerate [10%]	Mix 1.0 qt product in 100 gal water. Wet animal with up to 1.0 qt of solution.	For use only on non-lactating sheep or goats. Repeat application in 30 days if necessary. Do not apply more than 2 times in spring and 2 times in fall. Do not apply within 2 days of slaughter.
lice, mites, sheep keds, ticks	Permethrin [11%]	Mix 1.0 pt product in 25.0 gal water. Apply 1-2 qt of coarse spray/ animal over entire body surface.	Do not contaminate feed or drinking water. Check label for details.
lice, sheep keds, ticks, fleeceworms	Coumaphos [25%]	Follow directions according to label.	Repeat as necessary but not within 15 days of slaughter.
fleeceworms	Permethrin	Follow directions according to label.	See label.

¹May be applied as a spray or dip.

Do not apply to sick, convalescent, or stressed livestock, or to any animals less than 3 months old except in Federal and State eradication programs. Do not treat animals for 10 days before or after shipping or weaning, or after exposure to contagious and infectious diseases except in Federal or State eradication programs. Do not spray in confined non-ventilated area.

Animals must be wet thoroughly to penetrate wool for control of lice next to the skin. Dipping is the most reliable method of eliminating lice on sheep.

Table 2.32 - Pour-ons

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
lice, sheep keds	Fenvalerate [10%]	Mix 4.0 oz product in 1.5 gal of water. Apply up to 4.0 oz of solution down midline of back 1-2 times in the spring.	For use only on non-lactating sheep and goats. Repeat application in 30 days if necessary. Do not apply more than 2 times in the fall pest season. One application after shearing is usually adequate for sheep ked control. Do not apply within 2 days of slaughter. Repeat as needed, but not more than once every 2 weeks.
	Permethrin [1.0%] & Piperonyl Butoxide synergist [1.0%]	Apply 0.25 oz/50 lbs of body weight, up to maximum of 3 oz/animal.	
	Permethrin [1.0%]	Ready to use. Apply along back. Use 0.25 oz/50 lbs of body weight, up to 3 oz/animal.	
	Permethrin [1.0%] + Piperonyl Butoxide [1.0%]	Apply at rate of 0.25 oz/50 lb body weight up to a maximum dosage of 3 oz/animal.	
face flies, horn flies, lice, sheep keds	Permethrin [5%]	Apply 0.05 oz/50 lbs body weight, up to 0.61 ml/animal.	Repeat as needed, but not more than once every 2 weeks

Table 2.33 - Dust

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
lice, sheep keds, ticks	Zeta-Cypermethrin [0.075%] + Piperonyl Butoxide [0.15%]	Check label for specific application instructions.	Check label for precautions. Wear protective clothing and gloves as recommended on the label.

Scabies

Sheep scabies is a disease caused by mange mites. Virginia has been declared free of this disease for several years. Nevertheless, scabies may occur occasionally on sheep in areas that have been declared free of the disease. Scabies suspected on sheep in Virginia should be reported immediately to your county Extension office or to representatives of the State Veterinarian's office of the Virginia Department of Agriculture and Commerce, Richmond, Virginia. Inspection and diagnosis is a free service. If scabies is positively identified, the necessary treatment will be applied without charge by the Virginia Department of Agriculture and Consumer Services.

Longhorned Tick Control for Sheep and Goats

The Asian Longhorned Tick, *Haemaphysalis longicornis*, is a recently recognized tick in Virginia and other states in the eastern United States. If you suspect that you have this tick please submit a sample to the Insect Identification Lab or a State Veterinarian to have it confirmed. ALT can reproduce without mating, aiding rapid proliferation, and only female ticks are found in the United States. Populations can build up into extreme numbers and impact animal health. For information see:

Asian Longhorned Tick (<https://www.pubs.ext.vt.edu/ENTO/ENTO-282/ENTO-282.html>)

Table 2.34 - Special section for Longhorned Tick Control on Sheep and Goats

Control Method for Ticks	Active Ingredients <i>Sold under various trade names</i>	Insecticide Mixing and Application Information	Precautions
Spot-on	Permethrin	Back and shoulders.	For animals older than 1 month.
Dip vat	Permethrin	Concentrate, diluted as per label instructions.	Wet fleece, hair-coat, through to the skin.
Pour On	Permethrin	Head, neck, and on top line of back.	Check label some versions are ready to use and some require dilution.
Dip	Permethrin	Hand soak or sponge.	
Emulsifiable concentrate spray	Permethrin	Treat head, neck, and along top-line.	
Ready to use spray	Permethrin	Spot treat by spraying directly onto ticks.	
Aerosol spray	Permethrin	Spray onto ticks in and outside the ears.	
Backrubber	Permethrin	Use where sheep congregate.	Keep applicator fully charged.

Horse External Parasites

Eric R. Day, Extension Entomologist, Virginia Tech

Research conducted in Virginia indicates that petroleum jelly applied in the ears of horses will provide up to 4 days protection from black flies.

Table 2.35 - Oral

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
bots	Ivermectin [1.87%]	Administer paste with single oral syringe at the dose rate of 91 mcg/lb. Each weight marking on the plunger delivers enough paste to treat 250 lb. It is important to know your horse's weight in order to calculate the proper dosage.	Refrain from smoking or eating when handling. Avoid contact with the eyes. Wash hands thoroughly after administration. Do not contaminate ground water. Swelling and itching reactions sometimes occur with severe infections. Consult a veterinarian if condition does not improve.
	Ivermectin [10 mg]	For liquid, 10 mg will treat a 1,100 lb horse. Read label for step-by-step instructions.	

Table 2.36 - Sprays and Wipe-ons

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
horn flies, lice, screwworms, ticks	Coumaphos [25%]	For horn flies and lice, mix 2 lb product in 100 gal water. To control ticks mix 4.0 lbs product in 100 gal water. To control screwworms mix 8.0 lbs product in 100 gal water.	Check label for precautions. Do not contaminate feed or water.
face flies, horn flies, house flies, stable flies	Fenvalerate [10%]	Mix 1.0 qt product in 25.0 gal water. Apply 8.0 oz as light spray with attention to head and legs. Repeat as necessary.	Do not treat animals intended for slaughter.
deer flies, horn flies, house flies, horse flies, mosquitoes	Tetrachlorvinphos [1%] + Pyrethrins [0.09%] + Piperonyl Butoxide [0.18%] + Repellent [0.8%]	No mixing is necessary. Available in ready-to-use form. Apply 1.0-2.0 oz/ animal as a wipe-on or spray to evenly cover the flanks, belly, and back of the horse or pony.	Do not allow product to come in contact with eyes. More frequent applications may be necessary if the legs are exposed to high grass and water. Do not treat slaughter animals. Repeat as necessary on perspiring animals.
face flies, house flies	Tetrachlorvinphos [1%] + Pyrethrins [0.09%] + Piperonyl Butoxide [0.18%] + Repellent [0.8%]	Apply 1.0-2.0 oz/animal as a wipe-on preferably to the head area. Pay particular attention to area around the nostrils and eyes.	Do not allow product to come in contact with eyes. Do not treat slaughter animals. Repeat as necessary on perspiring animals.

Table 2.36 - Sprays and Wipe-ons (cont.)

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
stable flies	Tetrachlorvinphos [1%] + Pyrethrins [0.09%] + Piperonyl Butoxide [0.18%] + Repellent [0.8%]	Apply 1.0-2.0 oz/animal as a wipe-on or spray to the legs and flanks, leaving no unprotected area. More frequent application may be necessary if the legs are exposed to high grass or water. Repeat as necessary on perspiring animals.	Do not allow product to come in contact with eyes.
biting gnats	Tetrachlorvinphos [1%] + Pyrethrins [0.09%] + Piperonyl Butoxide [0.18%] + Repellent [0.8%]	Apply 1.0-2.0 oz/animal as a wipe-on preferably to the head, neck, belly, and forelegs. Be sure to apply to the inside surfaces of the ears.	Check label for details. Do not allow product to come in contact with eyes. Repeat as necessary on perspiring animals.
horse flies, house flies, stable flies, face flies, horn flies, deer flies, gnats, mosquitoes, lice, deer ticks	Cypermethrin [0.15%] + Pyrethrins [0.2%] + Piperonyl Butoxide [1.6%] + Butoxypoly-propylene glycol [5%]	Shake well before using. Shampoo and rinse dirty horses thoroughly. Wait until coat is dry before applying. For horse's face, always apply as a wipe. Use clean, absorbent cloth, towel or sponge. Spray or wipe entire body while brushing against the lay of the coat. Apply liberally. Reapply every 5-7 days initially, then every 10-14 days, and reapply each time animal is washed or exposed to heavy rain.	Wear rubber gloves or mittens when applying as a wipe. Avoid getting spray in horses eyes, nose or mouth.
lice, stable flies, horn flies, face flies, deer flies, eye gnats, ticks	Permethrin [7.4%] + Piperonyl Butoxide [7.4%] Dichlorvos Synthrin s-Methoprene Cyphenothrin	Can be applied topically to horses. Check label for specific application instructions	Check label for precautions.
black flies	petroleum jelly	Apply to the inside of the ears.	

Table 2.37 - Hand Dusting

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
horn flies, lice, ticks	Zeta-Cypermethrin [0.075%] + Piperonyl Butoxide [0.15%]	Check label for specific application instructions.	Wear protective clothing and gloves as recommended on the label.
horn flies, lice	Permethrin [0.25%] (horse lice duster)	Ready to use. Apply 2.0 oz dust per animal to the head, neck, shoulders, and back and tailhead.	Avoid getting dust in the animal's eyes. Wear face mask respirator when applying dust formulations. Wear protective clothing and gloves as recommended on the label.

Longhorned Tick Control for Equids

The Longhorned Tick, *Haemaphysalis longicornis*, is a recently recognized tick in Virginia and other states in the eastern United States. If you suspect that you have this tick please submit a sample to the Insect Identification Lab or a State Veterinarian to have it confirmed. ALT can reproduce without mating, aiding rapid proliferation, and only female ticks are found in the United States. Populations can build up into extreme numbers and impact animal health. For information see:

Asian Longhorned Tick (<https://www.pubs.ext.vt.edu/ENTO/ENTO-282/ENTO-282.html>) and Managing the Asian Longhorned Tick: Checklist of Best Tick Management Practices for Horse Owners (<https://www.pubs.ext.vt.edu/ENTO/ENTO-348/ENTO-348.html>)

Table 2.38 - Special section for Longhorned Tick Control on Equids

Control Method for Ticks	Active Ingredients <i>Sold under various trade names</i>	Insecticide Mixing and Application Information	Precautions
Spot-on	Permethrin	Head, neck, and on top line of back and where ticks are found.	Check label some versions are ready to use and some require dilution.
Spot On	Permethrin	Head, neck, and on top line of back and where ticks are found.	Safe for foals older than 3 months.
Ready to use spray	Permethrin	Head, neck, and on top line of back and where ticks are found.	Spot treat legs, tail, mane, and ears.
Aerosol spray	Permethrin	Ready to use.	Spray onto ticks in and outside the ears.
Backrubber	Permethrin	Use where horses congregate or loaf.	Keep applicator fully charged.
Dip	Permethrin	Hand soak or sponge.	Wet to skin, drip dry, avoid face.
Garment/cover	Permethrin	Leg or blanket covering.	Deterrent.
Wipe-on	Permethrin	Use mitt.	Safe for foals older than 3 months.

Poultry External Parasites

Eric R. Day, Extension Entomologist, Virginia Tech

Table 2.39 - Caged Layer Treatments

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
northern fowl mite ¹	Permethrin [5.7%]	Mix 1 qt product in 25.0 gal of water. Apply 1.0 gal of diluted spray/100 birds. Be sure to treat vent area thoroughly.	Check label for precautions and apply only to animals listed on label.
lice, mites	Tetrachlorvinphos [50%]	Mix 8.0 lb product in 100 gal of water. Apply at a rate of 1.0 gal solution/100 birds. Spray, vent, and fluff areas from below. Repeat when necessary. For northern fowl mite, use a power sprayer at 100-125 psi.	Do not repeat more often than once every 14 days. Treat roosters carefully and individually to avoid reinfestation of breeding flocks.
	Tetrachlorvinphos [23%] & Dichlorvos [5.3%]	Mix 1.0 gal product in 50.0 gal of water. Apply 1.0 gal of solution/100 birds under high pressure (no less than 100-125 psi) to the vent and fluff areas from below.	Repeat as needed but not more often than once every 14 days. Treat roosters carefully and individually to avoid reinfestation of breeding flocks.
lice, mites	Cumaphos	3.0-6.0 oz/5 gal of water.	3.0-oz rate for mites. 6.0-oz rate for lice.
	Sevin	Mix 4.0 oz/5 gal of water. Use 1 gal/100 birds.	Check label for precautions. Wear protective clothing and gloves as recommended on the label.
lice, mites	Piperonyl + Pyrethrins s-Methoprene	See label.	Check label for precautions. Wear protective clothing and gloves as recommended on the label.

¹This treatment will aid in the control of adult house flies.

Table 2.40 - Litter Treatment

Pests	Insecticide Active Ingredient [Percent A.I. in Product]	Mixing and Application Information	Precautions
lice, mites (including northern fowl mite), litter beetles	Tetrachlorvinphos [50%]	Mix 4.0 lbs product in 50.0 gal of water. Apply 1.0-2.0 gal of spray/100 square feet. Can be used as a dry dust. Use 0.75 oz product/100 sq ft. Use a rotary, mechanical or electrostatic duster.	Wear a face mask when applying.
lice, mites	Sevin, Dichlorvos, Tetrachlorvinphos	Follow label	Check label for precautions. Wear protective clothing and gloves as recommended on the label.

Longhorned Tick Control for Poultry

The Longhorned Tick, *Haemaphysalis longicornis*, is a recently recognized tick in Virginia and other states in the eastern United States. As of 2023 the Longhorn Tick has not been found on poultry. If you suspect that you have this tick please submit a sample to the Insect Identification Lab or a State Veterinarian to have it confirmed. ALT can reproduce without mating, aiding rapid proliferation, and only female ticks are found in the United States. Populations can build up into extreme numbers and impact animal health. For information see:

Asian Longhorned Tick (<https://www.pubs.ext.vt.edu/ENTO/ENTO-282/ENTO-282.html>)

Table 2.41 - Special section for Longhorned Tick Control on Poultry

Control Method for Ticks	Active Ingredients Sold under various trade names	Insecticide Mixing and Application Information	Precautions
Dip wash	Permethrin	Wet feathers through to skin and air dry.	Check label some versions are ready to use and some require dilution.
Emulsifiable concentrate spray	Permethrin	Spray/soak plumage, skin, and vent.	Wear protective clothing when making applications.
Ready to use dust or spray	Permethrin	Spot treat legs, tail, wings & comb. For dust, treat at the rate 1 lb. per 100 birds, make sure vent area is treated.	Wear protective clothing. If using dust, include a NIOSH approved respirator.

Disease and Nematode Management in Corn and Sorghum

David Langston, Extension Plant Pathologist, Virginia Tech Tidewater AREC

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General Considerations

The yield and quality of field crops are reduced to some degree by diseases and nematodes each year. Management strategies for disease and nematode control vary by crop, field, and year. An **integrated** approach is necessary to minimize unnecessary inputs and maximize profits to the grower. Integrated disease and nematode management combines multiple approaches including cultivar selection, cultural practices such as crop rotation, and judicious use of pesticides based on disease advisories, economic thresholds, and/or scouting. The following points should be considered when making disease and nematode management decisions:

- **Susceptibility of crop variety to disease and/or nematodes.** Varieties have a high turnover rate so check with your local extension office or seed dealer for current information on which varieties have some level of resistance. Be aware of the specific diseases and nematodes your variety is susceptible or resistant to.
- **Yield potential and commodity price.** If yield potential or price received is low, you do not have much to gain and pesticide applications are less likely to be profitable.
- **Previous crop and cropping system (e.g. no till).** Many pathogens are able to survive on crop residues. Tillage and rotation to non-host crops helps bury and decompose this residue. Keep in mind that some pathogens require a living plant host and must move in from warmer regions each year (e.g. some rusts). Crop parasitic nematodes need a plant host to reproduce, so nematodes with a narrow host range can be controlled by rotating to a non-host.
- **Crop growth stage and timing of fungicide applications.** Diseases are more likely to impact yield at particular growth stages of the crop (typically during development of the grain) and fungicide applications should be timed accordingly to maximize efficacy.
- **Proper pathogen and nematode identification.** Field crops can be affected by a variety of fungi, bacteria, viruses, and nematodes. Each type of pathogen requires a different approach for disease management. Many abiotic issues including compaction, drought, nutrient deficiencies, and chemical damage can appear similar to some diseases. Proper identification of biotic and abiotic problems impacting the crop are key to avoiding ineffective or unnecessary chemical applications.
- **Disease and nematode pressure.** Are diseases present at amounts that require intervention? Scout fields regularly to maximize profits. Future nematode management decisions can be based on economic damage thresholds if crop parasitic nematode populations are quantified at harvest.
- **Weather.** Temperature and humidity greatly influence the onset and development of disease. Even if the crop is susceptible and a pathogen is present, the risk of yield loss to disease may be low if environmental conditions are not conducive for pathogen growth and reproduction. Warm, humid conditions favor many foliar diseases in our region. In some cases, the micro-climate within a field may be conducive for disease development even when ambient conditions are relatively dry, especially when high plant populations and a dense canopy are present in a field.

All of these factors should be considered before making plant disease and nematode management decisions, especially before applying a fungicide or nematicide that may or may not be needed. **Plant pathogens and nematodes are most effectively managed by integrating several of the following practices:**

1. **Adapted, disease and nematode resistant cultivars** - produce plants able to resist pathogen and nematode attack. Every variety has a resistance “package” that provides levels of resistance or tolerance to specific pests. This information can be obtained from seed dealers, commercial companies, and University variety trials such as those conducted at Virginia Tech and The University of Delaware. Some diseases and nematodes cannot be managed with resistance, and not every variety has adequate resistance to all potential pests. However, growers who do not consider resistance when selecting varieties are taking a considerable and likely a costly, risk.
2. **Rotation** - avoid build up of pathogens and nematode populations by not continually planting the same crop in the same fields year after year. Rotation reduces the amount of residue, and therefore the amount of some pathogens, in fields. Rotation also is essential for reducing populations of some plant parasitic nematodes.

3-2 Disease and Nematode Management in Field Crops: *Corn and Sorghum*

- 3. Sanitation** – use tillage when possible and manage weeds. Deep tillage (not disking) buries plant pathogens, favoring their decomposition and reducing their ability to reach the plant and cause damage. However, many pathogens are “regional” and therefore disking one field may not have any impact on disease if nearby fields contain ample residue. In addition, the widespread use of conservation or no-till agriculture prohibits the use of tillage, making it impractical in many cases.
- 4. Planting date** - avoid pathogens or reduce the infection period by avoiding early planting. This is particularly effective in managing seedling diseases.
- 5. Seed bed preparation and balanced fertility** - provide good seed to soil contact and fertility to promote vigorous plant stands. Healthy plants are likely to be less stressed and less prone to some diseases and damage from parasitic nematodes.
- 6. Good quality, disease-free seed** - promote healthy, vigorous seedling development. In addition, some pathogens can move in or on seed. Using clean, certified seed can help reduce the development of these and maximize stands.
- 7. Chemical control** - judicious use of fungicides and nematicides is necessary in some cropping situations. If pathogen or nematode pressure is high, chemical control may be needed to protect crop yields.

This section includes lists of fungicides and nematicides that are currently registered for use in field crops in the region. The information in this section is provided as a guide to available products but does not substitute for or supersede the information found on the pesticide label of a specific product. Trade names are included to aid in the identification of the specific active ingredient of a pesticide known to be effective. No discrimination against a similar product is intended or implied by omission. Mention of a commercial product does not constitute an endorsement by the authors or by their respective Extension Services. Consult the pesticide label for any changes in rate, timing, handling, or registration. Use pesticides only as directed.

Corn and Sorghum Diseases

Seed and Seedling Diseases of Corn and Sorghum

Seed treatment for corn continues to be a highly effective and inexpensive disease management tool for early-season seed and soilborne problems. In particular, because corn yield depends on plant population, seed treatments help to protect the yield potential by reducing stand losses from early-season diseases. As a result all major brands of hybrid seed are sold already treated. Similarly, hybrid sorghum production also benefits from seed treatments, as nontillering types depend on emergence to achieve optimum plant populations. Treating sorghum seed is also important for preventing the development of certain seedborne smut diseases, the systemic form of downy mildew and for reducing the introduction of and damage caused by sorghum ergot. Hybrid sorghum seed, like corn, is therefore sold already treated.

Foliar Diseases of Corn

A few chemical control measures are registered for foliar diseases of corn. However, they are generally not necessary when resistant hybrids and proper crop rotations are employed. Occasionally, when a highly susceptible hybrid is planted no-till into corn stubble and favorable conditions develop for a disease such as gray leaf spot, an economic return on a fungicide can be realized. Use resistant hybrids, especially in continuous no-till production systems. Many disease causing organisms are harbored in infested corn debris; thus, they are more readily available to infect corn in systems where debris remains on the soil surface and is allowed to build up. Foliar fungicides do not directly control stalk rots. However, lodging due to stalk rotting can be reduced through the management of foliar diseases. Hybrids with resistance to leaf diseases or susceptible hybrids treated with a fungicide are less likely to have severe stalk rotting. Hybrids with good “stay green” characteristics are also less likely to have severe stalk rotting. Foliar fungicide use in the absence of foliar disease pressure or risk is not recommended.

Gray Leaf Spot, Southern Corn Leaf Blight, and Northern Corn Leaf Blight

Three economically important blighting diseases of corn in Virginia and the mid-Atlantic region are gray leaf spot (*Cercospora zea-maydis*), southern corn leaf blight (*Bipolaris maydis*), and northern corn leaf blight (*Setosphaeria turcica*). Gray leaf spot is recognized by its characteristically long rectangular lesions (1/8 - 1/4 inch wide and 1/2 to 2 1/2 inches in length). These lesions typically show a grayish cast when the fungus is sporulating. As the disease progresses from the lower leaves upward and the disease becomes more severe, lesions may coalesce and cause the death of the entire leaf. (See Virginia Cooperative Extension Fact Sheet: Grayleaf Spot Disease of Corn, Pub. No. 450-612, at <http://pubs.ext.vt.edu/450/450-612/450-612.html>). Northern corn leaf blight lesions are long (2 - 6 inches), wide (1 - 1.5 inches), and elliptical or boat-shaped. Lesions are tan to

gray-green and may show faint concentric rings of spores on the lesion surface. Southern corn leaf blight lesions are elongated between veins, tan, and up to 1 inch long with parallel margins. Southern leaf blight is favored by warmer weather compared to northern leaf blight and gray leaf spot.

Yield Loss

Foliar diseases are most damaging when leaves are blighted at or just after silking stage. At this critical time disease can cause severe yield reduction. Early blighting of the leaves above the ear leaf on susceptible hybrids has led to severe yield losses often exceeding 50% in experimental plots in Virginia. Blighting that does not occur until the R5 (dent) growth stage results in very little grain loss. Premature stalk death and lodging is enhanced by severe leaf blighting and leads to difficulty in mechanically harvesting. Hybrids that are more resistant and slow to blight may prevent significant yield reduction.

Epidemiology

An understanding of the epidemiology of these foliar fungal pathogens is helpful in understanding why disease has increased in intensity, severity, and distribution over the past 25 years. *C. zea-maydis* and other fungal pathogens overwinter in the debris of previously diseased corn plants remaining on the soil surface. In spring, conidia (spores) are produced and disseminated to corn plants by wind and splashing rain. These conidia require several days of high relative humidity to germinate and infect corn leaves. Several weeks may be required for the development of mature lesions on leaves. Conidia for secondary spread are produced from two to four weeks after initial leaf infection. No till or minimal till production systems serve as overwintering sources for the fungus and provide the primary inoculum to produce severe levels of foliar disease in the next season.

Management of Gray Leaf Spot, Southern Corn Leaf Blight, and Northern Corn Leaf Blight

In conventional tillage systems, burying residue through tillage will significantly reduce disease pressure for the subsequent corn crop. Growers utilizing a minimal tillage system should promote residue decomposition by sizing residue, turbo tilling, or lightly disking fields. Avoid planting into unworked corn residue. Growers should continue to use conservation tillage methods wherever practical, but consider planting different crops in rotation with corn in their farming system. A one- or two-year rotation away from corn will help reduce inoculum levels of these fungal pathogens. However, infested (diseased) corn debris on adjacent fields may be plentiful enough to initiate significant disease losses on moderately- to highly-susceptible hybrids. Growers with a history of gray leaf spot in their fields are encouraged to select one or more of the newer gray leaf spot resistant hybrids. Selection should be based on yield potential and standability under gray leaf spot pressure.

Common and Southern Rust

Common and Southern rusts can occasionally cause yield loss in the mid-Atlantic region. The fungi causing rusts require a living host to survive and reproduce and as a result do not survive the winter months. Each growing season these pathogens must blow into the mid-Atlantic from central America and parts of the deep south. Damage is dependent on when these diseases arrive relative to the growth stage of corn. Arrival of either disease before the R3 (milk) growth stage could result in significant yield loss under the appropriate conditions. Rusts are characterized by orange pustules that occur on foliage. When these pustules are rubbed against hands or clothing they will leave an orange to brown, rusty color (hence the name rust). Common rust pustules are often ellipsoid, cinnamon brown, and can be found on both the upper and lower surfaces of the leaf. In contrast, Southern rust forms round, brown to orange pustules that are found predominantly on the upper leaf surface. Pustules may also be found on husks and stalks. Disease development of common rust is favored by moderate temperatures (42-77°F) whereas Southern rust prefers warmer weather (77-82°F). Hot temperatures limit the development of common rust and causes pustules to become inactive. As a result, Southern rust typically arrives later in the growing season (July-August) compared to common rust.

Yield Loss

Rusts are most damaging when they reach the ear leaf or above by R3. Estimates for yield losses vary, but range from 3-8% for each 10% of total leaf area infected by the R5 (dent) growth stage.

Management of Rusts

Selection of hybrids with good resistance is the primary means of managing both rusts. In 2008, a race of Southern rust was identified that was able to overcome a Southern rust resistance gene. Fungicides applied preventatively can help to manage rusts; however, optimal timings likely differ for the two diseases. Movement of Southern rust can be monitored on the ipmPIPE website (<https://corn.ipmPIPE.org/southerncornrust/>).

3-4 Disease and Nematode Management in Field Crops: *Corn and Sorghum*

Stalk Rots

Stalk rots are the most common and devastating diseases/disorders affecting corn. These diseases are insidious, and often growers are unaware of their effects until harvest. Low levels of stalk rot occur in nearly every corn field in the mid-Atlantic, and severity and incidence varies from year to year. Losses of over 50% can occur in severe cases.

Stalk rot pathogens decay the central pith, which weakens the stalk. One can envision a healthy stalk being a solid rod of plant tissue. A rotted stalk is no more than a tube with decaying pith loosely packed inside. Thus, corn suffering from stalk rot may easily lodge when exposed to windy conditions. Initial symptoms of stalk rots include premature wilting and ear drop. As the disease progresses stalks senesce rapidly and turn brown to grey.

Factors that Favor Stalk Rots

Carbohydrate Stress

Carbohydrate stress in corn can be caused by either limits to photosynthesis or over-commitment of carbohydrate resources to the ear. The following are generalizations. For more detailed information refer to agronomy texts or primary literature.

Limitation to photosynthesis can be caused by numerous factors. The most important factors impacting stalk rots in corn are foliar diseases, insect damage, cloud cover, high plant density, and nutrient and water deficiencies. Disease and insect damage reduce the amount of photosynthetic area, thereby reducing the overall carbon budget. As levels of damage to foliage by pathogens and pests increase, so too does the amount of stalk rot. Cloud cover and high planting density reduce the amount of light accessible to foliage and therefore photosynthetic rate. High planting densities also can limit access to water and nutrients, which reduce photosynthetic rate through other mechanisms.

Hybrid characteristics such as a large cob size and high kernel numbers may predispose plants to stalk rots. This is because the aforementioned factors increase the amount of “pull” the cob has on the plant carbon budget. After flowering, the carbohydrates, produced through photosynthesis in the ear leaf, are preferentially diverted to the ear. However, if the ear leaf cannot meet the demands of grain fill, carbohydrates are mobilized from the root and stalk. Without a sufficient carbohydrate supply, the production of chemicals for defense of plant tissues is reduced, resulting in increased levels of infection by stalk rotting pathogens. For this reason, many of the stalk-rotting pathogens are opportunistic, and disease is caused by whatever organism happens to be in the vicinity when carbohydrate stress occurs

Fertility

Limited access to nutrients critical to photosynthesis can cause carbohydrate stress and increase stalk rots. Although there is variability in terms of specific nutrients and diseases, in general, stalk rots increase when nutrients are lost during the growing season. Conversely, over fertilization can cause excessively lush growth. Lush growth is often structurally weak and easily invaded by fungi.

Water

Limitations to water impact the amount of gaseous carbon that moves to the foliage from the atmosphere. Plants contain tiny openings in the foliage and stems that allow gas exchange. When water is plentiful, these openings open. When water is deficient, these openings close, which limits the amount of carbon that enters the plant leaf and therefore the amount of carbohydrates available for grain fill, plant defense, etc. Therefore, any factor that limits the ability of the plant to access water may ultimately predispose the plant to stalk rot. Excessively wet conditions can leach nitrogen from the soil and stress roots, facilitating fungal infection.

Hybrid Genetics

Hybrids differ in their susceptibility to stalk rots. In general, hybrids with low ratings of stalk strength or those that produce exceptionally large ears tend to be more prone to stalk rots than those with strong stalks and smaller ears. Hybrids also can differ in their water and nutrient use profiles, which as mentioned previously, impact the carbon budget of the plant.

Management

Management of stalk rots should include the use of: 1) hybrids with resistance to stalk rot pathogens and/or high ratings of stalk strength and stay green characteristics; 2) a balanced fertility program based on the environment, population, and hybrid; 3) programs to control foliar diseases and insects; 4) irrigation to avoid drought stress.

Fungicide Efficacy for Control of Corn Diseases

The Corn Disease Working Group (CDWG) has developed the following information on fungicide efficacy for control of major corn diseases in the United States. Efficacy ratings for each fungicide listed in the table were determined by field testing the materials over multiple years and locations by the members of the committee. Efficacy ratings are based upon level of disease control achieved by product, and are not necessarily reflective of yield increases obtained from product application. Efficacy depends upon proper application timing, rate, and application method to achieve optimum effectiveness of the fungicide as determined by labeled instructions and overall level of disease in the field at the time of application. Differences in efficacy among fungicide products were determined by direct comparisons among products in field tests and are based on a single application of the labeled rate as listed in the table. **Table includes systemic fungicides available that have been tested over multiple years and locations. The table is not intended to be a list of all labeled products¹.** Efficacy categories: NR=Not Recommended; P=Poor; F=Fair; G=Good; VG=Very; Good; E=Excellent; NL = Not Labeled for use against this disease; U = Unknown efficacy or insufficient data to rank product.

Table 3.1 - Fungicides for Management of Foliar Diseases in Corn

Class	Active ingredient (%)	Product/Trade name	Rate/A (fl oz)	Anthracnose leaf blight	Common rust	Gray leaf spot	Northern leaf blight	Southern rust	Harvest Restriction ²
QoI Strobilurins Group 11	azoxystrobin 22.9%	Quadris 2.08 SC, Multiple Generics	6.0 – 15.5	VG	E	E	G	G	7 days
	pyraclostrobin 23.6%	Headline 2.09 EC/SC	6.0 – 12.0	VG	E	E	VG	VG	7 days
	picoxystrobin 22.5%	Approach 2.08 SC	3.0 – 12.0	VG	VG-E	F-VG	VG	G	7 days
DMI Triazoles	propiconazole 41.8%	Tilt 3.6 EC, Multiple Generics	2.0 – 4.0	NL	VG	G	G	F-G	30 days
	prothioconazole 41.0%	Proline 480 SC	5.7	U	VG	U	VG	G	14 days
Group 3	tebuconazole 38.7%	Folicur 3.6 F, Multiple Generics	4.0 – 6.0	NL	U	U	VG	F-G	36 days
	tetraconazole 20.5%	Domark 230 ME, Multiple Generics	4.0 – 6.0	U	U	E	U	G	R3 (milk)
Mixed mode of action	flutriafol 20.9%	Xyway LFR 1.92 SC LFR	7.6 – 15.2	NL	U	NL	G	VG	N/A
	azoxystrobin 13.5%	Quit Xcel 2.2 SE, Multiple Generics	10.5 – 14.0	VG	VG-E	E	VG	VG	30 days
	benzovindiflupyr 2.9%	Trivapro 2.21SE	13.7	U	U	E	VG	E	30 days
Group 7	azoxystrobin 10.5%	Approach Prima 2.34 SC	3.4 – 6.8	U	U	E	VG	G-VG	30 days
	propiconazole 11.9%								
	cyproconazole 7.17%								
Group 11	picoxystrobin 17.94%	Fortix 3.22 SC, Preemptor 3.22 SC	4.0 – 6.0	U	U	E	VG-E	VG	R4 (dough)
	flutriafol 19.3%								
	fluoxastrobin 14.84%								

Table 3.1 - Fungicides for Management of Foliar Diseases in Corn (cont.)

Class	Fungicide(s)				Common rust	Gray leaf spot	Northern leaf blight	Southern rust	Harvest Restriction ²
	Active ingredient (%)	Product/Trade name	Rate/A (fl oz)	Anthracnose leaf blight					
Mixed mode of action	pyraclostrobin 13.6%	Headline AMP 1.68	10.0 – 14.4	U	E	VG	G-VG	20 days	
	metconazole 5.1%	SC							
	prothioconazole 16.0%	Delaro 325SC	8.0 – 12.0	VG	E	VG	VG	14 days	
	trifloxystrobin 13.7%								
	prothioconazole 14.9%	Delaro Complete	4.0 – 12.0 fl oz	U	U	VG-E	G-VG	14 days	
	trifloxystrobin 13.1%								
	fluopyram 10.9%								
	pydiflumetofen 7.0%	Miravis Neo	13.7	U	U	VG-E	VG	30 days	
	azoxystrobin 9.3%	2.5SE							
	propiconazole 11.6%								
	mefentrifluconazole 17.56%	Veltyma	7.0 – 10.0	U	U	U	U	21 days	
	pyraclostrobin 17.56%								
	bixafen 15.55%	Lucento	3.0 – 5.5	U	U	U	U	30 days	
	flutriafol 26.47%								
	pyraclostrobin 28.58%	Priaxor	4.0 – 8.0	U	VG	VG-E	G	21 days	
	fluxapyroxad 14.33%	4.17 SC							
	trifloxystrobin 32.3%	Stratego YLD	4.0 – 5.0	VG	E	VG	G-VG	14 days	
	prothioconazole 10.8%	4.18 SC							
	azoxystrobin 9.35%	Affiance 1.5 SC	10.0 – 17.0	U	U	G-VG	G	7 days	
	tetraconazole 7.48%								
	flutriafol 18.63%	TopGuard EQ	5.0 – 7.0	U	F	VG	U	45 days	
	azoxystrobin 25.30%								
	flutriafol 15.7%	Adastrio 4.0	7.0 – 9.0	U	U	U	U	30 days	
	azoxystrobin 15.7%	SC							
	fluidapyr 10.5%								
	mefentrifluconazole 26%	Revylok	4.5 – 6.5	U	U	VG-E,	VG	21 days	
	fluxapyroxad 8.7%								

Table 3.1 - Fungicides for Management of Foliar Diseases in Corn (cont.)

¹Additional fungicides are labeled for disease on corn, including contact fungicides such as chlorothalonil. Certain fungicides may be available for diseases not listed in the table, including Gibberella and Fusarium ear rot. Applications of Proline 480 SC for use on ear rots requires a FIFRA Section 2(ee) and is only approved for use in Illinois, Indiana, Iowa, Louisiana, Maryland, Michigan, Mississippi, North Dakota, Ohio, Pennsylvania, and Virginia.

²Harvest restrictions are listed for field corn harvested for grain. Restrictions may vary for other types of corn (sweet, seed or popcorn, etc.), and corn for other uses such as forage or fodder. Many products have specific use restrictions about the amount of active ingredient that can be applied within a period of time or the amount of sequential applications that can occur. Please read and follow all specific use restrictions prior to fungicide use. This information is provided only as a guide. It is the responsibility of the pesticide applicator by law to read and follow all current label directions. Reference to products in this publication is not intended to be an endorsement to the exclusion of others that may be similar. Persons using such products assume responsibility for their use in accordance with current directions of the manufacturer. Members or participants in the CDWG assume no liability resulting from the use of these products.

Nematodes Affecting Corn

Cultural practices, in particular rotation with non-host crops or fallow, are the most effective nematode management tactics. The length of rotation needed depends on nematode population level and species. Only when these practices are not feasible should chemical control measures be considered. Fumigant nematicides are not recommended. Non-fumigant nematicides will suppress populations and reduce infection but will not provide full-season control. Seed treatments have early season activity against nematodes. Until more independent test information is available, expect seed treatment control of nematodes to be shorter-lived than soil treatments. Nematode infestations are not uniformly distributed in fields. Therefore, plan to treat problem sites rather than whole fields. Base the need for a nematicide on the results of a soil test for the presence and level of plant parasitic nematodes and on the site history. The best time to collect samples for nematode testing is fall, immediately after harvest. Before deciding to use a nematicide, consult your county Extension office for information on proper soil sampling procedures for nematode testing and for information on threshold levels. Nematode testing is available for a fee through Virginia Cooperative Extension and some commercial soil testing laboratories.

Table 3.2 - Corn Nematicides

Nematodes	Active ingredient	Trade name	Application rate per acre	PHI (days)	Remarks
Southern root-knot, stubby-root, sting, lesion, lance, and stunt	terbufos	Counter 20G	5.0-6.5 oz	7	Apply at planting in seed furrow or 8 in. band over row and incorporate in soil. Use of ALS herbicides on corn treated with Counter may cause crop injury.
	clothianidin + <i>Bacillus firmus</i>	Poncho/ Votivo	2.7 fl oz/80,000 seeds	-	Must be applied to seed by commercial liquid application equipment for suppression of insect pests and nematodes
	abamectin + thiamethoxam	Avicta Duo	Rate based on seed count per bag	-	Application only in Syngenta-certified corn seed treatment facilities having closed transfer and application systems.
	<i>Burkholderia rinojensis</i>	BioST Nematicide 100	8 oz/100 lb seed	-	Also provides protection against soil dwelling insects.
	fluopyram	Velum	3.0 - 6.84 fl oz/acre	PHI = 30	Apply specified dosage using any of the following methods: <ul style="list-style-type: none"> • In-furrow spray during planting directed on or below seed. • Chemigation into root-zone through low-pressure drip or trickle irrigation.
	abamectin	Averland	4.0 - 6.0 fl oz/acre		Apply in-furrow in a minimum of 5 gallons per acre of final volume as a spray or dribble directed on the seed during planting. rates are based on a 30" row spacing.

Foliar, Stalk, and Grain Diseases of Sorghum

Diseases impacting sorghum grain production in the mid-Atlantic include anthracnose, stalk rots, and head mold. *Colletotrichum sublineolum*, the causal agent of sorghum anthracnose, infects vegetative portions of the plant (leaf, stalk), the panicle, and the grain, and significant yield losses to this disease have been documented. Stalk rots, caused by fungi including *C. sublineolum* and *Fusarium* spp., can interfere with grain filling and cause lodging of the sorghum plant. Head mold of sorghum, caused by various fungi including mycotoxin-producing *Fusarium* spp., reduces grain mass and quality, has the potential to result in mycotoxin contamination of the grain, and may result in further grain deterioration during storage. Best management practices for controlling fungal diseases of sorghum include selection of resistant hybrids, maintaining soil fertility, and timely harvest so that fungal deterioration and mycotoxin contamination of grain is less likely to occur. Sorghum anthracnose can be controlled with foliar applications of the registered fungicides listed below.

Table 3.3 - Foliar Applied Fungicides for Sorghum

Active ingredient	Fungicide trade name	Application rate per acre	PHI (days)	Remarks
azoxystrobin	Quadris, Multiple Generics	6.0-15.5	14	Group 11 fungicides. To reduce the development of fungi resistant to this group of fungicides, do not apply more than two sequential applications of this or other group 11 containing fungicide per season.
azoxystrobin + propiconazole	Quilt, Xcel, Multiple Generics	10.5-14.0	21	Group 11 fungicides. To reduce the development of fungi resistant to this group of fungicides, do not apply more than two sequential applications of this or other group 11 containing fungicide per season.
picoxystrobin	Aproach	6.0-12.0	Do not apply after flowering.	Group 11 fungicides. To reduce the development of fungi resistant to this group of fungicides, do not apply more than two sequential applications of this or other group 11 containing fungicide per season.
pyraclostrobin	Headline SC	6.0-12.0	Apply no later than 25% flowering.	Group 11 fungicide. Do not make more than one application per year.
flutriafol	Xyway LFR	7.6 - 15.2	–	May be applied to corn in-furrow at planting or post-emergence directed to the soil at the base of the plant. For control of late-season infestations, heavy disease pressure situations, or foliar diseases not listed above, a supplemental foliar application may be needed. * Please refer to row space conversion chart in application instructions for application rates on row spacings other than 30". May be applied in a 2x2 band at the full use rate with starter fertilizer.
fluxapyroxad + pyraclostrobin	Priaxor	4.0 – 8.0	21	Do not make more than one application. Do not apply more than 8 fl oz/A per season.
fluxapyroxad + pyraclostrobin + propiconazole	Nexicor	7.0-13.0	21	Group 11 fungicide. Do not make more than one application per year.

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Table 3.3 - Foliar Applied Fungicides for Sorghum (cont.)

Active ingredient	Fungicide trade name	Application rate per acre	PHI (days)	Remarks
fluoxastrobin	Evito 480 SC	2.0-4.0	21	Group 11 fungicide. Do not make more than two applications per season with a minimum interval of 14 days between applications. Do not apply more than 8 fl oz/A per season.
mefentrifluconazole + pyraclostrobin	Veltyma	7.0-10.0	21	Do not make more than one application. Do not apply more than 10 fl oz/A per season.

Soybeans

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Managing Seed and Seedling Diseases of Soybeans

There are several pathogens that can kill seedlings and reduce soybean stands. Seedling pathogens that may be problematic in mid-Atlantic soybeans include *Rhizoctonia* spp., *Fusarium* spp., and on occasion, *Pythium* spp. In general, environmental conditions that reduce germination and emergence increase the risk for seedling blights.

Scouting: Examine at least one site per 10 acres of field every week until 3-4 weeks after emergence.

Management: Plant soybeans when the daily soil temperatures at the 4 inch depth average at least 65 F or more. Avoid compaction and improve drainage when practical. Consider seed treatments for seed lots that have less than 85 percent germination (by the warm germination test). There are many commercial seed treatments available that may help with stand establishment, and can help improve stands in some circumstances. Treat seed with a fungicide if germination is lower than 85 percent. Seed with germination below 75 percent generally should not be treated or used for seed. Many of the newer seed treatments have low use rates and must be applied by certified seed treatment applicators. Consult with your chemical or seed salesperson or agricultural supply dealer for product information. Hopper-box or slurry applications are still available. Remember, once seed are treated, they cannot be used for food, feed, or oil.

Fungicide Efficacy for Control of Soybean Seedling Diseases

The members of the Identification and Biology of Seedling Pathogens of Soybean project funded by the North Central Soybean Research Program and plant pathologists across the United States have developed the following ratings for how well fungicide seed treatments control seedling diseases of soybeans in the United States. Efficacy ratings for each fungicide active ingredient listed in the table were determined by field-testing the materials over multiple years and locations by the members of this group, and include ratings summarized from national fungicide trials published in Plant Disease Management Reports (and formerly Fungicide and Nematicide Tests) by the American Phytopathological Society at <http://www.apsnet.org>. Each rating is based on the fungicide's level of disease control, and does not necessarily reflect efficacy of fungicide active ingredient combinations and/or yield increases obtained from applying the active ingredient.

The list includes the most widely marketed products available. It is not intended to be a list of all labeled active ingredients and products. Additional active ingredients may be available, but have not been evaluated in a manner allowing a rating. Products listed are the most common products available as of the release date of the table; all available products may not be listed. Additional active ingredients may be included in some products for insect and nematode control, however; only active ingredients for pathogen control are listed and rated.

Many active ingredients and their products have specific use restrictions. Read and follow all use restrictions before applying any fungicide to seed, or before handling any fungicide-treated seed. This information is provided only as a guide. It is the applicator's and users legal responsibility to read and follow all current label directions. Reference in this publication to any specific commercial product, process, or service, or the use of any trade, firm, or corporation name is for general informational purposes only and does not constitute an endorsement, recommendation, or certification of any kind by members of the group, or by the North Central Soybean Research Program. Individuals using such products assume responsibility for their use in accordance with current directions of the manufacturer. Efficacy categories: E = Excellent; VG = Very Good; G = Good; F = Fair; P = Poor; NR = Not Recommended; NS = Not Specified on product label; U = Unknown efficacy or insufficient data to rank product. Please note: Efficacy ratings may be dependent on the rate of the fungicide product on seed. Contact your local Extension plant pathologist for recommended fungicide product rate information for your area.

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Table 3.4 - Fungicide Efficacy for Control of Soybean Seedling Diseases

Fungicide active ingredient	Pythium sp. ¹	Phytophthora root rot	Rhizoctonia sp.	Fusarium sp. ^{1,3}	Sudden death syndrome (SDS) (Fusarium virguliforme)	Phomopsis sp.
azoxystrobin	P-G	NS	VG	G	NR	P
carboxin	U	U	G	U	NR	U
chloroneb	U	P	E	P	NR	P
ethaboxam	E	E	U	U	U	U
fludioxonil	NR	NR	G	F-VG	NR	G
fluopyram	NR	NR	NR	NR	VG	NR
fluxapyroxad	U	U	E	G	NR	G
ipconazole	P	NR	F-G	F-E	NR	G
mefenoxam	E ²	E	NR	NR	NR	NR
metalaxyl	E ²	E	NR	NR	NR	NR
PCNB	NR	NR	G	U	NR	G
penflufen	NR	NR	G	G	NR	G
prothioconazole	NR	NR	G	G	NR	G
pydiflumetofen	NR	NR	NR	NR	VG	NR
pyraclostrobin	P-G	NR	F	F	NR	G
sedaxane	NR	NR	E	NS	NR	G
thiabendazole	NR	NR	NS	NS	P	U
trifloxystrobin	P	P	F-E	F-G	NR	P-F

¹ Products may vary in efficacy against different *Fusarium* and *Pythium* species.

² Areas with mefenoxam or metalaxyl insensitive populations may see less efficacy with these products.

³ Listed seed treatments do not have efficacy against *Fusarium virguliforme*, causal agent of sudden death syndrome.

Table 3.5 - Seed Treatment Products Containing Seedling Disease Fungicides

Product/Trade name	Active ingredient
Acceleron	DX-612 fluxapyroxad
	DX-309 metalaxyl
	DX-109 pyraclostrobin
Allegiance FL	metalaxyl
Allegiance LS	metalaxyl
Apron XL LS	mefenoxam
ApronMaxx RFC	fludioxonil
	mefenoxam
ApronMaxx RTA	fludioxonil
	mefenoxam
Catapult XL	chloroneb
	mefenoxam
CruiserMaxx	fludioxonil
	mefenoxam

Table 3.5 - Seed Treatment Products Containing Seedling Disease Fungicides (cont.)

Product/Trade name	Active ingredient
CruiserMaxx Advanced or Cruiser Maxx Plus	fludioxonil
	mefenoxam
CruiserMaxx Advanced Vibrance	fludioxonil
	mefenoxam
	sedaxane
Dynasty	azoxystrobin
EverGol Energy SB	metalaxyl
	penflufen
	prothioconazole
ILeVO	fluopyram
Inovate Pro	ipconazole
	metalaxyl
Intego	ethaboxam
Maxim 4FS	fludioxonil
Mertect 340 F	thiabendazole
	carboxin
Prevail	metalaxyl
	PCNB
Saltro	pydiflumetofen
Trilex 2000	metalaxyl
	trifloxystrobin
Vibrance	sedaxane
Warden CX	fludioxonil
	mefenoxam
	sedaxane
Warden RTA	fludioxonil
	mefenoxam

Managing Foliar, Stem, and Pod Diseases of Soybeans

Foliar fungicides are tools that protect yields from plant pathogenic fungi. Research indicates that foliar applied fungicides do not always increase soybean yields in the mid-Atlantic and may not be economical in the absence of disease.

Scouting: Scout fields for foliar disease at 7 to 14 day intervals from growth stage R1 (flowering) up to R6 (full seed) for early detection of disease and effective timing of fungicide sprays.

Management: Plant varieties with resistance or tolerance to common foliar diseases. Fungicides may be needed to protect yield if a variety is susceptible to disease, disease pressure is high, and/or weather conditions are conducive for disease development (e.g. warm and wet/humid). Fungicides are more likely to be beneficial and economical for soybeans that are grown for seed production, as seed quality can be protected from moderate infestations and/or late season diseases.

Vegetative Growth Stages: Current data indicate that fungicide applications are not needed in the early vegetative growth stages. Spraying just prior to crop flowering (R1) may be prudent if a disease is increasing. Fungicide applications are not recommended after the crop reaches the full pod (R6) growth stage.

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R1-R5 Reproductive Stages: Foliar, pod, and stem diseases are most prevalent, and increase most rapidly, during crop reproductive-growth stages. Foliar fungicides may or may not be needed to protect soybean yield. Decisions of whether or not to apply foliar fungicides should be based on susceptibility of the planted variety to disease, disease pressure, weather conditions, and cropping system (see introduction for more information on integrated disease management). In the absence of a need for disease control at growth stages R1-R2, the most likely stages for disease to impact yield would be stages R3, R4, or R5. Consecutive applications of either strobilurins or triazoles alone should never be made due to resistance concerns. For example, resistance to QoI (Group 11) fungicides has been reported in frogeye leaf spot in Virginia and other states where soybean is grown. Refer to fungicide labels for specific directions and restrictions.

R6 and later: Spraying at late-growth stages is not recommended due to lack of yield response. In addition, many fungicides have days-to-harvest (preharvest) intervals or growth-stage restrictions. Refer to fungicide labels for specific directions and restrictions.

Fungicides for Managing Soybean Diseases

The North Central Regional Committee on Soybean Diseases (NCERA-137) has developed the following information on foliar fungicide efficacy for control of major foliar soybean diseases in the United States. Efficacy ratings for each fungicide listed in the table were determined by field-testing the materials over multiple years and locations by the members of the committee. Efficacy ratings are based upon level of disease control achieved by product, and are not necessarily reflective of yield increases obtained from product application. Efficacy depends upon proper application timing, rate, and application method to achieve optimum effectiveness of the fungicide as determined by labeled instructions and overall level of disease in the field at the time of application. Differences in efficacy among fungicide products were determined by direct comparisons among products in field tests and are based on a single application of the labeled rate as listed in the table, unless otherwise noted. Table includes systemic fungicides available that have been tested over multiple years and locations. The table is not intended to be a list of all labeled products. Efficacy categories: NR = Not Recommended; P = Poor; F = Fair; G = Good; VG = Very Good; E = Excellent; NL = Not labelled for use against this disease; U = Unknown efficacy or insufficient data to rank product efficacy.

Table 3.6 - Foliar Fungicide Efficacy for Control of Foliar Soybean Diseases

Class	Fungicide(s)		Aerial web blight	Anthracnose spot	Cercospora leaf blight ²	Frogeye leaf spot ³	Phomopsis/Diaporthe (Pod and stem blight)	Soybean rust	White mold ⁴	Harvest Restriction ⁵	
	Active ingredient (%)	Product/Trade name									Rate/A (fl. oz)
QoI Strobilurins Group 11	azoxystrobin 22.9%	Quadris									
		2.08 SC ⁵ , Multiple Generics	6.0 – 15.5	VG	P	P	U	G-VG	P	14 days	
	fluoxastrobin 40.3%	Aftershock 480 SC	2.0 – 5.7	VG	G	P	P	U	U	NL	R5 (beginning seed) 30 days
		Evito 480 SC									
	picoxystrobin	Approach	6.0 – 12.0	VG	G	P	P	U	G	G ⁸	14 days
		2.08SC									
	pyraclostrobin 23.6%	Headline 2.09	6.0 – 12.0	VG	G	P	P	U	VG	NL	21 days
		EC/SC									
	DMI Triazoles Group 3	cyproconazole 8.9%	Alto 100 SL	2.75 – 5.5	U	VG	F	U	VG	NL	30 days
		flutriafol 11.8%	Topguard 1.04SC	7.0 – 14.0	U	VG	P-G	VG	U	VG-E	F
propiconazole 41.8%	Tilt 3.6EC Multiple Generics ⁶	2.0 – 4.0	P	VG	NL	F	NL	VG	NL	R5 (beginning seed)	
prothioconazole 41.0%	Proline 480SC ⁷	2.5 – 5.0	NL	NL	NL	G-VG	NL	VG	F	21 days	
tetraconazole 20.5%	Domark 230ME Multiple Generics	4.0 – 5.0	NL	VG	P-G	G-VG	U	VG-E	F	R5 (beginning seed)	
MBC Thiophanates Group 1	thiophanate-methyl	Topsin-M									
		Multiple Generics	10.0 – 20.0	U	U	F	VG	U	G	F	21 days
SDHI Carboximides Group 7	boscalid 70%	Endura 0.7 DF	3.5 – 11.0	U	NL	VG	U	NL	VG	21 days	

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Table 3.6 - Foliar Fungicide Efficacy for Control of Foliar Soybean Diseases (cont.)													
Class	Active ingredient (%)	Fungicide(s)	Product/Trade name	Rate/A (fl. oz)	Aerial web blight	Anthracnose	Brown spot	Cercospora leaf blight ²	Frogeye leaf spot ³	Phomopsis/Diaporthe (Pod and stem blight)	Soybean rust	White mold ⁴	Harvest Restriction ⁵
	azoxystrobin 18.2% difenoconazole 11.4%		Quadris Top 2.72 SC	8.0 – 14.0	U	U	G-VG	P-G	VG	U	VG	NL	14 days
	azoxystrobin 19.8% difenoconazole 19.8%		Quadris Top SBX 3.76 SC	7.0 – 7.5	U	U	U	U	G-VG	U	U	U	14 days
	azoxystrobin 7.0% propiconazole 11.7%		Quilt 1.66 SC Multiple Generics ⁶	14.0 – 20.5	U	U	G	F	F	U	VG	NL	21 days
Mixed mode of action	azoxystrobin 13.5% propiconazole 11.7%		Quilt Xcel 2.2 SE	10.5 – 21.0	E	VG	G	F	F	U	VG	NL	R6
	pyraclostrobin 28.58% fluxapyroxad 14.33%		Priaxor 4.17 SC	4.0 – 8.0	E	VG	E	P-G	P-F	U	VG	P	21 days
	pyraclostrobin 28.58% fluxapyroxad 14.33% tetraconazole 20.50%		Priaxor D 4.17 SC 1.9 SC	4.0 (each component)	U	U	VG	U	G-VG	U	U	P	21 days R5 (beginning seed)
	trifloxystrobin 32.3% prothioconazole 10.8%		Stratego YLD 4.18 SC ⁸	4.0 – 4.65	VG	VG	VG	F	F	U	VG	NL	21 days
	cyproconazole 7.17% picoxystrobin 17.94%		Approach Prima 2.34 SC	5.0 – 6.8	U	U	VG	P-G	G	U	U	NL	14 days

Table 3.6 - Foliar Fungicide Efficacy for Control of Foliar Soybean Diseases (cont.)

Class	Fungicide(s)		Aerial web blight	Anthracnose	Brown spot	Cercospora leaf blight ²	Frogeye leaf spot ³	Phomopsis/Diaporthe (Pod and stem blight)	Soybean rust	White mold ⁴	Harvest Restriction ⁵
	Active ingredient (%)	Product/Trade name									
	flutriafol 19.3% fluoxastrobin 14.84%	Fortix SC Preemptor SC	U	U	G	P-G	VG	U	U	U	R5 (beginning seed)
	trifloxystrobin 32.3% prothioconazole 10.8%	Stratego YLD 4.18 SC ⁸	VG	VG	VG	F	F	U	VG	NL	21 days
	tetraconazole 7.48% azoxystrobin 9.35%	Affiance 1.5 SC	U	VG	VG	F	G	U	U	U	14 days R5
	benzovindiflupyr 2.9% propiconazole 11.9% azoxystrobin 10.5%	Trivapro	E	U	VG	P-G	F-G	G	VG-E	NL	14 days R6
	azoxystrobin 25.3% flutriafol 18.63%	Topguard EQ 4.29SC	U	U	VG	U	G-VG	U	U	P	21 days
	flutriafol 26.47% bixafen 15.5%	Lucento 4.17SC	U	U	VG	U	VG	U	U	U	21 days
	prothioconazole 16.0% trifloxystrobin 13.7	Delaro 325SC	U	U	VG	U	G-VG	U	U	NL	21 days
	prothioconazole 14.9% trifloxystrobin 13.1% fluopyram 10.9%	Delaro Complete	U	U	VG	U	U	U	U	U	21 days

Table 3.6 - Foliar Fungicide Efficacy for Control of Foliar Soybean Diseases (cont.)

Class	Fungicide(s)		Aerial web blight	Anthracnose	Brown spot	Cercospora leaf blight ²	Frogeye leaf spot ³	Phomopsis/ Diaporthe (Pod and stem blight)	Soybean rust	White mold ⁴	Harvest Restriction ⁵
	Active ingredient (%)	Product/Trade name									
	pydiflumetofen 6.9% difenoconazole 11.5%	Miravis Top 1.67SC	13.7	U	VG	P-G	VG	G	U	U	14 days
	pydiflumetofen 7.0% azoxystrobin 9.3% propiconazole 11.6%	Miravis Neo 2.5 SC	13.7	U	U	U	U	U	U	P	
	tetraconazole 17.76% flouxastrobin 17.76	Zolera FX 3.34SC	4.4 – 6.8	U	U	U	G-VG	U	U	U	30 days R5
	thiophanate-methyl 21.3% tetraconazole 4.2%	Acropolis	20.0 – 23.0	NL	U	U	VG	U	VG-E	U	30 days R5
	mefentrifluconazole 11.61% pyraclostrobin 15.49% fluxapyroxad 7.74%	Revytek	8.0 – 15.0	U	U	U	U	U	U	U	21 days
	pyraclostrobin 17.56% mefentrifluconazole 17.56%	Veltyma	7.0 – 10.0	U	U	G-VG	U	U	U	NL	
	mefentrifluconazole 26% fluxapyroxad 8.7%	Revylok	4.5 – 6.5	VG	F-VG	G-VG	U	VG-E	P		21 days

¹Multiple fungicides are labeled for soybean rust only, powdery mildew, and Alternaria leaf spot, including tebuconazole (multiple products) and Laredo (myclobutanil). Contact fungicides such as chlorothalonil may also be labeled for use.

²Cercospora leaf blight efficacy relies on accurate application timing, and standard R3 application timings may not provide adequate disease control. Fungicide efficacy may improve with earlier or later applications. Fungicides with a solo or mixed QoI or MBC mode of action may not be effective in areas where QoI or MBC resistance has been detected in the fungal population that causes Cercospora leaf blight.

³In areas where QoI-fungicide resistant isolates of the frogeye leaf spot pathogen are NOT present, QoI fungicides may be more effective than indicated in this table.

⁴White mold efficacy is based on an R1-R2 application timing, and lower efficacy is obtained at an R3 application timing, or if disease symptoms are already present at the time of application.

⁵Harvest restrictions are listed for soybean harvested for grain. Restrictions may vary for other types of soybean (edamame, etc.) and soybean for other uses such as forage or fodder.

⁶Multiple generic products containing this mode of action may also be labeled in some states.

⁷Proline has a supplemental label (2ee) for soybean, only for use on white mold in IL, IN, IA, MI, MN, NE, ND, OH, SD, WI. A separate 2ee for NY exists for white mold.

⁸Stratego YLD has a supplemental label (2ee) for white mold on soybean only in IL, IN, IA, MI, MN, NE, ND, OH, SD, WI.

Many products have specific use restrictions about the amount of active ingredient that can be applied within a period of time or the amount of sequential applications that can occur. Please read and follow all specific use restrictions prior to fungicide use. This information is provided only as a guide. It is the responsibility of the pesticide applicator by law to read and follow all current label directions. Reference to products in this publication is not intended to be an endorsement to the exclusion of others that may be similar. Persons using such products assume responsibility for their use in accordance with current directions of the manufacturer. Members or participants in the NCERA-137 group assume no liability resulting from the use of these products.

Managing Nematodes in Soybean

Scouting and sampling: Scout every other week from flowering (R1) through maturity. Affected plants often occur in circular patches, in sandy soils, and raised areas of the field. Symptoms include stunting, wilting, yellowing of leaf margins, and reduced nodulation of roots. In severe cases plants may die. In order to determine if nematodes are present, growers should collect soil samples and have them assessed by a nematode diagnostic lab. Consult your local Extension office for more information on proper sampling procedures for nematode testing. Once nematodes are identified and quantified, management decisions can be made based on whether or not nematode populations present in the field exceed economic risk thresholds.

Table 3.7 - Nematode Economic Damage Thresholds for Soybeans (per 500 cm³ soil)

	LOW	MODERATE	HIGH
Soybean cyst juveniles	0-20	20-60	>60
Cysts	0	-	>1
Soybean cyst eggs	0-500	500-4,000	>4,000
Lance	0-300	300-1,000	>1,000
Lesion	0-100	100-500	>1,000
Ring	0-200	200-700	>700
Root-Knot	0-50	50-170	>170
Spiral	0-1000	>1,000	-
Sting	0-10	10-20	>20
Stubby Root	0-90	>90	-
Stunt	0-300	300-1,000	>1,000

Low = nematodes are unlikely to cause crop damage.

Moderate = borderline populations in which crop damage may occur if other factors stress the crop

High = populations likely to cause crop damage and significant yield loss

Prevention and Sanitation: Sanitation measures should be implemented that prevent the spread of nematodes. Equipment, especially tillage equipment, will spread nematodes from one field to another. Reducing tillage has been an effective means of control. All equipment should be cleaned thoroughly after coming out of a field known to be infected with nematodes.

Rotation: Crop rotation is the best option for reducing nematodes. However, many nematodes can survive, reproduce and/or increase in numbers in other crops. For rotation to work, the rotational crop must not be a host to that particular nematode. Unfortunately, soybeans host nearly all damaging species. Use the table below to help choose good rotational crops.

Table 3.8 - Acceptable Rotations Using Common Crops Grown in Virginia for Several Nematode Species

Nematode	Corn	Cotton	Peanut	Soybean	Perennial grass forage
Soybean Cyst	Yes	Yes	Yes	No	Yes
Dagger	Yes	Yes	No	No	Yes
Lance	No	No	Yes	No	No
Lesion	No	No	No	No	Yes
Ring	No	Yes	No	No	No
Northern Root- Knot	Yes	Yes	No	No	Yes
Southern Root-Knot	No	No	Yes	No	Yes
Spiral	Yes	Yes	Yes	No	Yes
Sting	No	No	No	No	Yes
Stubby Root	No	No	No	No	No
Stunt	Yes	Yes	Yes	No	Yes

3-20 Disease and Nematode Management in Field Crops: *Soybeans*

*Note that no indicates that the crop is not a good rotational crop and “yes” indicates the crop is a poor or non-host for the indicated nematode and therefore a good choice for a rotational crop.

Resistant Varieties: Use of resistant or tolerant varieties, when available, is an effective strategy for managing nematodes. One year of a rotation to a non-host crop may not reduce nematode populations below economic thresholds. Depending on the nematode species and one’s crop rotation, variety selection may be the only option. Integrating a resistant variety with effective rotation will result in a greater response than just one tactic. Before purchasing seed, review local reports of cultivar performance and characteristics for the region. Most soybean varieties have soybean cyst nematode resistance and a few have root-knot nematode resistance. Check seed-company guides or contact your seed provider for a list a nematode resistance and other traits.

Chemical control: The use of nematicides should be considered as a last resort due to economic factors and performance inconsistencies. Thus, growers should not rely solely on nematicides or seed treatments to control nematode populations. Seed treatments are generally applied to seed by commercial liquid application equipment and the rate is based on the seed count per bag.

Table 3.9 - Nematode Seed Treatments for Soybean

Product	Nematode	Activity	Nematicide a.i.
Avicta Complete Beans	Root knot, soybean cyst, others	Fungicide	Abamectin
		Insecticide	
		Nematicide	
lLeVO	Root knot, soybean cyst, others	Fungicide	Fluopyram
		Nematicide	
Saltro	Root-knot, soybean cyst, others	Fungicide	Pydiflumetofen
		Nematicide	
Clariva	Soybean cyst	Biological nematocide	<i>Pasteuria</i>
Poncho/VOTiVO	Root knot, soybean cyst	Biological nematocide	<i>Bacillus firmus</i>
BioST Nematicide 100	Root knot, soybean cyst, sting, others	Biological nematocide/ insecticide	<i>Burkholderia rinojenses</i>
Velum		Fungicide	Fluopyram
		Nematicide	

Small Grains

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Small Grain Diseases

Disease management is critical for those interested in maximizing small grain yields and grain quality. Many pathogens cause disease in mid-Atlantic small grains, and several significantly impact yields during years that favor disease. This section discusses how to manage diseases that growers and consultants will encounter in mid-Atlantic small grains fields. Remember, management starts with accurate diagnosis. Contact your local Extension Agent, plant disease diagnostic clinic, or Extension Specialist for assistance with identifying and diagnosing issues in your small grains.

Table 3.10 - Effectiveness of Management and Cultural Practices on Diseases of Wheat

Diseases	Sanitation	Crop rotation	Planting date	Balanced fertility	Disease free seed	Resistant cultivars	Fungicide Seed	Fungicide Foliar	Insecticide Seed
Powdery mildew	-	-	2 ¹	3	-	1	1	1	-
Leaf rust	-	-	3	-	-	1	3	1	-
Leaf and glume blotch	2	2	-	-	2	3	2	1	-
Tan spot	2	2	-	-	-	3	-	2	-
Loose smut	-	-	-	-	1	-	1	-	-
Head scab ²	3	2	3	-	-	2	-	2	-
Take-all	2	1	3	3	-	-	-	-	-
Barley yellow dwarf	-	-	1	-	-	2	-	-	1
Wheat spindle streak	-	-	2	-	-	1	-	-	-
Wheat streak mosaic virus	1	2	-	-	-	-	-	-	-

¹1 = highly effective; 2 = moderately effective; 3 = slightly effective; and - = no effect in reducing disease.

²Seed infested with the head scab fungus will produce weak seedlings that are prone to seedling blight. A fungicide seed treatment may be of some benefit if germination rates are acceptable. Scabby seed does not produce head-scabbed plants.

Table 3.11 - Effectiveness of Management and Cultural Practices on Diseases of Barley

Diseases	Sanitation	Crop rotation	Planting date	Balanced fertility	Disease free seed	Resistant cultivars	Fungicide Seed	Fungicide Foliar	Insecticide Seed
Covered smut	-	-	-	-	1 ¹	2	1	-	-
Loose smut	-	-	-	-	1	2	1	-	-
Powdery mildew	-	-	2	3	-	1*	2	1	-
Leaf rust	-	-	2	-	-	1	3	1	-
Barley scald	1	1	-	-	-	1	-	1	-
Net blotch	1	1	-	-	-	1	2	1	-
Head scab ²	1	2	3	-	-	-	-	2	-
Barley stripe	2	3	-	-	1	2	1	-	-
Barley yellow dwarf	-	-	2	-	-	1	-	-	1

¹1 = highly effective; 2 = moderately effective; 3 = slightly effective; and - = no effect in reducing disease.

²Seed infested with the head scab fungus will produce weak seedlings that are prone to seedling blight. A fungicide seed treatment may be of some limited benefit if germination rates are acceptable. Scabby seed does not produce plants with head scab.

* The powdery mildew population has been shifting and some varieties that were previously resistant may now be susceptible to this disease. An example of this occurring can be seen in 'Thoroughbred'.

Managing Seed and Seedling Diseases of Small Grains

Some diseases such as loose smut, stinking smut, ergot, and some Fusarium diseases can be transmitted in or on seed. These diseases can potentially cause losses, although infrequently, in mid-Atlantic small grains. Fungicide seed treatments, properly applied, can be considered inexpensive stand establishment insurance. Seed treatments minimize losses from seed decay, seedling blights, and seed and soil borne diseases, and for small grains are the only means of combating the smut diseases. There are currently numerous seed treatment fungicides that are available for small grains. Many of these chemicals must be applied by certified seed treatment applicators. Consult with your chemical or seed salesperson or agricultural supply dealer for product information. Hopper-box or slurry applications are still available.

Foliar Fungicides in Small Grains

The North Central Regional Committee on Management of Small Grain Diseases (NCERA-184) has developed the following information on fungicide efficacy for control of certain foliar diseases of wheat for use by the grain production industry in the U.S. Efficacy ratings for each fungicide listed in the table were determined by field testing the materials over multiple years and locations by the members of the committee. Efficacy is based on proper application timing to achieve optimum effectiveness of the fungicide as determined by labeled instructions and overall level of disease in the field at the time of application. Differences in efficacy among fungicide products were determined by direct comparisons among products in field tests and are based on a single application of the labeled rate as listed in the table. Table 3.12 includes most widely marketed products, and is not intended to be a list of all labeled products.

Table 3.12 - Efficacy of Fungicides for Wheat Disease Control Based on Appropriate Application Timing

Class	Fungicide(s)		Rate/A (fl. oz)	Product	Powdery mildew	Stagonospora leaf/glume blotch	Septoria leaf blotch	Tan spot	Stripe rust	Leaf rust	Stem rust	Head scab	Harvest Restriction	
	Active ingredient(s)	Product												
Strobilurin	picoxystrobin 22.5%	Approach SC	6.0 - 12		G ¹	VG	VG ²	VG	E ³	VG	VG	NL ⁴	Feekes 10.5	
	pyraclostrobin 23.6%	Headline SC	6.0 - 9.0		G	VG ²	VG ²	E	E ³	E	G	NL ⁴	Feekes 10.5	
Triazole	metconazole 8.6%	Caramba 0.75 SL	10.0 - 17.0		VG	VG	--	VG	E	E	E	G	30 days	
	propiconazole 41.8%	Tilt 3.6 EC ⁵	4.0		VG	VG	VG	VG	VG	VG	VG	P	Feekes 10.5.4	
	prothioconazole 41%	Proline 480 SC	5.0 - 5.7		--	VG	VG	VG	VG	VG	VG	G	30 days	
	tebuconazole 38.7%	Folicur 3.6 F ⁵	4.0		NL	NL	NL	NL	E	E	E	F	30 days	
	prothioconazole 19%	Prosaro 421 SC	6.5 - 8.2		G	VG	VG	VG	E	E	E	G	30 days	
	metconazole 10.91%	Sphaerex	4.0 - 7.3		VG	VG	VG	VG	E	E	E	G	30 days	
	prothioconazole 18.19%													
	metconazole 7.4%	TwinLine 1.75 EC	7.0 - 9.0		G	VG	VG	VG	E	E	E	VG	NL ⁴	Feekes 10.5
	pyraclostrobin 12%													
	fluxapyroxad 14.3%	Priaxor	4.0 - 8.0		G	VG	VG	VG	E	VG	VG	G	NL ⁴	Feekes 10.5
pyraclostrobin 28.6%														
fluoxastrobin 14.8%	Nexicor EC	7.0 - 13.0		G	VG	VG	VG	E	E	E	VG	NL ⁴	Feekes 10.5	
pyraclostrobin 18.7%														
propiconazole 11.7%														
propiconazole 11.7%	Quilt Xcel 2.2 SE ⁵	10.5 - 14.0		VG	VG	VG	VG	VG	E	E	VG	NL ⁴	Feekes 10.5	
azoxystrobin 13.5%														
prothioconazole 10.8%	Stratego YLD	4.0		G	VG	VG	VG	VG	VG	VG	VG	NL ⁴	Feekes 10.5	
trifloxystrobin 32.3%													35 days	
Mixed modes of action ⁶	cyproconazole 7.17%	Approach Prima SC	3.4 - 6.8		VG	VG	VG	VG	E	VG	--	NR ⁴	45 days	
	picoxystrobin 17.94%													
	tebuconazole 22.6%	Absolute Maxx SC	5.0		G	VG	VG	VG	VG	E	VG	NL ⁴	35 days	
	trifloxystrobin 22.6%													
	fluoxastrobin 14.8%	Fortix	4.0 - 6.0		--	--	VG	VG	E	VG	--	NL ⁴	Feekes 10.5 and 40 days	
	flutriafol 19.3%													
	benzovindiflupyr 2.9%	Trivapro SE	9.4 - 13.7		VG	VG	VG	VG	E	E	VG	NL ⁴	Feekes 10.5.4 and 14 days	
	propiconazole 11.9%													
	azoxystrobin 10.5%													
	prothioconazole 16.0%	Delaro 325 SC	8.0		G	VG	VG	VG	VG	VG	VG	NL	Feekes 10.5 and 35 days	
trifloxystrobin 13.7%														

Table 3.12 - Efficacy of Fungicides for Wheat Disease Control Based on Appropriate Application Timing (cont.)

Class	Fungicide(s)		Product	Rate/A (fl. oz)	Powdery mildew	Stagonospora leaf/glume blotch	Septoria leaf blotch	Tan spot	Stripe rust	Leaf rust	Stem rust	Head scab	Harvest Restriction
	Active ingredient(s)	Rate/A (fl. oz)											
	prothioconazole 14.9%		Delaro Complete	8.0	VG	VG	VG	VG	VG	VG	VG	NL	35 days
	trifloxystrobin 13.1%												
	fluopyram 10.9%												
	flouxastrobin 14.8%		Preemptor SC	4.0 - 6.0	G	VG	VG	VG	E	VG	VG	NL	Feekes 10.5 40 days
	flutriafol 19.3%												
	pydiflumetofen 13.7%		Miravis Ace	13.7	VG	VG	VG	VG	VG	VG	VG	G	Feekes 10.5.4
	propiconazole 11.4%												
	prothioconazole 17.39%		Prosaro Pro 400	10.3	G	VG	VG	VG	E	E	E	G	30 days
	tebuconazole 8.70%		SC	- 13.6									
	fluopyram 8.70%												
	azoxystrobin 25.30%		Topguard EQ	4.0 - 7.0	G	VG	VG	VG	VG	VG	VG	NL	Feekes 10.5.4
	flutriafol 18.63%												

Mixed modes of action⁶

¹Efficacy categories: NL=Not Labeled; NR=Not Recommended; P=Poor; F=Fair; G=Good; VG=Very Good; E=Excellent; -- = Insufficient data to make statement about efficacy of this product.

²Product efficacy may be reduced in areas with fungal populations that are resistant to strobilurin fungicides.

³Efficacy may be significantly reduced if solo strobilurin products are applied after stripe rust infection has occurred.

⁴Application of strobilurin products after heading may result in elevated levels of the mycotoxin deoxynivalenol (DON) in grain damaged by head scab.

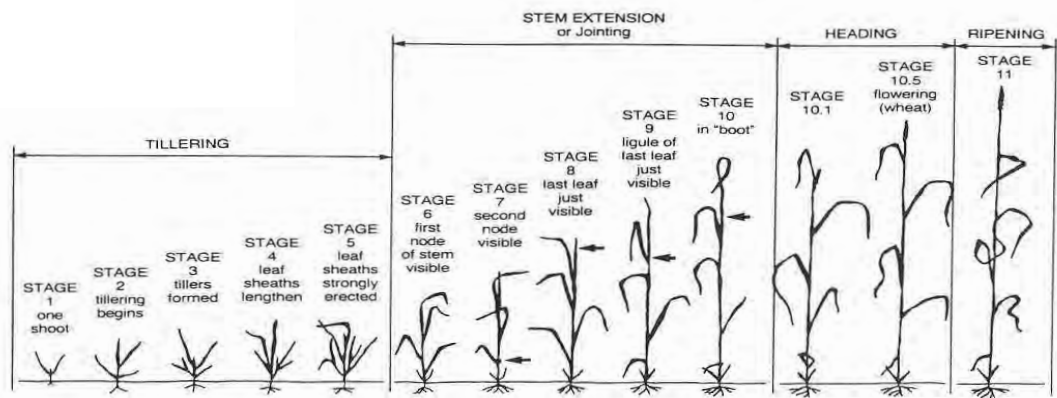
⁵Multiple generic products containing the same active ingredients also may be labeled in some states.

⁶Products with mixed modes of action generally combine triazole and strobilurin active ingredients. Priaxor, Nexicar, and the Trivapro copack include carboxamide active ingredients.

Fungicides are not needed in every field every year and the use of fungicides may not always be profitable. Although some individuals claim that fungicides may boost yield in situations where diseases are absent, university research indicates this is not the case. Foliar fungicides are likely to be most profitable in 1) high yield settings (70+ bu/A); 2) fields where susceptible varieties are planted and scouting indicates threshold levels of disease are present; 3) the stage of crop growth is suitable for treatment; and 4) the forecast indicates that conditions will be favorable for continued disease development, in particular long periods of humid or rainy weather.

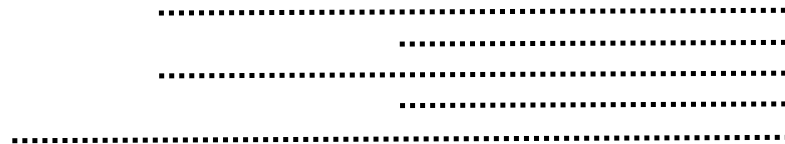
Scouting Small Grains for Disease

Scouting fields is an easy way to ensure that you are staying on top of yield-robbing diseases. Growers who scout their fields will benefit by 1) being able to make pesticide applications in a timely manner and 2) learning about the disease issues associated with a particular field or variety. This information can be used in future seasons to better maximize productivity. There are many diseases that can impact mid-Atlantic small grains, but seldom do they all attack at the same time. Specific diseases occur at certain times of the year when the environment is conducive or the plant growth stage is susceptible to disease.



Foliar Diseases

- Powdery Mildew
- Rusts
- Leaf Blotch Complex
- Tan Spot
- Viruses



Head Diseases

- Glume Blotch
- Fusarium Head Blight
- Loose Smut



Other

- Take All
- Root/crown rots



Scouting Calendar for Major Diseases of mid-Atlantic Small Grains

Diseases of Small Grains

Virus Diseases

Scouting: Examine fields at least once a month during active growing periods from Feekes 2 through Feekes 10.5. Scout at least 1 site per 10 acres of field. At each site observe plants within a 5- to 10-foot radius.

General Symptoms: Stunted, deformed plants. Foliage may be streaked or mottled. Leaf discoloration (red/orange). Entire fields are rarely affected. Instead look for single or small groups of plants in patches.

Diagnosis: Specialized tests that can be conducted by the Plant Disease Clinic or commercial testing services such as Agdia Inc.

Barley Yellow Dwarf

Barley yellow dwarf virus (BYDV) is the most widely distributed and destructive of the viral diseases that affect wheat. Symptoms of BYDV are often confused with various nutritional or non-biological disorders. Leaf discoloration induced by the virus infection typically ranges from shades of yellow to red and sometimes purple, especially extending from the leaf tip to the base and from the leaf margin to the mid-rib. Seedling infections have the greatest impact on yield. Plants infected in the fall may not survive the winter or are severely stunted and discolored when growth resumes in the spring. These diseased plants often occur in circular patches within the field. These patches are associated with the feeding and colonization by aphid vectors in the fall and early spring. Grain yields from such plants have been reduced by 30 to 35 percent in experimental plots in Virginia. The virus can be transmitted by more than 20 species of aphids (five species of which are known to occur in Virginia). The virus persists in small grains (barley, oats, rye, and wheat), in corn, and in over 80 species of perennial and annual grasses. The spread of this virus is entirely dependent on the activity of the aphid vectors. The environmental conditions that favor BYDV epidemics are cool temperatures (50° to 65°F) with rainfall that supports wheat and grass growth as well as aphid reproduction and movement. Infections can occur throughout the season and are most abundant where high populations of aphids survive the winter. The leaf discoloration symptoms indicating virus infection develop within about two weeks of inoculation at temperatures between 65° to 70°F. When infections occur at temperatures above 85°F, symptoms do not develop.

Management: Plant after the Hessian fly-free date. Plant varieties tolerant to BYDV. Manage aphids in the fall via insecticide seed treatments. Foliar insecticides may provide some benefit if aphid populations increase past threshold levels in the fall, within a month of planting, or in early spring.

Wheat Spindle Streak Mosaic Virus (Wheat Yellow Mosaic)

Wheat spindle streak mosaic virus (WSSMV) is common in some fields in Virginia. Symptoms are typically expressed in leaves as yellow-green mottling with parallel dashes or streaks with tapered ends—hence the name wheat spindle streak. The virus is transmitted to wheat by a soil-borne fungus, *Polymyxa graminis*, which, in the absence of wheat, is associated with the roots of grassy weeds and other monocot crops (e.g., barley, corn, millet, rye, sorghum, etc.). Most significant infections take place during cool, wet periods in the fall. Often large areas of a field may be affected. Infection does not occur at temperatures above 68°F. Thus, an increase in temperature allows the plant to outgrow the virus and may mask symptoms later in the growing season. The optimal temperature for symptom expression is between 48° and 55°F. The earlier in the life of the wheat plant that infection occurs, the more severe the symptom expression. During cool spring conditions, the yellow spindle streaks may become necrotic. Affected plants may be mildly stunted and produce fewer tillers and seeds per head.

Management: Plant resistant wheat varieties. Plant after the Hessian fly-free date. Improve soil drainage and improve compaction in problem fields.

Wheat Streak Mosaic Virus

Wheat streak mosaic virus (WSMV) was observed for the first time in more than 25 years during the 2000 growing season. The incidence and severity of this disease depends on the environment, vector survival, distribution and frequency of volunteer wheat plants that serve as a source of virus and a haven for the vector, and wheat cultivar susceptibility. Symptoms of wheat streak mosaic virus typically appear in the spring. These symptoms can look very similar to wheat spindle streak caused by WSSMV. However, the field pattern of WSMV is related to the distribution and activity of the vector, the wheat curl mite, *Aceria tulipae*. As the wheat crop develops, plants affected with WSMV are typically severely stunted with yellow mottled and

streaked leaves. These yellow streaks are often seen as discontinuous dashes running parallel to the leaf veins. As the season progresses, plants affected and colonized by the curl mites may develop “leaf rolling.” Leaves appear upright while the margins roll inward. This symptom of mite feeding looks like drought stress in the affected plants. WSMV symptoms tend to become more severe as the weather warms, and severely affected plants may produce sterile heads or die prematurely. The mite requires living hosts such as volunteer wheat or corn to survive and move to emerging wheat in the fall. Mites can then move to nearby or distant sources into wheat fields, feed on wheat, and can spread the virus.

Management: Eliminate volunteer wheat and corn before wheat emerges in the fall.

Foliar Diseases

Leaf Blotch Complex

Examine the following leaf positions at the indicated growth stage:

Flag-4 and Flag-5 for Zadoks growth stages 31 to 37 and Feekes growth stages 6 to 8 (jointing to flag leaf emergence)

Flag-3 for Zadoks growth stages 38 to 45 and Feekes growth stages 9 to 10 (flag leaf fully expanded to boot)

Flag-2 for Zadoks growth stages 46 to 59 and Feekes growth stages 10.1 to 10.5 (boot splitting to heading)

Scout fields weekly from Zadoks growth stage 31 through 59 (Feekes 6 through 10.5). Randomly select 10 locations within a wheat field. At each location, examine and record the number of indicator leaves out of ten main tillers with one or more leaf and glume blotch lesions. If 25 percent of the 100 indicator leaves in the field have one or more lesions, then a fungicide application may be beneficial.

Scouting: Examine fields at least every other week during active growing periods from Feekes 5 through Feekes 10.5. Scout at least 1 site per 10 acres of field. At each site observe plants within a 5- to 10-foot radius.

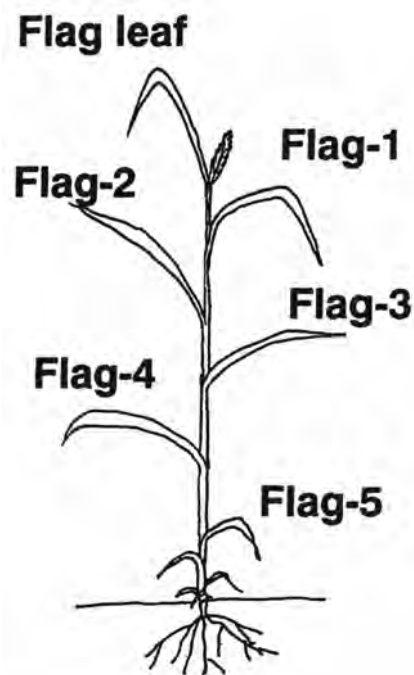


Fig 3.1 Determination of treatment threshold for septoria leaf and glume blotch in wheat.

General Symptoms: Lesions that may be blocky, oblong, or cats-eye in shape and surrounded by a thin yellow halo. *Septoria tritici* lesions tend to follow leaf veins and often contain multiple, black fungal structures within a lesion. Cream-colored cirri can be produced under extended periods of wet or humid weather. Lesions caused by *Parastagonospora nodorum* (Syn. *Stagonospora nodorum*) are shaped like a cats-eye and contain very small, brownish colored fungal structures within the lesion. Lesions may be hard to see and can be embedded in the plant tissue. Cirri can also be produced under humid conditions but unlike *S. tritici*, they are salmon colored.

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Diagnosis: May be diagnosed by trained individuals in the field with the aid of a hand lens. Confirmation through culturing or other techniques can be carried out by a Plant Diagnostic Clinic.

Description:

Leaf blotch complex is caused by two fungal diseases: *Parastagonospora nodorum*, which also causes Glume Blotch, and *Septoria tritici*. Both diseases are residue- and seed-borne and develop first on lower leaves and move up the plant under favorable environmental conditions. *S. tritici* is a cool weather pathogen and is favored by high humidity and temperatures between 59-69°F. *P. nodorum* does best under warmer conditions (69-81°F) and humid weather. Epidemics of both diseases can originate from wind or rain dispersed spores, either from local or distal sources. Infection by *P. nodorum* tends to occur later in the stages of plant development. Both diseases can significantly reduce yields in susceptible varieties and under appropriate environmental conditions. Test weights may also be reduced.

Management: Plant resistant varieties. Varieties with resistance to leaf blotch may not be resistant to glume blotch and vice versa. Plant certified disease-free seed and use recommended fungicide seed treatments. Destroy weeds and volunteer wheat or barley in fields prior to planting. If a susceptible variety is planted, foliar fungicides applied after flag leaf emergence can be beneficial if the disease is present and the environment conducive for further disease development.

Tan Spot

Scouting: Examine fields at least every other week during active growing periods from Feekes 5 through Feekes 10.5. Scout at least 1 site per 10 acres of field. At each site observe plants within a 5- to 10-foot radius.

General Symptoms: Tan spot is caused by *Pyrenophora tritici-repentis* and produces symptoms very similar to Leaf Blotch Complex. Tan spot lesions are cats-eyed shaped but unlike *P. nodorum*, lesions do not often coalesce. The lesions will have dark centers but do not have black or brown fungal structures within lesions.

Diagnosis: May be diagnosed by trained individuals in the field with the aid of a hand lens. Confirmation through culturing or other techniques can be carried out by a Plant Diagnostic Clinic.

Description: *Pyrenophora tritici-repentis* is a residue-borne organism that can infect wheat, barley, rye, and numerous other grassy hosts. Disease occurs over a wide temperature range, but symptoms are often more pronounced at later stages in crop growth. Depending on the variety, as few as 6 hours of leaf wetness may be needed for disease development. The disease spreads through the dissemination of spores in wind and rain.

Management: Same as for Leaf Blotch Complex

Powdery Mildew

Scouting: Examine fields at least every other week during active growing periods from Feekes 2 through Feekes 10.5. Scout at least 1 site per 10 acres of field. At each site observe plants within a 5- to 10-foot radius.

General Symptoms: White fuzzy growth on stems and foliage of plants. Over time black pinhead-like structures can be observed in and on the white growth. Very old infections appear grey to brown.

Diagnosis: Easily identified with the naked eye in the field.

Description:

Blumeria graminis is common throughout the mid-Atlantic. The fungus overwinters in small grain stubble as well as overwintering wheat and barley. Powdery mildew is favored by cool temperatures (60-68°F) and high relative humidity (>90% RH). Unlike other foliar diseases, free water on the leaf surface may inhibit spore germination and infection. Disease progress ceases at temperatures above 77°F. Disease increases with nitrogen fertilization and lush growth. Spores of powdery mildew can be dispersed on air currents over large distances. Infection can cause lodging as well as yield losses resulting from foliar infection. Population shifts have overcome previously effective resistance genes in barley and this may occur in wheat.

Management: Plant resistant varieties. Avoid planting wheat or barley early in the fall. Avoid excessive nitrogen levels. Foliar fungicides, especially when a susceptible variety is planted and the disease is detected early in the growing season, may be beneficial in some years. Protection of the flag leaf is key.

Rusts (Stripe and Leaf)

Scouting: Examine fields every week during active growing periods from Feekes 2 through Feekes 10.5. Scout at least 1 site per 10 acres of field. At each site observe plants within a 5- to 10-foot radius. Consider a fungicide application for a high yield crop when rust covers 1 percent of upper, fully expanded leaves prior to heading, Fig 3.2.

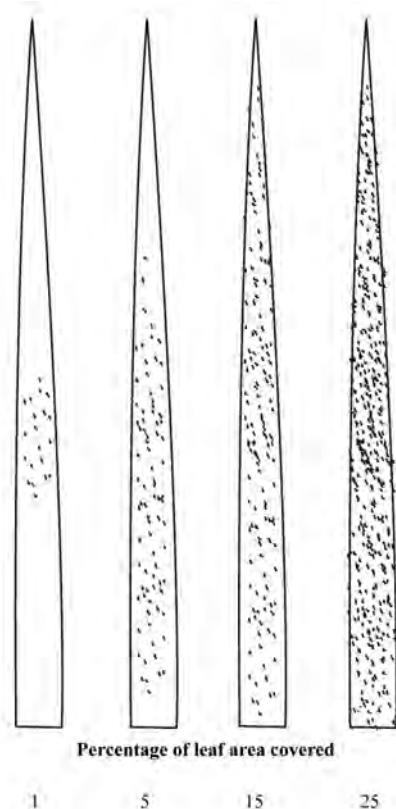


Fig 3.2

Percentage of leaf area affected by leaf rust. (James, C. 1971. *A Manual of Assessment Keys for Plant Diseases*. Publication 1458. Canada Department of Agriculture.)

General Symptoms: Early infections appear as small yellow/orange spots on the foliage. Spots eventually develop into brown/orange raised pustules that will leave a brown/red rusty residue on fingers when pustules are rubbed between fingers. Leaf rust appears on the upper leaf surface and is generally brown in color. Stripe rust follows the leaf veins and is light orange in color.

Diagnosis: Easily identified with the naked eye in the field.

Description:

Puccinia recondita f.sp *tritici* (leaf rust) and *P. striiformis* f.sp *tritici* (stripe rust) occur frequently in the mid-Atlantic. These rusts may overwinter as mycelium in dormant wheat in the southernmost areas of the mid-Atlantic, particularly following a mild winter. More commonly, rusts blow in from the south and therefore arrive later in the growing season. Leaf rust does well under moderate temperatures (60-70°F) whereas stripe rust is favored by cool weather (50-60°F). Temperatures above 68°F inhibit stripe rust. Spores produced from pustules are wind distributed over large distances and are deposited by rain onto plants. When the environment is favorable, epidemics can develop rapidly and cause losses approaching 50% in susceptible varieties. Early season infections have the most impact on yield and can reduce root and tiller formation. Late season infections, which are common in many parts of the mid-Atlantic, are unlikely to cause significant yield reductions. New races of stripe rust have been identified that can better tolerate warm temperatures and ever-changing populations have overcome resistance in some varieties.

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Management: Plant resistant varieties. Foliar fungicides applied before disease is present or reported in the area may be beneficial, particularly if a susceptible variety is planted. Avoid planting a variety in a subsequent year if stripe rust was detected in that variety the previous season.

Head Diseases

Glume Blotch

Scouting: Examine fields every week from Feekes 9 through Feekes 10.5. Scout at least 1 site per 10 acres of field. At each site observe plants within a 5- to 10-foot radius.

General Symptoms: Gray to brown spots form the chaff, typically starting on the upper $\frac{3}{4}$ of the glumes. Over time lesions can grow and brownish fungal structures form within gray centers of the lesion.

Diagnosis: Can be confused with other disorders such as bacterial diseases or chemical injury. Fungal structures are diagnostic but difficult to see without the aid of a hand lens.

Description:

Glume blotch is caused by *Parastagonospora nodorum*, a component of Leaf Blotch Complex, which is described in the previous section.

Management: Plant resistant varieties. Varieties with resistance to leaf blotch may not be resistant to glume blotch and vice versa. Plant certified disease free seed and use recommended fungicide seed treatments. Destroy weeds and volunteer wheat or barley in fields prior to planting. Foliar fungicides applied before disease is present on the glumes may be beneficial if the environment is favorable for disease development.

Fusarium Head Blight

Scouting: Examine fields every week from Feekes' 10.5 to Feekes' 11. Scout at least 1 site per 10 acres of field. At each site observe plants within a 5- to 10-foot radius.

General Symptoms: Heads completely or partially bleached. Under humid conditions, masses or orange spores may be present at the base of infected kernels. Severely infected kernels may be shrunken, chalky, and shriveled. Infected heads may have elevated levels of deoxynivalenol (DON) a mycotoxin.

Diagnosis: Can be confused with other disorders such as insect injury, eyespot, or frost damage

Description:

Fusarium head blight (FHB) in the mid-Atlantic is caused predominantly by *Fusarium graminearum*. This is a reemerging disease that is likely to increase in incidence and severity due to widespread no-till and corn acres. This fungus overwinters in small grain or corn residue and produces spores under wet conditions ($>70\%$ RH) and over a wide temperature range (60-85°F). Longer periods of wet weather are required for severe epidemics to occur under cool conditions. Approximately 70% of spores are ejected and carried long distances on wind currents and deposited at night. The remaining spores (30%), called macroconidia, are locally dispersed via rain splash. FHB only causes disease on heads and disease is most severe when appropriate conditions occur at or around flowering (Feekes' 10.5.1-yellow anthers observable at the center of heads). Once spores germinate, they can enter the head, resulting in kernel abortion and characteristic head bleaching. Depending on the environment, variety, and fungal strain, mycotoxins (DON and others) may be produced. Elevated levels of DON can result in dockage or rejection at the grain mill. Bleaching does not always indicate elevated DON levels in grain.

Table 3.13 - Deoxynivalenol (DON) Advisory Levels Established by the FDA

Maximum Allowable DON Level (ppm)	Consumer
1	Humans
5	Swine and all animal species except cattle and poultry (Not to exceed 20% of the diet for swine and 40% for other animals)
10	Ruminating beef and feedlot cattle older than 4 months and poultry (Not to exceed 50% of diet).

Management: Plant moderately resistant varieties with good tolerance to DON accumulation. DON management should be the focus when selecting a variety as DON levels do not correlate well with levels of bleaching, although bleached heads may indicate elevated levels of mycotoxins in a field. Research indicates that overall, the use of a locally adapted, moderately resistant variety can reduce DON by over 50% compared to susceptible varieties. Virginia Tech screens commercial and experimental wheat varieties for DON accumulation and growers should refer to these ratings when selecting a variety. The FHB fungus does not grow as well on soybean residue, so planting wheat after soybeans may help reduce local inoculum levels. Burial of residue through tillage may also help reduce local levels of inoculum. However, because the pathogen can be dispersed over long distances, local residue management may only have a minor effect on overall suppression of FHB and DON, particularly during severe epidemics. Staggering planting date may help reduce the likelihood that all fields will enter a susceptible stage when the environment favors FHB, although differences in flowering are likely to be subtle in warm environments. Several fungicides are available for suppression of FHB and DON. These products should be applied at least 10-20 gallons per acre with fine to medium-size droplets (approximately 300-350 microns). If the ground rig is traveling less than 6 mph use forward and backward facing nozzles angled 30° to 45° down from horizontal to achieve optimal coverage; if traveling above 6 mph use a single forward-facing nozzle 30° down from horizontal. Aerial applicators should apply at 5 gallons per acre. The lowest labeled rate of a non-ionic surfactant may improve coverage of the head. Maximum product efficacy is obtained if fungicides are applied when plants have entered Feekes 10.5.1. Fungicides can be applied up to 6 days after the start of Feekes 10.5.1 without a notable drop-off in efficacy. Research trials indicate that currently, the most effective fungicides for disease and DON suppression are Miravis Ace, Prosaro, Prosaro Pro, Sphaerex, Caramba, and Proline. If applied properly these products reduce DON by approximately 45% compared to untreated controls. The use of moderately resistant varieties and recommended fungicides applied around Feekes 10.5.1 has been shown to reduce DON levels by 70% relative to untreated susceptible varieties in replicated national trials. The Fusarium Head Blight Prediction Center uses multiple sources of environmental weather data to determine the probability of FHB epidemics for wheat at a susceptible stage of growth (<http://www.wheatcab.psu.edu/>). This site can be used to help determine if a fungicide application is likely to be needed during the growing season. Remember, fungicide use alone is not likely to bring down DON levels to a manageable level if a susceptible variety is planted in an FHB-favorable year. Therefore, growers should integrate multiple practices to manage this disease.

Loose Smut

Scouting: Examine fields every week from Feekes' 10.5 until harvest. Scout at least 1 site per 10 acres of field. At each site observe plants within a 5- to 10-foot radius.

General Symptoms: Heads will contain a black/brown dusty mass of spores in the place of kernels and chaff. These spores eventually blow away, leaving a bare spike with a sooty appearance. Heads of infected tillers emerge from the boot earlier than healthy tillers and prior to heading diseased plants may appear darker than healthy plants.

Diagnosis: Easily identified in the field.

Description:

Loose smut is a disease that is infrequent in the mid-Atlantic, mostly as a result of seed treatment fungicides in wheat production systems. The disease is caused by the fungus, *Ustilago tritici* and yield losses can be significant in some situations. Spores of the fungus often enter the field on infested seed. After seed germination, the fungus grows within the plant without producing symptoms. When the head emerges the fungus invades the contents of the head, converting everything except the pericarp membrane and rachis to a mass of black fungal spores. Wind then disperses spores over long distances where they may land on flowering wheat or barley. Light rains and temperatures between 60 and 72°F favor germination of spores and infection. Once the fungus has established itself in the kernel it goes into dormancy. Infected seeds cannot be distinguished from uninfected seeds. The fungus only becomes active again when the infected kernel germinates.

Management: Plant certified disease-free seed. Utilize recommended seed treatment fungicides.

Other

Take-All

Scouting: Examine fields every other week from Feekes 5 through harvest. Scout at least 1 site per 10 acres of field. At each site observe plants within a 5- to 10-foot radius.

3-32 Disease and Nematode Management in Field Crops: *Small Grains*

General Symptoms: Around head emergence leaves may become yellow and plants may be stunted or uneven. The most conspicuous symptom is premature white tillers. Take-all often occurs in patches but can also be uniform in distribution in some fields. The roots of infected plants will be brittle and rotten. If the outer leaf sheath is removed from the stem a shiny discoloration of the basal stem will be evident.

Diagnosis: Can be confused with other disorders such as head blight, sharp eyespot, frost injury, and insect damage. The shiny black appearance of the basal stem is diagnostic for the disease.

Description:

Take-all is caused by the fungus *Gaeumannomyces graminis*. This pathogen survives in fields on residue from infested small grains or grassy weeds. During the growing season, the fungus invades plant roots, compromising nutrient and water uptake. The pathogen is often most active in cool soils. Poorly drained soils, low soil fertility, and alkaline conditions may favor infection by *G. graminis*. Take-all is not often an issue due to the crop rotations that are commonly practiced in the mid-Atlantic.

Management: Rotation away from small grains for 2 years will reduce inoculum levels in the soil. Apply fertilizers and lime according to soil test recommendations. Minimize compaction and drainage issues.

On a related note, growers may have heard of a phenomenon known as, “Take-all decline.” This has been observed in other regions where wheat monocultures are used extensively. In these cases, several years of wheat monoculture allows for the accumulation of antagonistic bacteria that compete with the pathogen for soil nutrients and resources.

Forage Crop Diseases

David Langston, Extension Plant Pathologist, Virginia Tech, Tidewater AREC

Disease management in perennial forage crops is based on planting locally adapted, disease-resistant cultivars and using good cultural practices to help reduce losses from diseases. Disease resistance ratings of alfalfa cultivars are compiled by the National Alfalfa & Forage Alliance and are updated annually. The list can be viewed on the web at <https://www.alfalfa.org>. You may download the list for free, or purchase a copy of the list for a nominal fee from the organization. Note that at this time no commercially available alfalfa cultivars have an acceptable level of resistance to Sclerotinia crown and stem rot.

Sclerotinia crown and stem rot is best managed by avoiding no-till seeding of new stands in the fall. Stand establishment of forage legumes may benefit from the use of seed-protectant fungicides, particularly in spring no-till seeding, when conditions slow the germination process. In general, cool, wet soil conditions favor seed decay and damping-off diseases. Most seed companies now sell alfalfa seed treated with a fungicide for damping-off management. However, most other forage crops are not commonly pretreated.

Table 3.14 - Major Diseases, Probability of Outbreaks and Recommended Minimum Level of Resistance for Alfalfa Cultivars to be Grown in the Mid-Atlantic

	Bacterial wilt	Verticillium wilt	Fusarium wilt	Anthrax-nose	Phytophthora root rot	Root-knot nematode	Aphanomyces root rot	Sclerotinia crown and stem rot	Leaf & stem spots
Outbreak probability	Low	Moderate	Moderate	Moderate	Moderate	Low	Unknown ³	No-till fall seeding High	High
Recommended minimum resistance ¹	MR	MR	MR	R	R	Soil test ²	MR	NA	NA

¹Always get the highest level of resistance available whenever possible. Recommended minimums will not prevent serious losses in the event of a major outbreak.

²Nematode risk can be determined with a soil test prior to planting. When root-knot nematode is a threat and you must plant alfalfa, choose a variety with as high a level of resistance as you can find.

³Aphanomyces root rot has not been formally identified or surveyed for in the mid-Atlantic. It is, however, likely to be a problem. In general, plant cultivars that have at least an MR rating, except if planting in spring in which case select cultivars with at least an R rating.

Key: MR = moderately resistant, R = resistant, NA = resistance varieties not available.

Table 3.15 - Fungicide Treatment

Crop	Disease	Active ingredient	Trade name	Remarks
<i>Seed treatment fungicides</i>				
Alfalfa and other forage legumes	Damping-off and early season Phytophthora root rot	metalaxyl	Allegiance FL Acquire Belmont 2.7 FS Dyna-Shield Metalaxyl Metalaxyl 265 ST MetaStar ST Sebring 318 FS	Registered for application by commercial seed treaters only. Excellent control of Pythium damping-off.
Alfalfa, clover, and vetch	Seed decay and damping-off	thiram	Protector-D	Control of Pythium damping-off is less effective than metalaxyl or mefenoxam. Apply seed treatment materials in a slurry or with commercial mist-type equipment. Follow instructions on label.
<i>Soil treatment fungicides</i>				
Alfalfa	Damping-off and early season Phytophthora root rot	mefenoxam	Ridomil Gold SL Ultra Flourish	Soil treatment generally is not necessary if seed is treated with Allegiance or Apron. Consider soil treatment only where there is a history of Phytophthora, soil is heavy, cold and wet conditions are expected after seeding, and the variety is relatively susceptible. Most alfalfa seed is treated with Apron. Use the low rate of Ridomil with Apron-treated seed. Apply 1/4 to 1/2 pints per acre of SL formulation as a broadcast surface spray at planting in a minimum of 20 gallons of water per acre. Do not feed green forage or cut hay for 60 days following application.

Tobacco

Yuan Zeng, Extension Plant Pathologist, Virginia Tech Southern Piedmont AREC
T. David Reed, Extension Agronomist, Tobacco, Virginia Tech Southern Piedmont AREC

Effective management of tobacco diseases and nematodes **depends** on accurate identification of the problems and the implementation of multiple disease management approaches (crop rotation, resistant varieties, early removal and destruction of stalk and root, etc.).

Disease Management Practices

Crop Rotation

Crop rotation is a valuable cultural method to reduce losses caused by plant pathogens and nematodes. Tobacco following tobacco should be avoided because this practice will build up pathogen population densities.

Table 3.16 - Value of Rotation Crops for Tobacco Disease Control¹

Rotation Crop	Black Shank	Granville Wilt	Root-Knot Nematodes	Tobacco Cyst Nematodes	Tobacco Mosaic Virus	Black Root Rot
Fescue	H	H	H	H	H	H
Small grain	H	H	H	H	H	H
Lespedeza "Rowan"	H	H	H	-	H	L
Soybean	H	H	L ²	H	H	L
Corn	H	M	L	H	H	H
Sweet potato	H	M	L ³	-	H	H
Cotton	H	M	N	-	H	L
Milo	H	M	L	H	H	H
Peanuts	H	L	N	H	H	L
Pepper	N	N	N ⁴	L	N	H
Potato	N	N	N	L	H	H
Tomato	N	N	N ²	N	N	M

¹Adapted from Flue-Cured Tobacco Information, North Carolina Cooperative Extension Service. Ratings indicate the value of each rotation crop for reducing damage caused by each disease in the subsequent tobacco crop with the assumption of excellent weed control in each rotation crop; H = high value, M = moderate value, L = Little value, N = no value – may be worse than continuous tobacco, - = unknown.

²However, root-knot resistant soybean cultivars can be highly effective as rotation crops for managing root-knot nematodes on tobacco.

³Root-knot resistant sweet potato cultivars are moderately effective rotation crops for tobacco.

⁴May be highly valuable for some species or races of root-knot nematodes.

Early Removal and Destruction of Stalk and Root

This practice helps reduce disease, insect, and weed population densities that will carry over into future tobacco crops. *Most effective when tobacco stalks and roots are destroyed immediately after final harvest.*

The following steps should be completed to maximize benefit: 1) **flue-cured** - cut stalks into small pieces with bushhog or similar equipment the day that harvest is completed; 2) **all types** - disc or plow-out roots the day harvest is completed. Roots must be exposed to air for about 2 weeks to obtain maximum drying of roots; 3) after 2 weeks, re-disc field to provide additional root kill and to bury crop residue; 4) plant a cover crop when root systems are killed and plant debris is buried.

Disease-resistant Varieties

Planting disease-resistant varieties offers excellent control over most of tobacco diseases. However, growers should consider the major disease problem and the level of pathogen population density when selecting a resistant variety. In severe disease situations, chemical control should also be required to obtain satisfactory results. The Virginia Cooperative Extension Tobacco Production Guides summarize the latest disease resistance information on the most current tobacco varieties.

Disease Control in Tobacco Greenhouses

Disease causing organisms can be introduced into a greenhouse through contaminated soil or plant debris. Entrances should be covered with asphalt, concrete, gravel, or rock dust. Footwear should be cleaned or disinfected before entering a greenhouse. Float bays should be re-lined with fresh plastic each year and be free of soil and plant debris. Greenhouse equipment should be sanitized periodically. A 1:10 solution of household bleach and water is sufficient for these purposes.

Float trays should always be thoroughly cleaned and disinfected before fumigation. If float trays are to be sanitized by steaming, they should remain in aerated steam at 160° F to 175°F for at least 30 minutes in order to minimize *Rhizoctonia* damping-off and sore shin, as well as *Pythium* damping-off.

If tobacco mosaic virus (TMV) occurred in the previous year, greenhouse surfaces should be disinfected. Such surfaces include side-curtains, center walkways, and the 2x6 boards that form the float bays. There is no need to spray the purline supports or the plastic covers over the greenhouse. *Relatively new float trays that were used when TMV were present should be sanitized.* Older trays should be discarded and replaced. TMV has a number of weed hosts (horsenettle, ground cherry), and they should be removed from the vicinity of tobacco greenhouses.

Do not fill float bays with water from streams or ponds as these sources may be contaminated. Filling bays with water long before floating the trays can make *Pythium* problems worse. Be careful to avoid introducing disinfectants into water intended for plant uptake. Avoid moving water from one greenhouse bay to another because it increases the chance of spreading water-borne pathogens like *Pythium*.

To avoid spreading TMV, mower blades and decks should be sanitized with a 1:1 bleach and water solution between greenhouses and after each clipping. Plant debris left on trays after clipping is one of the primary causes of collar rot problems. Clippings, unused plants, and used media should be dumped at least 100 yards from the greenhouse.

Condensation on the underside of the greenhouse top and on leaf surfaces creates favorable conditions for plant pathogens. This condensation results from a difference in temperature between the inside and outside of the greenhouse, particularly at sunset. **Increasing air exchange near dusk by temporarily lowering the side curtains will reduce such differences in air temperature. Ventilating the greenhouse with horizontal airflow fans will also help reduce potential condensation.** Minimize overhead watering and potential splashing of media from one tray cell to another. Correcting drainage problems in and around the greenhouse will also help avoid excess humidity.

Bacterial soft rot causes a slimy, watery rot of leaves and stems that can easily be confused with damage from collar rot. Greenhouse management practices that help minimize collar rot will also help prevent bacterial soft rot. Management practices for angular leaf spot and wildfire (two other diseases caused by bacteria) can also help reduce bacterial soft rot.

Waiting to seed tobacco greenhouses and float beds until March, and eliminating any volunteer tobacco plants within these structures, should be an essential component of each grower's disease control plan. As a general rule, plants closely related to tobacco (tomatoes, peppers, etc.) should not be grown in greenhouses used for transplant production.

Diseases

Blue mold

Unused tobacco transplants should be destroyed as soon as possible after transplanting has been completed. If possible, fields that seem to favor blue mold development (shady areas with poor air drainage) should be avoided. Fields should be irrigated early enough in the day that leaves can dry before nightfall. Suspected blue mold should be reported to Virginia Cooperative Extension. Most tobacco cultivars currently being planted are not resistant to tobacco blue mold. Dark-fired tobacco is generally less susceptible than flue-cured tobacco, which is generally less susceptible than burley tobacco, although burley cultivar KT 206LC has low-to-moderate resistance to blue mold. Burley tobacco cultivar TN 90LC is somewhat less resistant to blue

mold than KT 206LC. KT 204LC is less resistant than TN 90LC, but is less susceptible to blue mold compared to most other burley tobacco cultivars. A number of effective fungicides are available for controlling tobacco blue mold when it occurs, and several are relatively new, including Revus, Orondis Ultra, and Presidio.

Fusarium wilt

Caused by *Fusarium oxysporum* f. sp. *nicotianae*. Recent studies at Virginia Tech’s Southern Piedmont AREC showed that other *Fusarium* species are also associated with the disease. Fusarium wilt can become a serious problem when tobacco plants are stressed by abiotic (e.g., drought, warm) and other biotic factors (e.g., nematode). Infected plants are often wilted on one-side, and leaves or parts of leaves are significantly yellowed or chlorotic. Early destruction of tobacco stalks and roots and crop rotation (for as long as possible, but not with cotton or sweet potato) will also help reduce problems with Fusarium wilt. Soil fumigation using a product containing chloropicrin may be required where significant stand loss has occurred.

Black shank and granville wilt

Calculating and recording the percentage of diseased plants in each field at the end of each season can enable growers to evaluate the cost-effectiveness of their disease control program.

Severity Level	Black Shank or Granville Wilt
Low	Less than 1%
Moderate	1-5%
High	More than 5%

Black shank

Caused by a fungal-like pathogen (*Phytophthora nicotianae*) that lives in the soil and attacks tobacco roots, stalks, and leaves. Disease losses can be minimized by planting highly tolerant cultivars with polygenetic resistant mechanisms in fields that have been rotated in and out of tobacco production. The longer the interval between tobacco crops, the less black shank to be expected. This doesn’t mean that black shank cannot occur in fields that don’t have a recent history of tobacco production. The pathogen can be introduced or moved from other fields (on field equipment, for example), and severe disease can develop if weather conditions during the growing season favor its spread. *Phytophthora nicotianae*-infested fields used to produce burley or dark-fired tobacco should be rotated out of tobacco for longer periods of time than normally used with flue-cured tobacco. **Tobacco cultivars possessing the *Php* or *Phl* genes are highly resistant to RACE 0 of the black shank pathogen, but vary in resistance to RACE 1. Determining physiological races of *P. nicotianae* (race 0 or 1) and their population densities in a tobacco field can aid in selection of tobacco cultivars. Current tobacco varieties are always at least as resistant to race 0, but many are much less resistant to race 1 than to race 0. If black shank disease was present in fields to be planted with tobacco, always know the resistance to race 1 before selecting a variety.** Several highly effective black shank fungicides are also currently available, but don’t forget that maximum use of a soil fungicide will not necessarily protect a variety with low black shank resistance against significant damage, particularly in fields where tobacco was planted the previous year. Consistently reliable black shank control, especially with less resistant tobacco cultivars, will likely require 2-3 fungicide applications during the growing season, starting at or near transplanting. Ridomil Gold and Orondis Gold 200 are labeled for application at or near transplanting, and while these fungicides are highly effective, a transplant water fungicide application alone is unlikely to provide season-long black shank control. Follow-up field sprays should alternate to a black shank fungicide with a different mode of action (for example, Presidio). See Table 3.19 for these products and directions for their use. Pre-plant soil fumigation with a product containing chloropicrin may assist results from a black shank fungicide, but fumigation alone is not as effective against black shank as it is for the management of Granville wilt or nematodes.

Granville (Bacterial) wilt

Caused by a soil-inhabiting bacterium (*Ralstonia solanacearum*) that invades tobacco plants through natural openings and wounds of roots and subsequently kills the entire plant. The pathogen can also invade tobacco plants through wounds caused by cultivation, mechanical topping, and mechanical harvest. For this reason, **early, shallow cultivation and topping by hand** can help reduce disease spread in infested fields. Although symptoms are somewhat similar to those associated with black shank, intermediate symptoms of Granville wilt involve **wilting on only one side of affected plants.** Leaves of infected plants will tend to wilt more quickly and take longer to yellow during curing than plants with black shank. Crop rotation (particularly

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with soybeans) and the use of resistant varieties are *essential* for Granville wilt control. Disease reduction and yield increases are generally much larger from the use of resistant varieties than from soil fumigation, but sometimes fields should be fumigated with a resistant variety planted when disease pressure is severe. However, mechanical topplers and tobacco harvesters can spread bacterial wilt widely, late in the season, and infection through wounded stems, rather than roots, bypasses the protection available in wilt resistant tobacco cultivars. Hand-topping and adjusting harvesters as precisely as possible are the only measures available to minimize late season spread of bacterial wilt via field equipment. **Granville wilt-resistant varieties are not available in burley and dark-fired tobacco. These types of tobacco generally should *not* be planted in fields infested by the Granville wilt pathogen.**

Nematodes

Nematodes are microscopic roundworms. Many live in soil and parasitize plant roots. Root-knot, lesion, and tobacco-cyst nematodes are important pests of all tobacco types grown in Southside Virginia. Because symptoms of nematode injury are often confused with other problems, nematodes may go undetected for years. However, plant-parasitic nematodes can *significantly* increase problems with root diseases such as bacterial wilt, black shank, and Fusarium wilt, even when nematode populations are very low. The specific pesticides, rotation crops, and resistant varieties vary among the different types of nematodes that damage tobacco. A Nematode Assay Clinic at Virginia Tech provides a *Diagnostic Nematode Assay* and a *Predictive Nematode Assay*. The *Diagnostic Nematode Assay* determines if plant-parasitic nematodes are the cause of stunted or unthrifty plants. Plant roots should always accompany soil samples submitted for the assay. When nematodes are found to be the cause of problems, it is usually impractical to initiate control measures until the year following the diagnosis. The *Predictive Nematode Assay* focuses on sampling for nematodes in the fall to identify fields with damaging nematode populations so that control measures can be initiated before or at the time of planting. Any soil samples submitted for this assay should be obtained by a systematic sampling procedure. Each soil sample should represent an area no larger than 2 acres and should consist of at least 25 cores or subsamples taken 6 to 8 inches deep. Predictive nematode assay samples must be received by Virginia Tech by November 30 for results to be available by planting. Assay results indicate the presence or absence of economically significant nematode populations. If damaging nematodes are not found, the producer can choose to not use a nematicide. In addition, the type and number of nematodes will influence the choice of nematicide if one is needed. Contact your local Cooperative Extension agent for information on methods of collecting samples and interpreting assay results.

Lesion nematodes

Early root and stalk destruction and crop rotation can significantly reduce populations of these nematodes. Use of a nematicide rated good (G) or excellent (E) may be profitable when a soil assay detects 50-100 lesion nematodes/500 cc of soil. A combination of crop rotation and soil fumigation should be used when populations of lesion nematodes are greater than 100 nematodes/500 cc of soil. Be aware that grass cover or rotation crops may not reduce lesion nematode populations to the same extent as for root-knot or tobacco cyst nematodes. Fall soil samples should be collected from soybean fields when tobacco is the intended crop in the following spring to ensure that damaging lesion nematode populations are not present.

Root-knot nematodes

Root-knot nematodes are common in Virginia tobacco fields, and several types of root-knot can be present in damaging numbers in the same field. Most “root-knot resistant” tobacco cultivars are only resistant to races 1 and 3 of the southern root-knot nematode (*Meloidogyne incognita*), and other types or species are now common. *Any root galling on a currently grown flue-cured tobacco cultivar indicates the presence of these other types of root-knot.* Rotating tobacco with pasture grasses and small grains reduces populations of all types of root-knot, but be careful to rotate tobacco with root-knot resistant cultivars for row crops such as soybean. Forage legumes can increase root-knot nematode populations to damaging levels. Flue-cured tobacco cultivars CC 13, CC 33, CC 35, CC 37, and PVH 2275 claim resistance to several types of root-knot. Consult the flue-cured tobacco production guide for more information on these varieties. A preplant nematicide may be necessary when root-knot populations are high, as indicated in the following table.

Table 3.17 - Interpreting Root-knot Nematode Infestation Levels

Risk of Crop Loss	% Roots Galled	Nematodes/500 cc of soil		Control Options ¹
		Fall Sample	Spring Sample	
Very Low	1-10	1-200	1-20	Practice crop rotation and/or plant a resistant variety.
Low	11-25	201-1,000	21-100	Use crop rotation in combination with a resistant variety or a nematicide rated 'G' or higher.
Moderate	26-50	1,001-3,000	101-300	Use crop rotation in combination with a resistant variety and a nematicide rated 'G' or higher.
High	Over 50	Over 3,000	Over 300	Increase rotation interval if at all possible. Use a resistant variety and a nematicide rated 'E'.

¹Be aware that most "root-knot resistant" tobacco varieties are only resistant to the most common types of root-knot nematodes. **Risks of crop loss are high if galling on roots at the end of the growing season is greater than 20%.** Rotation intervals should be increased as long as possible and a soil nematicide or fumigant should be applied when this level of galling has been observed.

Tobacco-cyst nematode (TCN)

Tobacco-cyst nematode (TCN) (*Globodera tabacum* subsp. *solanacearum*) is present in most tobacco-producing counties in Southside Virginia. Taking soil samples for a Predictive Nematode Assay of tobacco fields on a regular basis (before rotating a field to another crop) will help avoid detecting TCN populations "the hard way." **Varieties of flue-cured tobacco that possess the *Php* gene will reduce TCN populations to non-damaging levels after several years of use; TCN populations will increase very quickly to damaging levels when fields are planted continuously with flue-cured tobacco cultivars without the *Php* gene.** Crop rotation with corn, sorghum, small grains, or pasture grasses will also significantly improve TCN control, particularly when used in addition to TCN-resistant varieties.

Viruses

Tobacco mosaic virus (TMV)

Anything that moves sap from diseased to healthy plants will also move TMV. TMV can spread via contaminated clipping mowers in the greenhouse and from manufactured tobacco products, old tobacco sheets, tobacco roots and stalks left in the soil from previous crops, and from weed hosts such as horse-nettle and ground cherry. Washing hands regularly with detergent can help reduce TMV incidence early in the season. Roguing infected plants before layby will reduce spread of the virus within a field. TMV can be eliminated by using of resistant varieties along with crop rotation and early root and stalk destruction. All burley varieties are resistant to TMV except HB 3307PLC, N 777LC, TN 86LC, and KT 215LC. Flue-cured tobacco cultivars CC 27, CC 37, CC 67, GL 26H, NC 297, PVH 2254, PVH 2275, and PVH 2310 are TMV-resistant. Traditional Virginia-type dark-fired tobacco cultivars (Shirey, for example) are susceptible to TMV, but some newer varieties (KT D6LC, KT D14LC, PD 7305LC, KY 171, DF 911) are TMV-resistant. *TMV-resistant varieties should be planted in tobacco fields when 30 to 50 percent of the plants are infected with TMV by topping. If a TMV-resistant variety is planted in an infested field, the entire field should be planted with the resistant variety. Planting resistant and susceptible varieties together in TMV problem fields can result in significant crop losses due to a severe hypersensitive reaction in the resistant cultivar that can actually kill plants.*

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Tomato spotted wilt virus (TSWV)

Spread by various species of thrips from wild weed hosts to tobacco and other crops. Removing infected plants from a tobacco field will not reduce damage. Crop rotation does not reduce the incidence of TSWV. All commercial tobacco varieties are equally susceptible to the virus. Spraying foliar insecticides is also ineffective. However, application of insecticides containing imidacloprid or thiamethoxam prior to or at transplanting can significantly reduce the damage caused by TSWV to tobacco, as will preplant use of Actigard. Application of Actigard before transplanting, in addition to imidacloprid or thiamethoxam, significantly improves TSWV control compared to use of a single product. Be aware, however, that some risk of significant stunting has been associated with preplant use of Actigard. For this reason, do not apply Actigard before transplanting unless 10% to 15% of the tobacco crop is expected to become infected with TSWV. See the chapters on tobacco insect control in the production guides for burley, dark, and flue-cured tobacco for more specific information on use of imidacloprid or thiamethoxam.

Other viruses

Tobacco etch virus (TEV), *Tobacco vein mottling virus (TVMV)*, *Cucumber mosaic virus (CMV)*, *Peanut stunt virus (PSV)*, *Potato virus Y (PVY)*, *Alfalfa mosaic virus (AMV)* - TVMV and TEV are the most common viruses found in burley tobacco, frequently occur together, and are often referred to as a virus complex. Other less common viruses found in the burley virus complex are AMV, CMV, and PSV. All of these viruses are transmitted by aphids that feed on infected weeds and then move into tobacco. Overwintering hosts of these viruses include horsenettle, ground cherry, curly dock (for TVMV), alfalfa (for AMV), and clovers for CMV and PSV. Symptoms of virus infections vary greatly depending on the virus involved, time of infection, and variety. Virus infected plants may show mosaic, vein clearing, stunt, chlorosis, vein banding, etch, and death of veins. The earlier the plants become infected the more severe the stunting, chlorosis, and necrosis. There are no known methods to prevent infection, nor are chemicals available to cure a virus-infected plant. Consult the regional *Burley and Dark Tobacco Production Guide* (Virginia Cooperative Extension publication 436-050) for information on resistance to these viruses in currently-grown burley varieties.

Application Methods

The performance and safety of a chemical is dependent on following the proper application methods. Proper application procedures will avoid crop injury and poor disease control.

Preplant incorporated (PPI)

Refer to section under weed control.

Foliar spray (FS)

Greenhouse fungicide sprays should not begin until seedlings are at least the size of a dime. Use flat-fan, extended-range tips at approximately 40 psi to maximize results. Flat-fan spray tips and spray volumes of 25-50 gallons per acre should generally be used for field sprays targeting the soil surface. Foliar field sprays should apply spray volumes of at least 20 gallons/acre at layby, gradually increasing to 80-100 gallons of spray solution/acre at topping to maximize spray coverage as tobacco plants increase in size. Hollow cone or similar spray tips should be used for foliar field sprays to reduce spray droplet size to improve coverage of leaves. Spray pressures should generally range between 40 and 100 psi. Improving spray coverage on bottom leaves, where fungal leaf spot diseases usually start and are concentrated, should significantly improve control. Fungicides applied using air-blast sprayers should be mixed at a two-times concentration, but only half the spray volume (gal mix/acre) should be delivered compared to a hydraulic sprayer.

Fumigation

Labels for products that contain chloropicrin and metam sodium require respirator fit-testing, full-face respirators (chloropicrin products only); completed “fumigant management plans” or FMPs *prior to application*; increased posting of treated areas, as well as buffer zones around fumigated fields; minimum distances between treated fields and “difficult to evacuate” sites (schools, etc.); 5-day “entry restricted periods” (ERPs) after soil fumigant application; completed “post-application summaries” within 30 days of application; and official notification requirements. Fumigant applicators must complete an EPA-approved training program within the previous 3 years in order to purchase and apply these products. This training isn’t required for those who use products without chloropicrin or metam sodium, such as Telone II (containing only 1,3-dichlo-

ropropene). Further information on certified fumigant applicator training is available at <https://www.epa.gov/soil-fumigants/soil-fumigant-training-certified-applicators>.

Field Procedures - Performance of all or most field procedures must be documented in the GAP section of the FMP for chloropicrin and metam sodium products. Soil should be in good seed bed condition, free of clods and undecomposed plant material, and with soil moisture at about 1/2 of field capacity when fumigants are applied. *If undecomposed plant material is present, plow down and allow to decompose before applying fumigant.* Soil temperature should be 50° to 80° F at the depth of injection. Fumigants are usually applied in tobacco fields by injecting the fumigant 6-8 inches deep with one chisel-type applicator in center of the row. In the same operation as fumigant application, seal the soil by bedding the fumigated row area with enough soil to bring the soil surface 14-16 inches above the point of infection.

After fumigation, leave soil undisturbed for an ‘exposure period’ of 7-14 days. Cold, wet soil retards diffusion of fumigants and requires a longer exposure period. Soil should be aerated at the end of the exposure period. Planting is generally considered safe when a residual odor of the fumigant is no longer detectable in the soil root zone. This condition is usually reached within 2-3 weeks of application, depending upon the specific soil fumigant used. *When rains or cold temperatures slow aeration during the exposure period, aeration can be improved by using a chisel implement to “open up” the bed, as long as soil is only disturbed above the original depth of injection. Do not rehill rows or turn soil if doing so risks contaminating beds with untreated soil. Do not use tools, equipment, and/or residues that may be contaminated with soil-borne pathogens. Remember, plant injury will occur if fumigant is still present in the soil at transplanting.*

Precautionary and restriction statements

Read and follow all directions, cautions, precautions, restrictions, and special precautions on each product label. This publication must not be used as the only source of precautionary and restriction statements.

Table 3.18 - Diseases of Tobacco Seedlings

Disease	Material	Rate	Remarks
Pythium root rot (<i>Pythium</i> spp.)	Terramaster 4EC	Preventative: 1.0 fl oz/100 gal Sequential: 1.0 fl oz/100 gal Curative: 1.4 fl oz/100 gal	Can be used before or after symptoms appear, but no earlier than 2 weeks after seeding. If symptoms reappear, a second application can be made no later than 8 weeks after seeding. No more than 2.8 fl oz/100 gal of water may be applied to any crop of transplants, regardless of the number of applications. Must be evenly distributed ; when mixing, first form dilute slurry, then distribute slurry evenly and thoroughly in float bed water. FRAC Code 14.
Blackleg (<i>Pectobacterium carotovorum</i>)	Oxidate 2.0	Preventive: 6-24 fl oz/1000 gal Curative: 1.25-2.5 fl oz/10 gal	Preventive: treat or maintain a residual 12.8 fl oz/1,000 gal of float bed water Curative: initial treatment of float bed water
	Oxidate 5.0	Preventive: 1.0 fl oz/100 gal H2O	
Anthracnose (<i>Colletotrichum gloeosporioides</i>) Blue mold (<i>Peronospora tabacina</i>) Target spot (<i>Thanatephorus cucumeris</i>) Damping off (<i>Rhizoctonia solani</i>)	Penncozeb 75DF	0.5 lb/100 gal (1 level tsp/gal)	Apply as a fine spray to the point of run-off to ensure thorough coverage. For best results, begin applications before disease has been observed, but not before seedlings are the size of a dime. Use 3 gal of spray mixture/1000 sq ft when plants are about the size of a dime. Use 6 gal/1,000 sq ft. when the canopy has closed and plants are close to ready for transplanting. Repeat applications on a 5-day interval to protect new growth. FRAC Code M3.

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Table 3.18 - Diseases of Tobacco Seedlings (cont.)

Disease	Material	Rate	Remarks
Target spot (<i>Thanatephorus cucumeris</i>)	Quadris	0.14 oz (4 cc)/1,000 sq ft	One application to tobacco seedlings in transplant greenhouses is allowed. Use enough water for thorough coverage (3-5 gal/1,000 sq.ft.). Follow-up applications are allowed in the field according to the Quadris field label.FRAC Code 11.
Gray mold (<i>Botrytis cinerea</i>)		0.14 oz (4c)/1,000 sq ft	Only one application prior to transplanting.
Angular leaf spot or Wildfire (<i>Pseudomonas syringae</i> p.v. <i>tabaci</i>)	Agrimycin 17, etc. Harbour, Fire-Wall 17WP, etc.	100-200 ppm 2-4 tsp/3 gal or 4-8 oz/50 gal	Foliar spray; preventive use: 100 ppm = 4.0 oz/50 gal or 0.5 lb/100 gal; curative use: 200 ppm = 0.5 lb/50 gal or 1.0 lb/100 gal. FRAC Code 25.
Blue mold (<i>Peronospora tabacina</i>)	Aliette WDG	0.5lb/50 gal 8 fl oz/acre	Foliar spray; apply no more than 0.6 lb/1,000 sq ft; can burn plants if washed into media or float water ; no more than 2 sprays/greenhouse season. Begin applications prior to disease development and continues on a 7-10 day interval. Make no more than 2 consecutive applications before switching to an effective non-Group 40 fungicide. May be tank-mixed with another blue mold fungicide with a different mode of action. Adding a spreader-penetrator, such as a non-ionic surfactant, may increase activity. Thorough coverage is needed for maximum activity. FRAC Code 33.

Table 3.19 - Foliar Diseases in the Field

Disease	Material	Rate	Remarks
Blue mold (<i>Peronospora tabacina</i>); Frogeye (<i>Cercospora nicotianae</i>); Target spot (<i>Thanatephorus cucumeris</i> -sexual; <i>Rhizoctonia solani</i> - asexual stage)	Quadris	6.0-12.0 fl oz	First application should be made prior to disease development or at first indication of disease development in the area; in sufficient water volume for complete coverage and canopy penetration, but apply no more than twice before switching to a different fungicide from a FRAC Group other than 11; may enhance weather flecking, but this does not affect yield or quality; up to 4 applications/year allowed; pre-harvest interval (PHI) is now 21 days. Tank mixing with insecticides formulated as ECs or containing high amounts of solvents may cause some crop injury. FRAC Code 11.
Blue mold (<i>Peronospora tabacina</i>)	Orondis Ultra Premix	5.5 – 8.0 fl oz	FRAC Groups U15 and 40. Do not use if Orondis Gold 200 has already been applied to soil. Begin applications before disease development and continue on a 7-to 10-day interval. Use higher rates when disease is present, for longer application intervals, or on more susceptible varieties. Make no more than 2 sequential applications before rotating to a fungicide with a mode of action other than 40. See label for additional use restrictions. Thorough spray coverage is important in maximizing disease control; adding a spreader-penetrating adjuvant may improve activity. No more than 4 applications (32 fl oz) allowed, with a 7-day PHI. If 3 or more fungicides are applied for blue mold control, Orondis Gold can be used for only 1/3 of the total sprays made.

Table 3.19 - Foliar Diseases in the Field (cont.)

Disease	Material	Rate	Remarks
Blue mold (<i>Peronospora tabacina</i>) (cont.)	Revus	8 fl oz/acre	Begin applications before disease develops and continue spraying on a 7-10 day interval. Spray no more than twice before switching to another effective fungicide that's not in FRAC Group 40. Revus and Orondis Ultra B may be tank-mixed with another effective blue mold fungicide that is not in FRAC Group 40. Thorough spray coverage is important in maximizing disease control; adding a spreader-penetrating adjuvant may improve activity. FRAC Group 40.
	Forum	7.0 fl oz/100 gal	Spray weekly for complete coverage until blue mold no longer threatens. Increase spray volume as the crop grows. Spray volumes should range from 20 gal/A for 1- 3 weeks after transplanting to 40 gal/A for tobacco near layby, to 60 gal/A for waist-high tobacco, to 80-100 gal/A for tobacco near topping or thereafter. If using an air blast sprayer, mix fungicide at 2X concentration, but calibrate sprayer to apply 1/2 the spray volume (gal/acre) used with hydraulic sprayers. Do not spray within 21 days of harvest for flue-cured tobacco or within 30 days of cutting burley tobacco. Forum is FRAC Group 40; mancozeb fungicides are FRAC Group M3.
	+ Penncozeb 75DF	2.0 lb/100 gal	
	Presidio	4 fl oz/A	Two foliar sprays are allowed, the first before or at disease onset. The second spray should be at least 7 days after the first Presidio application. Presidio must be tank-mixed with another blue mold fungicide for resistance management. FRAC Code 43.
	Penncozeb 75DF	2.0 lb/100 gal	Spray weekly for complete coverage until blue mold no longer threatens. Gradually increase spray volume as the crop grows. Spray volumes should range between 80 and 100 gal/A on tobacco ready to be topped. If using an air blast sprayer, mix fungicide at 2X concentration, but calibrate sprayer to apply 1/2 the spray volume (gal/acre) used with hydraulic sprayers. Don't spray within 21 days of harvest for flue-cured tobacco, or within 30 days of cutting burley tobacco. FRAC Code M3.
	Ridomil Gold SL Ultra Flourish	0.5-1.0 pt 1.0-2.0 pt	Flue-Cured – Apply low rate for early season control. Burley & dark-fired — Apply high rate for early season control. Note: Apply broadcast & incorporate in top 2-4 inches of soil preplant. Do not use in plant beds or float systems. Do not apply if mefenoxam or metalaxyl-insensitive pathogen strains have been reported to be present. FRAC Code 4.
	Ridomil Gold SL Ultra Flourish	0.5 pt 1.0 pt	Apply to soil beneath plants just before layby cultivation - don't spray leaves. Do not apply if mefenoxam or metalaxyl-insensitive pathogen strains have been reported to be present. FRAC Code 4.

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Table 3.19 - Foliar Diseases in the Field (cont.)

Disease	Material	Rate	Remarks
Blue mold (<i>Peronospora tabacina</i>) (cont.)	Aliette WDG	2.5-4.0 lb/A	Foliar spray; no more than 5 sprays allowed, 3-day preharvest interval; don't tank mix. FRAC Code 33.
	Actigard 50WG	0.5 oz/20 gal/A	Begin applications when blue mold threatens and plants are tall enough (12 inches for flue-cured and dark-fired tobacco, 18 inches for burley). Up to 3 sprays may be applied on a 10-day schedule. FRAC Code P01.

Table 3.20 - Root and Stem Diseases in the Field

Disease	Material	Rate/Acre	Remarks
Black shank (<i>Phytophthora nicotianae</i>)	Transplant Water Use		
	Orondis Gold Premix	24.0–27.8 fl oz	FRAC Groups 49 and 40. For transplant water (TPW) or in-furrow (IF) at planting application only. Risk of injury from TPW use drops with increasing TPW volume (100-200 gal/A. Premix in a tank separate from the TPW source tank to avoid negative interactions with fertilizers or other pesticides in the TPW solution. IF spray solutions should use a sufficient water volume to move into the root zone. Use the high labeled rate if disease pressure is expected to be severe. Follow-up with additional after planting sprays at 1st cultivation and/or layby using a fungicide outside of FRAC-49. See label for additional use restrictions. No more than 1 application allowed.
	Ridomil Gold SL	4.0-8.0 fl oz (0.25-0.5 pt)	Apply Ridomil Gold (FRAC Code 4) and/or Orondis Gold 200 (FRAC Code 49) in at least 100 gal (200 gal for burley and dark tobacco) transplant water/A. Orondis Gold 200 must not be applied sequentially (back-to-back). Transplant water use carries a risk of plant injury. Use higher rates if disease pressure is expected to be severe. Ultra Flourish and Meta Star are not registered for transplant water application. Season-long disease control usually requires an additional black shank fungicide application at 1st cultivation and/or layby, using a fungicide product with a different FRAC Code.
	Orondis Gold 200	4.8-19.2 fl oz (0.30-1.2 pt)	

Table 3.20 - Root and Stem Diseases in the Field (cont.)

Disease	Material	Rate/Acre	Remarks
Black shank (<i>Phytophthora nicotianae</i>) (cont.)	Pre-Plant Spray		Apply preplant sprays broadcast, then incorporate into the top 2-4 inches of soil. Presidio and Orondis Gold 200 are not labelled for this use. Black shank fungicides should always be used in conjunction with crop rotation and resistant varieties. Failure to control nematodes in treated fields may result in poor black shank control. FRAC Code 4. Direct banded sprays to soil beneath plants during field cultivation. If significant disease is likely, use after a pre- or at-plant black shank fungicide application. Do not apply either Presidio or Orondis sequentially (back-to-back), but alternate each with another black shank fungicide. Later application during cultivation usually extends disease control further through the harvest season. Do not exceed 3.0 pt of Ridomil Gold (FRAC Code 4), 6.0 pt of Ultra Flourish (FRAC Code 4), 12.0 pt of MetaStar (FRAC Code 4), 8.0 fl oz of Presidio (FRAC Code 43), or 38.6 fl oz Orondis Gold 200 (FRAC Code 49) per acre.
	Flue-Cured		
	Ridomil Gold SL	1.0-2.0 pt	
	Ultra Flourish	2.0-4.0 pt	
	Burley and Dark		
	Ridomil Gold SL	1.0-2.0 pt	
	Ultra Flourish	2.0-6.0 pt	
	Post-Plant Spray(s)		
	Ridomil Gold SL	1.0-2.0 pt	
	Ultra Flourish	2.0-4.0 pt	
Presidio	4.0 fl oz		
Orondis Gold 200	4.8-19.2 fl oz		
No-Till Sprays			For no-till tobacco, split between 2 sprays, before and 30-35 days after transplanting. See comments in tobacco weed control section for directions in calculating rates for band applications. FRAC Code 4.
Ridomil Gold SL	0.5-1.0 pt		
Ultra Flourish	3.0 pt		
Soil Fumigants			Inject 8 inches deep with one shank in center of row when soil temperatures are above 50° F. Wait 2-3 weeks after fumigation before planting. Fumigants should always be used in conjunction with host resistance and crop rotation. A soil fungicide should also always be used in addition to a soil fumigant when the fumigant is applied for black shank control.
100% Chloropicrin products	3.0 gal		
Pic+	4.2 gal		
Fusarium wilt (<i>Fusarium oxysporum</i> f. sp. <i>nicotianae</i>)	100% Chloropicrin products Pic+	3.0 gal 4.2 gal	In severe cases, apply a soil fumigant containing chloropicrin, and rotate the field out of tobacco for at least 2-3 years between tobacco crops. Do not rotate with sweet potatoes, since the same fungus attacks both crops.
Bacterial or Granville wilt (<i>Ralstonia solanacearum</i>)	100% Chloropicrin products Pic+	3.0 gal 4.0 gal	Fumigants should always be used in conjunction with host resistance and crop rotation.

Table 3.21 - Nematodes^{1,2}

Material	Rate/A	Application Method	Root-Knot And Others	Tobacco Cyst	Remarks
Non-Fumigants					
Velum Prime	6.5-6.84 fl oz	Transplant water drench	F	F	Suppression only. Do not apply more than 13.7 fl oz per acre per year, regardless of formulation or application method.
Majestene	8-16 pt	Soil incorporated Preplant, 1st cultivation, & Layby	P-F	P-F	OMRI-listed product for nematode suppression in organic tobacco. Multiple applications are needed: in the transplant water, then again at 1st cultivation, and again at layby, for example. Use sufficient water to soak the root zone around plants at each application. Use the high labeled rate if nematode pressure is expected to be severe. See label for additional use restrictions. 4 hr REI.
Fumigants					
100% Chloropicrin products	3.0 gal	Row	E	G	TriPic 100, etc.
42% metam sodium	20.0-25.0 gal	Row	nd	G	Metam CLR, Vapam, Sectagon, etc.
Pic+	4.0 gal	Row	E	G	
Telone II	9.0-10.0 gal	Row	E	G	

¹Control rating – E = Excellent; G = Good; F = Fair; P = Poor, - = no control or not labeled for disease; nd = no data

²**BANDED-PPI** - Research results indicate product performance is best when applied in a 12-24 inch band centered over where the transplanting furrow will be. **Row** – Inject 8 inches deep in row with single shank – 21 day waiting period before planting.

Table 3.22 - No Chemical Available for the Following Diseases

Disease	Comments
Collar rot (<i>Sclerotinia sclerotiorum</i>)	Symptoms of this disease (occurring only in greenhouse systems) resemble damping-off. Small groups of plants have brown, wet lesions near the base of stems. Leaf rot may appear to progress from leaf margins or tips toward the stem. White, cottony mold may be visible. Irregularly shaped, white to black objects (sclerotia) may also be found attached to severely infected plant parts. Infected plants, as well as plants immediately adjacent to diseased areas, should be discarded as soon as possible. Proper clipping procedures, improving ventilation, and reducing excess moisture will help reduce spread of the causal organism.
Frenching (nonpathogenic causal agent)	This disorder has been associated with toxins produced by a nonpathogenic bacterium (<i>Bacillus cereus</i>) and other nonpathogenic microorganisms. Frenching is more prevalent on wet, poorly aerated soils. This problem can be more severe on neutral or alkaline soils and is sometimes associated with lack of available nitrogen or other minerals. Proper soil drainage and fertilization can be beneficial. Do not plant in alkaline soils and avoid heavy application of lime.
Weather fleck (ozone)	This disorder appears as small brown to tan leaf spots in the plant bed and field. The major cause of this problem is ozone from thunderstorms and air pollution. Burley and flue-cured tobacco are more susceptible than dark-fired varieties.

Peanuts

David Langston, Extension Plant Pathologist, Virginia Tech, Tidewater AREC

Weather-Based Crop Advisories

The Peanut/Cotton Infonet is designed to electronically collect data from remote weather stations in the peanut and cotton producing areas of Southeastern Virginia. The data are used to provide daily summaries (air and soil temperature, rainfall), peanut leaf spot and Sclerotinia blight advisories, heat unit reports for peanuts, and degree-day reports for cotton. The Peanut Frost Advisory is another weather-based program that is provided during the fall-harvest period. Each program is designed to guide growers in making decisions that maximize yield, quality, and net profit. Because of constant changes in weather and pest populations during the growing season, information must be updated daily and made readily available to growers. The Tidewater Agricultural Research and Extension Center (AREC) in cooperation with Extension agents, growers, and industry make this information available in the following ways:

- **Peanut/Cotton InfoNet:** Information from four weather monitors is available on the Internet at <http://www.ipm.vt.edu/infonet/>. Up-to-date leaf spot and Sclerotinia fungicide advisories, heat units, and frost advisories are reported.
- The Virginia Peanut Hotline (1-800-795-0700) provide the last effective fungicide spray dates for leaf spot and Sclerotinia blight daily Monday-Friday.
- Contact your local Extension agent or call (757) 807-6536 and ask for David Langston or Linda Byrd-Masters if you need assistance.

Clinical Services

Diagnostic services for plant diseases are provided by the Tidewater AREC in Suffolk. Plant samples should be submitted with the required forms by unit Extension agents. A period of 3 to 5 days is needed to complete biopsy tests and email reports. Diagnostic tests for nematodes and soil fertility problems during the season are also performed in cooperation with laboratories at Virginia Tech. Diagnostic assays are provided free of charge for agents and growers.

Predictive Nematode Assay

This program provides data on the numbers and kinds of nematodes in soil and recommendations on needs for control. Soil samples must be collected in the fall no later than November 20. Local Extension offices have instructions, sample information sheets, and bags for packaging samples.

Management Inputs

The most effective and economical strategy for disease control combines the benefits of sanitation, crop rotation, resistant varieties, scouting, and judicious use of pesticides. For example, changing from a 2-year to a 3-year rotation of peanut with corn or cotton can reduce disease losses to leaf spot, Sclerotinia blight, and *Cylindrocladium* black rot by as much as 50 percent in as few as two or three cycles. Inputs for disease control should be determined on the basis of field history, scouting, disease advisory programs, and recommendations by Virginia Cooperative Extension. This approach to disease management will enable the judicious use of chemicals while providing for a maximum return on investments.

Sanitation

The decay of excess crop residues can be enhanced by disking fields after harvest. Plant debris may contain residual inoculum of organisms that cause disease and improve their capability for long-term survival in fields. Wash equipment frequently to avoid transport of inoculum from field to field. Peanut combines should be cleaned to remove loose soil and plant material after harvesting fields with heavy infestations of soil-borne diseases. Attempts at removal and/or destruction of peanut vines after harvest have some value in disease management, but this practice negates a significant part of the soil fertility benefits of peanut hay in the following year.

Crop Rotation

Using a 4-year rotation of peanuts with corn, grain sorghum, fescue, and other grass-type crops is beneficial to control of peanut diseases. Cotton is also a good rotational crop for peanuts in Virginia, but growers should not apply potash (K) in excess of rec-

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ommended rates of the soil test report. Elevated levels of potash can interfere with calcium uptake and result in pod rot by fungi such as *Rhizoctonia* and *Pythium* species. Soybean and other leguminous crops share many of the common destructive diseases with peanuts and should be avoided. Where soybean is grown in a peanut rotation, double crop soybean with wheat and follow with either cotton, corn, or another grass-type crop.

Resistant Varieties

No peanut varieties are immune to disease, but there is a wide range in susceptibility. Some important differences are noted below with respect to the most common diseases.

- **Cylindrocladium black rot (CBR):** Currently grown Virginia-type peanuts have good resistance to CBR.
- **Sclerotinia blight:** Bailey II has some tolerance to Sclerotinia blight.
- **Early and late leaf spot:** Currently planted peanut varieties have moderate susceptibility to leaf spots.
- **Tomato spotted wilt virus:** Compared to older Virginia-type varieties, current varieties are moderately susceptible to TSWV.

Scouting

Peanut fields should be scouted once a week for disease after pegging. Scouts should use different entry and exit points as well as travel patterns across fields at each visit. After a canopy of foliage covers the soil, scouts should part the vines and look for signs of soilborne diseases on plant stems at the soil surface.

Fungicides

A wide array of chemicals are registered for disease control in peanuts. Selection of the most effective/economical chemical requires knowledge of the target disease and other diseases in the field. Whenever the cause of disease is uncertain, plant samples should be submitted for diagnostic tests in the plant pathology clinic at the Tidewater AREC. Whenever nematode or soil fertility problems are suspected, a 1 pt sample of soil should be submitted. The Peanut/Cotton InfoNet is an important source of information for timing of fungicide applications to control leaf spot and Sclerotinia blight. The following tables provide listings of some of the approved chemicals for control of specific disease problems. Other products may be available, but these are the most common fungicides for control of peanut diseases in Virginia. **Read the label instructions attached to the pesticide containers before application.**

Though it primarily applies to exports, it should be noted that due to recent pesticide residue restrictions made by the European Union, certain peanut shellers will not accept ANY peanuts that have had the restricted chemicals applied. The new restrictions are NOT based on increased safety concerns, and they may still be labelled for use in the U.S. However, under the current circumstances peanut growers should NOT use them, and many chemical suppliers are voluntarily ceasing sales of these products for use in peanut. The chemicals fall into two major categories:

- 1) propiconazole-containing products and
- 2) mono/dipotassium salts or phosphorous acid based products.

Products in category 1 are used for leaf spot management and include Tilt (propiconazole), Tilt Bravo (propiconazole + chlorothalonil), Stratego (propiconazole + trifloxystrobin), and Artisan (propiconazole + flutolanil). There are several generic products with propiconazole as well, so be sure to check labels for propiconazole as an active ingredient. Some good alternatives to propiconazole in leaf spot fungicide programs include Alto (cyproconazole) + Bravo Weather Stik (chlorothalonil), Absolute (tebuconazole + trifloxystrobin), and Priaxor (fluxapyroxad + pyraclostrobin).

Fungicides in the second category are applied for management of *Pythium* pod rot, and there is not widespread use of these fungicides in Virginia. However, growers still need to be aware and be sure they are not using these. Typically, a different type of fungicide for *Pythium* control is included in seed treatments such as Dynasty, and these products are still okay to use.

Due to these restrictions, fungicide products containing these active ingredients are no longer recommended and are not included in the fungicide tables below.

Table 3.23 - Seed Treatments

Disease	Product and Formulation	Rate of Formulation/100 lb seed	Method and Timing of Application	Precautions and Remarks ¹
Seed decay and seedling disease	Allegiance-FL (metalaxyl)	0.1-0.375 fl oz	Apply as water-based slurry with commercial seed treatment equipment.	Controls Pythium seed rot and damping-off. Use in combination with a broad spectrum fungicide.
	Apron XL LS (mefenoxam)	0.16-0.64 fl oz	Same as above.	Same as above.
	Protégé (azoxystrobin)	0.153-1.53 fl oz	Same as above.	Controls Aspergillus crown rot and Rhizoctonia damping-off.
	Maxim 4FS (fludioxonil)	0.08-0.16 fl oz	Same as above.	Protects against seed decay, damping-off, and seed transmission of <i>Cylindrocladium</i> black rot.
	Captan 30DD OR Captan 400	6.0 fl oz 3.0-6.0 fl oz	Same as above.	Same as above.
	RTU-PCNB	1.75-2.5 fl oz	Same as above.	Controls damping-off by <i>Rhizoctonia sp.</i>
	42-S Thiram	3.0 fl oz	Same as above.	Protects against seed decay, damping-off and seedling blights.
	Vitavax-30C	3.0 fl oz	Same as above.	Controls Sclerotium rot and damping-off. Use in combination with a broad spectrum fungicide.
	Thiram 50WP	4.5 oz	Apply with dust treater.	Controls seed decay, damping-off, and seedling blights.
	Vitavax PC (captan + PCNB + Vitavax)	4.0-5.0 oz	Same as above.	Same as above.
	Trilex Optimum DS (captan, trifloxystrobin, metalaxyl)	4.0 oz	Same as above.	Same as above.
	Trilex Star DS (captan, trifloxystrobin, thiophanate methyl, metalaxyl)	4.0 oz	Same as above.	Same as above, and suppresses seed transmission of CBR.
	Dynasty PD (azoxystrobin + fludioxonil + mefenoxam)	3.0-4.0 oz	Same as above.	Controls seed decay, seedling diseases, and seed transmission of <i>Cylindrocladium</i> black rot.
	Rancona V PD (ipconazole + carboxin + metalaxyl)	4.0 oz	Same as above.	Controls seed rot, damping off, and seedling blight.

¹Do not use treated seed for food, feed, or oil purposes. Bags with treated seed should bear a tag or label cautioning against their use for these purposes as well as the reuse of bags.

Table 3.24 - Fungicide Sprays

Disease(s) controlled	Active ingredient	Product and formulation	Rate per Acre	Method and Timing of Application ¹	Precautions and Remarks ²		
Foliar diseases only (early and late leaf spot, web blotch)	chlorothalonil	Bravo 720 Bravo Ultrex Echo 720 Various others	1.5 pt 1.4 lb 1.5 pt	Apply according to leaf-spot advisory program or a calendar-based program using 14-21 day intervals.	Caution: Sclerotinia blight will be more difficult to control when these products are applied at intervals of less than 21 days.		
	tebuconazole + trifloxystrobin	Absolute 500SC	3.7-7.0 fl oz			Same as above.	Do not apply more than 4 sprays and apply chlorothalonil as the final spray for fungicide resistance management. Also controls limb rot.
	mancozeb	Koverall	1.0-2.0 lb			Same as above.	Only effective against early leaf spot.
	cyproconazole	Alto 100SL	5.5 fl oz			Same as above.	Mix or alternate with another fungicide to improve foliar disease control and reduce risk of fungicide resistance.
	picoxystrobin + cyproconazole	Aproach Prima	5.0 - 6.8 fl oz			Same as above.	Begin applications at early vegetative growth and prior to disease development. Use higher rate under high disease pressure.
	flutriafol	Topguard 1.04 SC	7-14 fl oz			Same as above.	Same as above.
	tetraconazole	Eminent 125SL	6-13 fl oz			Same as above.	Same as above.
Early and late leaf spot, web blotch, Rhizoctonia limb rot, Southern stem rot	tetraconazole	Domark 230ME	5.25 to 6.9 fl oz	Same as above.	Do not make more than 2 applications or 13.8 fl oz per acre per year. PHI = 14 days.		
	pydiflumetofen	Miravis	3.4 fl oz	Begin applications prior to disease development. For early and late leaf spot control, apply on a 21 to 28-day interval.	Do not make more than three applications of Miravis or other Group 7 fungicides before alternating with another fungicide mode of action. Also suppresses Sclerotinia blight.		

¹For best results, apply sprays according to leaf spot advisory program in a volume of 12.0 to 15.0 gal/A by ground sprayers or 5.0 gal/A with aircraft.

²Read labels and observe all precautions and restrictions on application, pre-harvest interval, and restrictions on feeding treated hay, vines, or hulls to livestock.

Table 3.24 - Fungicide Sprays (cont.)

Disease(s) controlled	Active ingredient	Product and formulation	Rate per Acre	Method and Timing of Application¹	Precautions and Remarks²
Early and late leaf spot, web blotch, Rhizoctonia limb rot, Southern stem rot (con't)	tebuconazole + prothioconazole	Provost Silver	13.0 fl oz	Same as above.	Label also allows up to 2 sprays at 14 oz/A for control of Rhizoctonia limb rot in addition to foliar diseases.
	metconazole	Quash 50 WDG	2.5-4 oz	Same as above.	Apply up to 4 sprays then use a fungicide with a different mode of action.
	tebuconazole	Folicur 3.6F Multiple generics	7.2 fl oz	Same as above.	Many populations of leaf spot fungicide are not controlled by tebuconazole alone. Mix with chlorothalonil or another fungicide with a different mode of action.
	penthiopyrad	Fontelis 1.67SC	16-24 fl oz	Same as above.	Apply up to 3 sprays, then use a fungicide with a different mode of action. Also suppresses Sclerotinia blight.
	azoxystrobin	Abound 2.08F	9.0-12.3 fl oz	Apply according to leaf spot advisory program, but do not make more than two applications.	Do not apply within 50 days of harvest. Not recommended for the last spray.
	azoxystrobin + tebuconazole	Custodia SC	15.5 fl oz	Apply according to leaf spot advisory.	Make up to 2 to 4 applications in mid-season as part of an advisory program.
	fluoxastrobin	Evito 480SC Aftershock	3.8-5.7 fl oz	Same as above.	Make up to 2 applications per season and rotate or mix with another fungicide with a different mode of action.
	fluoxastrobin + tetraconazole	Evito T	6-11.2 fl oz	Same as above.	Make up to 2 to 4 applications in mid-season as part of an advisory program.

¹For best results, apply sprays according to leaf spot advisory program in a volume of 12.0 to 15.0 gal/A by ground sprayers or 5.0 gal/A with aircraft.

²Read labels and observe all precautions and restrictions on application, pre-harvest interval, and restrictions on feeding treated hay, vines, or hulls to livestock.

Table 3.24 - Fungicide Sprays

Disease(s) controlled	Active ingredient	(cont.) Product and formulation	Rate per Acre	Method and Timing of Application¹	Precautions and Remarks²
Early and late leaf spot, web blotch, Rhizoctonia limb rot, Southern stem rot (con't)	pyraclostrobin	Headline 2.09EC, 2.08SC	6-15 fl oz	Same as above.	Make up to 2 applications per season and rotate or mix with another fungicide with a different mode of action.
	fluxapyroxad + pyraclostrobin	Priaxor	4-8 fl oz	Same as above.	Use 1 to 3 times per season. Use higher rates for limb rot and stem rot control.
	azoxystrobin + benzovindiflupyr	Elatus	7.3-9.5 fl oz	Same as above.	Make no more than 3 applications before alternating with a fungicide with a different mode of action. May also be applied as an early season banded application for suppression of soilborne diseases. Excellent stem rot control.
	bixafen + flutriafol	Lucento	3-5.5 fl oz	Apply according to leaf-spot advisory program or a calendar-based program using 14-21 day intervals.	Do not apply more than 11 fl oz of product/A per year. PHI = 14 days.
	mefentrifluconazole	Provysol	2.5-7.0 fl oz	For leaf spot, apply at 14 to 21 day intervals; for soilborne diseases apply at 14 to 28 day intervals. Use the higher rate for soilborne diseases.	Do not apply more than 21 fl oz/A per year. PHI = 14 days.
	mefentrifluconazole + pyraclostrobin + fluxapyroxad	Revytek	8.0-15.0	For leaf spot, apply at 14 to 21 day intervals; for soilborne diseases apply at 14 to 28 day intervals. Use the higher rate for soilborne diseases.	Do not apply more than 15 fl oz/A per year. PHI = 14 days.
	inpyrfluxam	Excalia	2.0-4.0 fl oz	Apply prior to disease development. Do not apply earlier than 30 days after planting.	Do not apply more than 8 fl oz/A per year. PHI = 40 days.

¹For best results, apply sprays according to leaf spot advisory program in a volume of 12.0 to 15.0 gal/A by ground sprayers or 5.0 gal/A with aircraft.

²Read labels and observe all precautions and restrictions on application, pre-harvest interval, and restrictions on feeding treated hay, vines, or hulls to livestock.

Table 3.24 - Fungicide Sprays (cont.)

Disease(s) controlled	Active ingredient	Product and formulation	Rate per Acre	Method and Timing of Application¹	Precautions and Remarks²
Sclerotinia blight	fluazinam	Omega 500F Vantana	1.0-1.5 pt	Make first application according to disease scouting and the Sclerotinia advisory program. Up to two additional sprays may be applied depending upon disease pressure.	Provides good control of Sclerotinia blight and suppression of southern stem rot and Rhizoctonia pod rot.
	boscalid	Endura 70 WG	8-10 fl oz	Make first application according to the Sclerotinia advisory program and disease scouting in problem fields. Up to three sprays are allowed, but do not make more than two sequential applications.	Provides partial control of Sclerotinia blight and suppression of stem rot. Also suppresses leaf spot and provides excellent control of web blotch.
	penthiopyrad	Fontelis 1.67SC	12-24 fl oz	Apply prior to disease onset and thereafter according to scouting or Sclerotinia blight advisory.	Suppression only. Also controls leaf spot, southern stem rot, and suppresses CBR. Do not apply more than three sequential sprays or 72 fl oz/A per season.
	prothioconazole + fluopyram	Propulse 3.34SC	13.6 fl oz	Apply the first spray when disease is initially detected, and if needed, a second application according to scouting or Sclerotinia blight advisory.	Suppression only. Also suppresses CBR and limb rot. Do not apply more than 34.2 fl oz/A per season. May also be applied to the seed furrow at planting for suppression of soil-borne diseases.
	pydiflumetofen tank-mixed with azoxystrobin + benzovindiflupyr	Miravis + Elatus	3.4 fl oz, Miravis 9.5 oz, Elatus	See above for both fungicides.	

¹For best results, apply sprays according to leaf spot advisory program in a volume of 12.0 to 15.0 gal/A by ground sprayers or 5.0 gal/A with aircraft.

²Read labels and observe all precautions and restrictions on application, pre-harvest interval, and restrictions on feeding treated hay, vines, or hulls to livestock.

Table 3.25 - Soil Treatments

Disease	Product and Formulation	Rate of Formulation /acre	Method and Timing of Application	Precautions and Remarks ¹
Cylindrocladium black rot (CBR) (<i>Cylindrocladium parasiticum</i>) and nematodes	Vapam HL 42%	7.5-gal	Use with resistant varieties in cases of severe disease pressure; plant other varieties only in cases of light CBR pressure. Apply 8 inches deep at least 14 days preplant with one injector shank in front of a bed shaper to mark rows. Do not mix treated soil with untreated soil by tillage or other cultural practices after application.	Apply after soil temperatures exceed 60° F at 4-inch depth, and temperatures are likely to be above this level for 5 days. Do not apply when rainfall levels are likely to exceed 1 inch in the 72-hour period after treatment.
	Metam 42%	7.5-gal		
	Sectagon 42% (metam sodium)	7.5-gal		
Cylindrocladium black rot (CBR)	Proline 480SC (prothioconazole)	5.7 fl oz or 0.4 fl oz/1000 ft of row	Apply to the seed furrow at planting in a volume of 5 gal/A with either a spray nozzle or micro-tube	Use for suppression of CBR in conjunction with crop rotations of 3 years or longer. Proline may help to reduce seed transmission of CBR as well as root infection in naturally infested soil.
Nematodes	Telone II (1,3 dichloropropene)	3.0-6.0 gal	Apply 8-12 inches deep in row and bed soil. Wait 7-14 days before planting.	See label for precautions and restrictions.
	Velum	6.5 - 6.84 fl oz	Apply in-furrow during planting directed on or below seed. May also be applied by chemigation into the root-zone.	May suppress early season early and late leaf spot.
	Propulse (fluopyram + prothioconazole)	13.6 fl oz	May be applied by chemigation or foliar spray.	For maximum nematode suppression, Propulse should be applied 45 days after planting following an at-plant nematicide (e.g. Velum Total). Also controls early and late leaf spot.
	AgLogic 15G, AgLogic 15GG (aldicarb)	7 lb	In furrow at planting.	See label for precautions and restrictions. Also controls thrips.

¹Read labels and observe all precautions and restrictions on application, pre-harvest interval, and restrictions on feeding treated hay, vines, or hulls to livestock.

Cotton

David Langston, Extension Plant Pathologist, Virginia Tech, Tidewater AREC

Seed and Seedling Diseases

Rapid emergence and strong early-season growth are recognized as being most important to success in cotton production. Seedling diseases occur more frequently under cool, wet conditions immediately after planting. Soil temperatures at the 4-inch depth should average above 60°F and the forecast should favor continuation of these conditions over the next 3 days. Daily soil temperatures and cotton degree days are available on the Web at <http://www.ipm.vt.edu/infonet/>. It is also advisable to check the 10-day forecast. Other factors, such as planting too deep, heavy soil crusting, sting and/or reniform nematodes, and misuse of herbicides may increase the problem. Seedling diseases do not usually kill an entire seedling population, but rather cause uneven, slow growing stands with skips in the row.

The first line of defense against seedling disease is to plant high quality seed that is coated with seed protectant fungicides and insecticides. Try to obtain seed with cool germination levels of 80 percent or higher. Avoid seed with cool germination levels below 70 percent. All commercial seed is routinely sold with protectant fungicide coatings which include Captan, Thiram, or Baytan plus PCNB, and metalaxyl.

Table 3.26 - In-furrow and Hopper-box Fungicides for Cotton

Disease	Fungicide Common Name	Fungicide Trade Name	Formulated Rate	Remarks
Seedling disease; damping-off; seed rot.	PCNB	Terraclor Super X 12.5G	8.0-12.0 lb/A	Apply to seed furrow at planting. Read and follow all label restrictions.
	+ etridiazole	Terraclor Super X 18.8G (Note: also available in liquid formulation)	6.0-9.0 lb/A	
	metalaxyl	Ridomil PC (Note: Also available in liquid formulation.)	7.0-10.0 lb/A	Same as above.
	+ PCNB			
	azoxystrobin	Quadris	0.4-0.6 fl oz/1000 row ft	Same as above.
	carboxin	Prevail	8.0-16.0 oz/cwt	Apply to seed in hopper at planting.
	+ PCNB			
	+ metalaxyl			

Foliar Diseases and Boll Rots

Rarely are fungicides needed in Virginia cotton. However they may arise on rare occasions. The table below lists fungicides currently registered for control of foliar and boll pathogens of cotton in Virginia.

Table 3.27 - Foliar Fungicides for Control of Leaf Spots and Boll Rots

Disease	Fungicide Common Name	Fungicide Trade Name	Formulated Rate	Remarks
Alternaria leaf spot Anthracnose leaf spot Areolate mildew Ascochyta leaf spot Cercospora blight Diplodia boll rot Hard lock boll rot <i>Phoma</i> boll rot Rust <i>Stemphylium</i> leaf spot Target spot	pyraclostobin	Headline 2.09SC	6-12 fl oz/A	Apply 1st spray prior to disease development and continue on 7- to 14-day interval if conditions are conducive for disease. Apply no more than two consecutive sprays of Headline. Do not apply more than 36 fl oz/A per season including in-furrow and foliar applications. PHI= 30 days.
	pyraclostrobin + metconazole	TwinLine 1.75EC	7-8.5 fl oz/A	Same as above. Do not apply more than 26 fl oz/A per season. PHI = 30 days.
	azoxystrobin	Quadris	6.0-9.0 fl oz/A	Same as above. Do not apply more than 27 fl oz/A per year. PHI = 45 days.
	fluxapyroxad + pyraclostrobin	Priaxor	4 to 8 fl oz/A	Same as above. Do not apply more than 24 fl oz/A per season. PHI = 30 days. May also be applied in-furrow (0.1 to 0.6 fl oz/1000 row ft) for control or suppression of seedling diseases.
	mefentrifluconazole + fluxapyroxad	Revylok	4.5 to 6.5 fl oz/A	The minimum retreatment interval is 7 days. Do not apply more than 6 .5 fl ozs per acre per application. Do not make more than 2 applications per year.

Nematodes

Nematodes cause significant damage to cotton in some fields in Southeastern Virginia. Sting nematode is recognized as highly destructive to cotton because of the crop's extreme sensitivity to this nematode but is generally only a problem in soils with >80% sand content. Root knot nematodes are generally not a problem when peanut and cotton are rotated in the same field since the two crops are hosts for different root knot nematode species. However, southern root knot nematodes have become an increasing problem where cotton is grown continuously for 5 or more years.

Diagnostic assays for nematodes in soil planted to cotton are conducted by the Nematode Diagnostic Laboratory at Virginia Tech. The Virginia Predictive Nematode Assay Program offers growers an opportunity to locate problem fields prior to planting. The best time to collect soil samples for assay is in the fall following harvest. Assay forms, sample bags, and instructions should be obtained from a local Virginia Cooperative Extension office before collecting samples. Counts of veriform species are all that is needed if cotton is the only crop to be grown. However, if soybean or possibly tobacco might be considered as possible alternative crops, then counts of cyst nematodes would be more important or even critical.

Nematode control is best accomplished by preventing the buildup of harmful numbers of nematodes in soil through crop rotation and good weed control. Some cotton varieties with resistance or tolerance to southern root knot nematode are available. If nematodes pose a threat to cotton production, chemical control can be used to minimize the risk of crop damage.

Table 3.28 - Nematicides for Use in Cotton

Nematode	Active ingredient(s)	Trade Name	Formulated Rate	Remarks ¹
Sting, Reniform, Lesion, Lance, Root knot, Stubby root	1,3 - D	Telone II	3.0 gal/A	Apply 8-12 inches deep in row and bed soil. Wait 7-14 days before planting.
	abamectin	Avicta 500FS	0.10 - 0.15 mg/seed	Must be applied by commercial applicator equipment with rate adjusted for seed size. For early season insect and disease control, Avicta should be combined with Cruiser 5FS (insecticide) and Dynasty CST (fungicide) seed treatments. In high nematode pressure situations, it may be necessary to combine a seed treatment with an in-furrow nematicide. Apply in-furrow in a minimum of 5 gallons per acre of final volume as a spray or dribble directed on the seed during planting. • Linear application rate is based on 36" rows. For different row spacing consult the Linear Application Rate Conversion Chart in the Instructions for At-Plant Applications section. In all cases do not exceed the maximum per acre use restriction.
	fluopyram	COPeO PRIME	0.2 - 0.3 mg ai/seed or 1.127 - 1.69 fl oz/100,000 cotton seeds	Currently available on Stoneville (all seed) and FiberMax (premium seed treatment) varieties. In high nematode pressure situations, it may be necessary to combine a seed treatment with an in-furrow nematicide.
	thiodicarb (nematicide/ insecticide) + imidacloprid (insecticide)	Aeris Seed-applied Insecticide/Nematicide	25.6 fl oz/100 cwt seed	Same as above, except lacks a fungicide for additional seedling disease control, and must be applied as an overcoat on fungicide-treated seed.
	<i>Burkholderia rinojenses</i>	BioST Nematicide 100	8 oz/100 lb seed	Can be applied with fungicide and insecticide seed treatments.

Table 3.28 - Nematicides for Use in Cotton (cont.)

Nematode	Active ingredient(s)	Trade Name	Formulated Rate	Remarks ¹
Sting, Reniform, Lesion, Lance, Root knot, Stubby root	fluopyram (nematicide) + imidacloprid (insecticide)	Velum	5.0 - 6.84 fl oz/A	Apply in-furrow during planting directed on or below seed. May also be applied by chemigation into the root-zone. Also suppresses <i>Fusarium</i> spp.
	aldicarb	AgLogic 15G	3.5 - 7.0 lb/A	This is a restricted use pesticide, so be sure to follow the precautions on the label. Also controls thrips and some other insect pests.
	abamectin	Averland FC	3.5 fl oz/A	Apply in-furrow in a minimum of 5 gallons per acre of final volume as a spray or dribble directed on the seed during planting.

¹Read product label carefully. Note application hazards, re-entry statements, restrictions on feeding livestock, rotation restrictions, and protective clothing required before treatment. Read and observe all requirements as defined on labels.

Insect Control in Field Crops

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Tim Bryant, Assistant Professor, Virginia Tech

Make sure that a definite insect problem exists before applying insecticides to a crop. Use recommended thresholds as a guide when making spray decisions. If you are unable to make this determination, contact your local county Extension office or state Extension Specialist for advice or assistance. Use pesticides only when necessary.

Grain Crops, Soybeans, Forages

Cultural Control Methods

Cultural control methods are powerful tools in managing insect pests. In many instances, growers who follow accepted cultural practices can expect little trouble from insect pests. Some of the most beneficial cultural methods for problem insects include:

Crop rotation

Crop rotation is an inexpensive and effective way of controlling most below ground pests. Rotations that include grass and non-grass crops (e.g., legumes), and rotations of at least two years are best. Multiyear rotations are most effective for wireworm because this insect may take several years to complete development.

Tillage

Conventional tillage is an effective way to manage multiple pests. Slugs, wireworms (eggs and young larvae), cutworms, white grubs, corn earworm, peanut burrower bug, and other pest populations will be reduced by disking in winter or early spring. Keep in mind that tillage does not always benefit pest management and may encourage some insect populations.

Planting date

Timely planting will effectively limit pest pressure late-season when insect populations have had time to build over the summer. Rapid germination and early vigor will enable plants to outgrow seedling injury.

Hybrid/variety selection

Uniform stand and healthy plants will minimize economic impact of insect pests. Early maturing varieties will reduce insect injury and avoid some species altogether. Some crop varieties offer increased tolerance to insects and microbial pests. Genetically modified Bt corn hybrids protect against a suite of above and below ground insect pests. The Handy Bt Trait Table published by Chris DiFonzo at Michigan State University provides a list of corn trait names and their insect protection benefits - <https://www.texasinsects.org/bt-corn-trait-table.html>. Western corn rootworm has evolved resistance to several Bt traits in Virginia. Virginia Tech specialists recommend planting hybrids with two or more rootworm Bt traits when rotation out of corn is not possible or practical. To minimize selection pressure, and future resistance problems, follow all refuge planting requirements.

4-2 Insect Control in Field Crops: Grain Crops, Soybeans, Forages

Chemical Control

Insecticides are sometimes necessary even when using proper cultural control techniques. Recommendations in this publication deal primarily with chemical control. It is critical to worker safety, efficacy of materials, and the marketability of crops to follow all label instructions. Most insecticides will kill honey bees and pollinating insects if applied to a crop in bloom. Label instructions will contain pollinator protection statements when applicable.

Forages: Alfalfa and Other Legumes

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Alfalfa Weevil

There are two cultural control tactics that can be utilized to reduce alfalfa weevil damage. In the late fall, remove the alfalfa for hay or by grazing. This removes the overwintering egg-laying sites for the adult weevils, and will help reduce the number of alfalfa weevil larvae attacking the crop the following spring. Early harvest can sometimes be used in the spring instead of insecticide sprays, if the crop has obtained sufficient growth before larval feeding damage becomes severe.

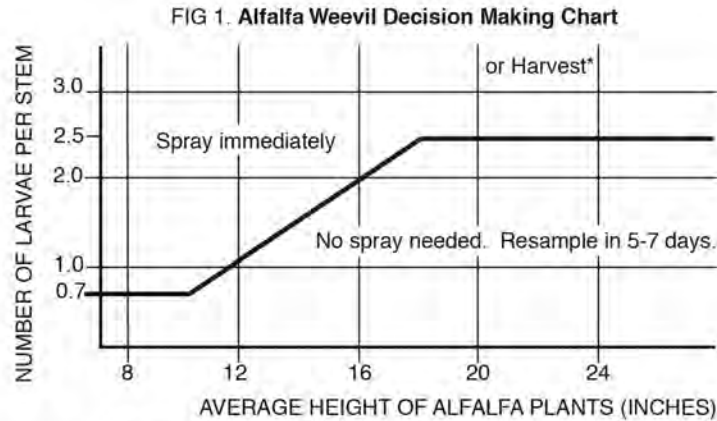
Sampling to Determine Whether Control Measures Are Needed

When the alfalfa starts growing in the spring, walk through the field at least once a week and closely inspect alfalfa tips for feeding injury. When damage and weevil larvae are observed, systematic sampling should be conducted (using the procedure described below) at least once weekly (or more frequently if weevil populations are approaching the action threshold) until the fields are sprayed, harvested, or the weevil season is over. If you are required to spray early and you use a short-residual insecticide, wait 2 to 3 weeks after spraying and resume the sampling program. Insecticide spray failures have been reported following periods of cooler temperatures. This may be the result of reduced activity by the insect (i.e., weevils are not eating treated material nor touching treated surfaces) as opposed to insecticide resistance. Larvae often feed in protected areas of the plant, ensure coverage by using adequate spray volume and pressure. Please report suspected cases of insecticide resistance to your local County Agent or Extension Specialist. As of 2024, widespread alfalfa weevil resistance to type II pyrethroids has been reported in the western US, so insecticide efficacy should be carefully monitored.

Equipment needed to sample a field includes a 3- to 5-gallon bucket, a shallow dishpan, a clipboard with pencil and paper, and tape measure or folding rule. Mentally divide the field into 6 equal sections and walk to the approximate center of the first section. Randomly pull 10 entire stems and place them, tip end first, into the bucket. Be careful to hold the bucket under each stem tip as it is pulled to catch any weevil larvae that may fall off. When the ten stems are collected, grasp them firmly by the base and shake them vigorously against the sides of the bucket for 5 to 10 seconds. As you are shaking the stems, hold the clipboard over the top of the bucket to prevent larvae from being thrown out. Pour the contents of the bucket into the shallow dishpan and count the total number of all weevil larvae.

Randomly select two of the stems from your sample and measure their lengths. Record the number of larvae and the two stem lengths on your clipboard. Walk to the approximate center of the other 5 sections of field and repeat the sampling procedure. Note: in a fairly large field (greater than 20 acres) you may wish to take a few extra samples to improve your sampling accuracy. When you have finished the field, total the larvae and stem lengths for all six sample sites. Determine the average number of larvae/stem by dividing the total by 60 (10 stems at 6 sites) and the average stem length by dividing by 12. Then refer to the decision-making chart, Fig. 4.1. Plot your average number of larvae/stem against stem height. If the point falls near or above the economic threshold line, either harvest or treat the field with a short-residual insecticide. If the point falls below the threshold line, no control measures are recommended; sample again in 5 to 7 days. More frequent sampling may be desired if population levels are approaching the threshold and daily temperatures are above 70° F. **Note: these thresholds are intended for alfalfa growing under adequate fertility and soil moisture conditions. Under drought stress conditions, when alfalfa is growing slowly, the threshold should be lowered by about 0.5 weevil per stem.**

4-4 Insect Control in Field Crops: *Forages: Alfalfa and Other Legumes*



* If harvested without spraying, inspect stubble closely after hay is removed for presence of weevils and feeding damage. A stubble spray may be required.

Fig. 4.1. Decision-making chart for determining the need to apply insecticides for alfalfa weevil control.

Using the Decision Making Chart

(Fig. 4.1) From the average number of larvae per stem and the average height of the plants, draw horizontal and vertical lines until they intersect. If the intersection point is above the treatment line, spray or harvest as soon as possible; if the intersection falls below the line, resample in 5 to 7 days. As can be seen from this chart, the economic threshold is variable, depending on plant height.

For example, if you sampled an average of 2 larvae per stem, and your average plant height was 12 inches, spraying would provide value. If your average plant height was 20 inches for the same larvae count, no spray would be needed. Keep in mind that this decision-making chart is intended for general use, and individual fields may vary considerably in plant response to the leafhopper feeding depending on soil moisture, fertility, and cultivar.

Spray or Harvest for Weevil Control?

In weevil control zone A, roughly east of the Blue Ridge Parkway, (Fig. 4.2), good survival of overwintering weevil eggs and warm temperatures often result in early larval hatch, causing damage when alfalfa is less than 6 inches tall. Population surveys should be initiated early. If 50 percent of the tips have been damaged and the alfalfa is less than 6 inches tall, spray as soon as possible. In zones B and C, however, the need to control alfalfa weevil varies from year to year, and field sampling should be conducted to determine population levels. Harvesting often can be used as an effective weevil control tactic, if enough growth is present to justify the harvesting process. Yield sacrificed in the first cutting by early harvest will be compensated in 2nd and subsequent cuttings. Cutting alfalfa early assures high quality hay with high protein and TDN, and reduces chance of losing hay to rainy weather later in the season. Early cutting also gives the second growth of alfalfa a head start before the potato leafhopper adults appear in early June. The decision to cut or spray should be based on favorable hay-making weather and time scheduling with other farm operations. If hay is cut before the bud stage in the first cutting, second and subsequent cuttings should be allowed to reach 10% bloom before cutting to insure adequate storage of root carbohydrates. Alfalfa may be harvested early only once during the growing season without reducing stand density or longevity.

Determining the Need for Stubble Sprays

If insecticide sprays are used prior to harvest of the first cutting, stubble sprays are seldom necessary. However, if no sprays have been used, or if the field has been cut early because of a heavy weevil infestation, stubble sprays **may** be necessary. Within a week after the hay has been removed from the field, closely inspect the growing shoots of the alfalfa for the presence of larvae or signs of feeding. No formal sampling plan or economic thresholds are available for this crop stage, but, generally, if weevil larvae are easily found, shoot damage is occurring, or regrowth appears delayed, a stubble spray should be applied. Adult weevils can occasionally cause severe damage to regrowth, but because the adult weevils usually hide under the alfalfa crown during the day, they are not easily seen.



Fig. 4.2. Alfalfa Weevil Control Zones

The dividing line between Zone A and Zone B is roughly the Blue Ridge Parkway.

The line dividing Zone B and Zone C roughly follows the county lines.

Table 4.1 - Recommended Insecticides for Control of Alfalfa Weevil Larvae

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.0125-0.022 lb	1.6-2.8 oz	hay harvest: 7 grazing: 7	RESTRICTED USE. Maximum product allowed per cutting is 5.6 oz/A. Maximum product allowed per crop season is 22.4 oz/A.
carbaryl (Sevin 80 Solupak) (Sevin 4F)	1.5 lb 1.5 lb	1.875 lb 1.5 qt	hay harvest: 7 grazing: 7	Highly toxic to bees. Avoid spraying weeds in bloom or alfalfa beyond 10% bloom.
dimethoate (Dimethoate 4EC)	0.25-0.5 lb	0.5-1.0 pt	hay harvest: 10 grazing: 10	Do not apply within 10 days of harvest or pasturing. Make only 1 application per crop cycle or cutting. Effective only on cutting to which applied. Do not apply if bees are visiting the area to be treated when crops or weeds are in bloom. Apply no more than three applications per year.
indoxacarb (Steward EC)	0.065-0.11 lb	6.7-11.3 oz	hay harvest: 7 grazing: 7	Apply no more than once per cutting. A total of 45 oz/A may be applied/season.
lambda-cyhalothrin (Karate Z [2.08EC]) (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	forage harvest: 1 hay harvest: 7	RESTRICTED USE. Apply as required by scouting. Ground application: use 10 to 20 gal water/A. Aerial application: use 2 to 10 gal water/A. Apply in sufficient water for full coverage. Do not apply >0.12 pt/A/cutting. Do not apply >0.48 pt/A/season.

4-6 Insect Control in Field Crops: Forages: Alfalfa and Other Legumes

Table 4.1 - Recommended Insecticides for Control of Alfalfa Weevil Larvae (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
malathion (Malathion 5EC) (Malathion 57EC)	1-1.5 lb	1.5-2.0 pt 2 pt	0 0	Spray may be applied by air or ground equipment. Dilute application: use 20 to 60 gal water/A. Concentrate application: use ≥5 gal water/A.
methomyl (Lannate LV 2.4)	0.9 lb	3.0 pt	hay harvest: 7 grazing: 7	RESTRICTED USE. 48 hour re-entry interval. Also labeled for beet armyworm.
zeta-cypermethrin (Mustang Maxx)	0.014-0.025 lb	2.24-4.0 oz	cutting/grazing: 3 seed harvest: 7	RESTRICTED USE. Minimum 7 days between applications. Maximum 0.025 lb AI/cutting. Maximum 0.075 lb AI/season.

Note: to avoid injury to honey bees, do not apply insecticides during bloom.

Blister Beetles

Blister beetles are not a direct pest of alfalfa but commonly aggregate and hunt their prey in alfalfa fields. The main concern is that when adult beetles are crushed and incorporated into hay during harvest it can have major health implications for the animals eating that hay. Blister beetle contaminated hay is particularly harmful for horses and may cause acute illness or death. The first cutting of alfalfa is at the lowest risk for blister beetle populations and that risk increases with subsequent cuttings throughout the rest of the season. Blister beetles are attracted to flowering alfalfa, so cutting just before or after flowering can reduce the risk of dangerous population levels. Broadleaf flowering weed management can also limit the attractiveness of the field to blister beetles. Beetles tend to aggregate along field margins, which can be scouted for their presence prior to harvest. Hay from the edge of a field should not be given to horses if blister beetle contamination is suspected. Insecticides are not a viable option as beetles that die as a result of the spray can still be incorporated into harvested hay. Additionally, preharvest intervals for insecticides limit their use and there may be use restrictions during flowering to protect pollinators.

Potato Leafhopper

Spring-planting alfalfa with a companion crop of oats will help prevent soil erosion, and also reduce potato leafhopper infestations in the first summer cutting of alfalfa.

Sampling Methods and Action Thresholds

Although several natural enemies prey upon potato leafhoppers in alfalfa, damaging levels of leafhopper are often reached, requiring insecticide application or harvest management. Leafhopper infestations are highly variable from field to field and from year to year; therefore, monitoring of individual fields is required for effective pest management decision-making. Leafhoppers are most easily sampled using a standard 15-inch diameter sweep net. At each of 6 randomly selected sites in a field, take 10 pendular sweeps with the net (swinging it back and forth in front of you) as you walk. One sweep equals one stroke of the net. After the last sweep, quickly grab the net to prevent insects from escaping. Carefully unfold the net, working your way toward the bottom. Count the number of leafhopper adults and nymphs as they emerge and leafhoppers in the bottom of the net. In fields with high leafhopper infestations, many leafhopper nymphs can be seen on the top and edge of the sweep net before the net is opened to examine the contents. Include these in your count. At each sample site, also measure and record the lengths of two randomly selected stems.

Record the total number of leafhoppers for all 6 sites and divide by 60 to determine the number of leafhoppers per sweep. Divide the total stem length by 12 to estimate average stem length. Then go to the Decision Making Chart shown in Fig. 4.3.

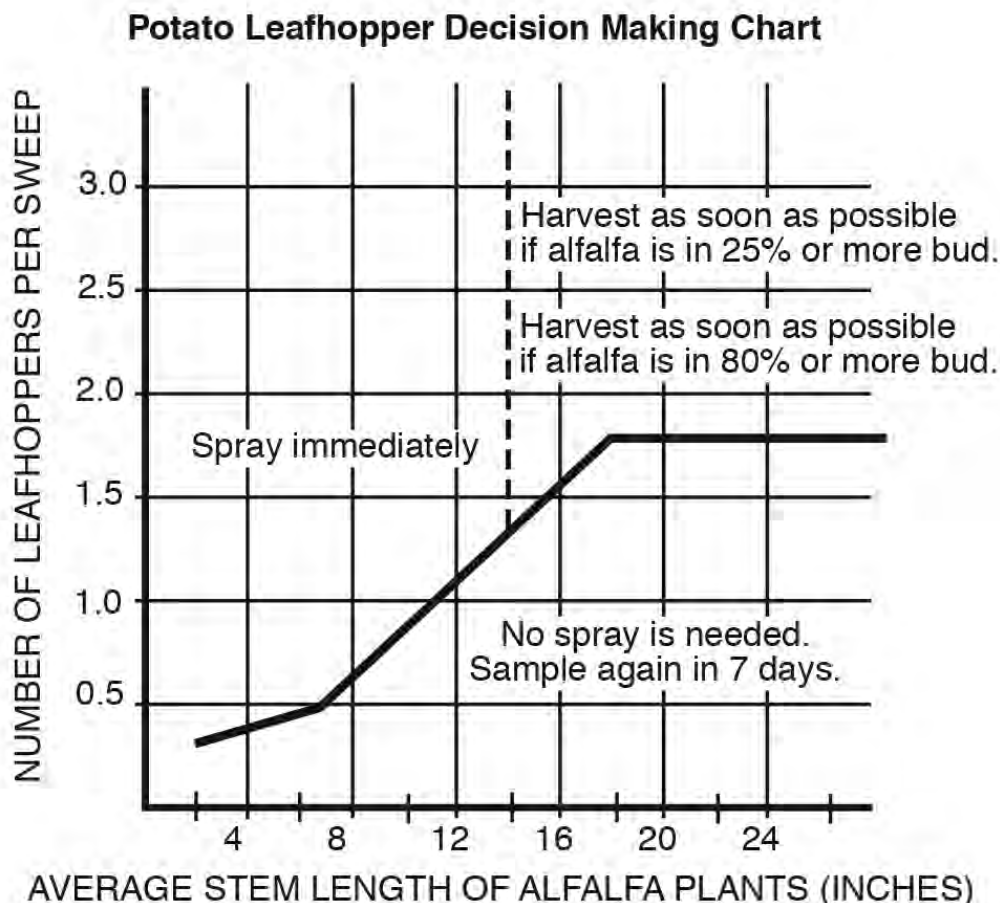


Fig. 4.3. Decision-making chart for determining the need to apply insecticides for potato leafhopper control.

Using the Decision Making Chart

(Fig. 4.3) From the average number of leafhoppers per sweep and the average height of the plants, draw horizontal and vertical lines until they intersect. If the intersection point is above the treatment line, spray or harvest (see below) as soon as possible; if the intersection falls below the line, resample in 5 to 7 days. As can be seen from this chart, the economic threshold is variable, depending on plant height.

For example, if you collected 30 leafhoppers in 60 sweeps for an average of 0.5 leafhoppers per sweep, and your average plant height was 4 inches, spraying would be indicated by the chart. If your average plant height was 12 inches for the same leafhopper count, no spray would be indicated. Keep in mind that this decision-making chart is intended for general use, and individual fields may vary considerably in plant response to the leafhopper feeding depending on soil moisture, fertility, and cultivar.

Spray or Harvest?

Alfalfa should be harvested whenever the crop is in 10 percent or more flower regardless of leafhopper levels. Insecticidal control is most effective if applied early in the crop’s growth (assuming leafhopper densities are above the economic threshold), since the spray will protect the alfalfa during the most susceptible stage of growth. As the alfalfa grows in height, the economic return on investment for insecticidal control is reduced but can still be justified if damaging population levels are present. Beyond a crop height of 14 inches, the value of insecticidal control becomes marginal, since considerable clogging of the plant’s vascular tissue will have already occurred.

If plants are greater than 14 inches tall and leafhopper numbers are above the treatment threshold (see Decision-Making Chart), two management options are recommended. If the leafhopper count is above the treatment line but less than 2.3 per sweep, and

4-8 Insect Control in Field Crops: Forages: Alfalfa and Other Legumes

the crop is showing 80 percent or more bud and less than 10 percent flower, harvest as soon as weather conditions are favorable. If the crop is not yet flowering, wait 7 to 10 days, then harvest. If the leafhopper count is greater than 2.3 per sweep, harvest as soon as the alfalfa shows 25 percent bud. Harvest as soon as possible if considerable damage has already occurred.

Harvesting will remove the damaged stems and allow new growth to begin. Newly-planted fields established in the spring are often so severely stunted by potato leafhoppers that harvesting would not produce a significant amount of hay. The crop should still be clipped to remove weeds and the damaged plants.

Determining the Need for Stubble Sprays

Harvesting alfalfa has been shown to kill most potato leafhopper nymphs and many adults. The adults are highly mobile and most adult leafhoppers surviving harvest will leave the field. Even though high numbers of leafhoppers may be present in the field prior to cutting, stubble sprays are not necessarily needed to protect the next cutting. Ideally, the alfalfa should be sampled with a sweep net (as described above) about a week after harvest, or as soon as the alfalfa starts to grow back. If leafhoppers are present at levels greater than 0.4/sweep, spraying is recommended. If sampling the regrowth is not feasible, and high numbers of leafhoppers were present before harvest, a stubble spray on the regrowth may be a good protective measure, especially if green alfalfa was left in the field following harvest. For best results, wait about 5 to 7 days after harvest, or until 4 to 6 inches of new growth has appeared.

Table 4.2 - Recommended Insecticides for Control of Potato Leafhopper

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.0065-0.0125 lb	0.8-1.6 oz	hay harvest: 7 grazing: 7	RESTRICTED USE. Maximum product allowed per cutting is 5.6 oz/A. Maximum product allowed per crop season is 22.4 oz/A.
dimethoate (Dimethoate 4EC)	0.25-0.5 lb	0.5-1.0 pt	10	Dimethoate also will control aphids and grasshoppers. Make only one application/cutting.
carbaryl (Sevin 80 Solpak) (Sevin 4F)	1.0 lb 1.0 lb	1.25 lb 2.0 pt	hay harvest: 7 grazing: 7	Highly toxic to bees; avoid spraying weeds in bloom or alfalfa beyond 10 percent bloom. May cause temporary bleaching of alfalfa foliage.
indoxacarb	0.09-0.11	9.2-11.3 oz	7	Suppression only. Apply no more than 11.3 oz per cutting.
lambda-cyhalothrin (Karate Z [2.08EC]) (Warrior II [2.08EC])	0.015-0.025 lb	0.96-1.60 oz	forage harvest: 1 hay harvest: 7	RESTRICTED USE. Apply as required by scouting. Ground application: use 10 to 20 gal water/A. Aerial application: use 2 to 10 gal water/A. Apply in sufficient water for full coverage. Do not apply >0.12 pt/A/cutting. Do not apply >0.48 pt/A/season.
malathion (Malathion 5EC)	1.0-1.5 lb	1.5-2.0 pt	0	Spray may be applied by air or ground equipment. Dilute application: use 20 to 60 gal water/A. Concentrate application: use ≥5 gal water/A.
zeta-cypermethrin (Mustang Maxx)	0.014-0.025 lb	2.24-4.0 oz	cutting/grazing: 3 seed harvest: 7	RESTRICTED USE. Minimum 7 days between applications. Maximum 0.025 lb AI/cutting. Maximum 0.075 lb AI/season.

Note: do not wait until yellowing occurs. Materials should be used as a preventative treatment after leafhoppers first appear.

Grasshopper

Table 4.3 - Grasshopper

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.0155-0.022 lb	2.0-2.8 oz	hay harvest: 7 grazing: 7	RESTRICTED USE. Maximum product allowed per cutting is 5.6 oz/A. Maximum product allowed per crop season is 22.4 oz/A.
chlorantraniliprole (Prevathon)	0.027-0.067 lb	8-20 oz	0	Add methylated seed oil (MSO) at the rate of 1 gallon per 100 gallons of spray volume. Target spray at nymph populations and ensure adequate coverage. Feeding should stop almost immediately, but it may take a week or longer for mortality.
indoxacarb	0.045-0.11	4.6-11.3 oz	7	Apply no more than 11.3 oz per cutting.
lambda-cyhalothrin (Karate Z [2.08EC]) (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	forage harvest: 1 hay harvest: 7	RESTRICTED USE. Apply as required by scouting. Ground application: use 10 to 20 gal water/A. Aerial application: use 2 to 10 gal water/A. Apply in sufficient water for full coverage. Do not apply >0.12 pt/A/cutting. Do not apply >0.48 pt/A/season.
malathion (Malathion 5EC, Malathion 57EC)	1.0-1.5 lb	1.5-2.0 pt	0	Spray may be applied by air or ground equipment. Dilute application: use 20 to 60 gal water/A. Concentrate application: use ≥5 gal water/A.
zeta-cypermethrin (Mustang Maxx)	0.017-0.025 lb	2.8-4.0 oz	cutting/grazing: 3 seed harvest: 7	RESTRICTED USE. Minimum 7 days between applications. Maximum 0.025 lb AI/cutting. Maximum 0.075 lb AI/season.

4-10 Insect Control in Field Crops: Forages: Alfalfa and Other Legumes

Armyworm, Cutworm

Armyworms can be problematic in late summer and early fall. Fall armyworm does not overwinter in Virginia and usually arrives in late summer/early fall when pushed north by weather patterns. Similar to other pests of alfalfa, mowing and baling for hay can significantly reduce the number of larvae in the field. If the larvae are small (<3/4 inch), and the alfalfa is not close enough to harvest an insecticide treatment may be effective. If larvae are larger than 3/4 of an inch they will be difficult to control with the insecticides listed below.

Table 4.4 - Armyworm (AW), Cutworm (CW)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	AW 0.0125-0.022 lb CW 0.0065-0.0125 lb	1.6-2.8 oz 0.8-1.6 oz	hay harvest: 7 grazing: 7	RESTRICTED USE. Maximum product allowed per cutting is 5.6 oz/A. Maximum product allowed per crop season is 22.4 oz/A. Effective against small armyworm larvae up to 2nd instar.
carbaryl (Sevin 80 Solpak) (Sevin 4F)	1.0-1.5 lb 1.0-1.5 lb	1.25-1.875 lb 1.0-1.5 qt	hay harvest: 7 grazing: 7	Apply when insects begin to cause injury. A 5% Sevin bait at 20 lb/A also is effective against cutworms.
chlorantraniliprole (Prevathon)	0.047-0.067 lb	14-20 oz	0	Reentry is 4 hours. No more than 60 fl oz or 0.2 lb ai products per year.
lambda-cyhalothrin (Karate Z [2.08EC]) (Warrior II [2.08EC]) armyworm use: cutworm use:	0.02-0.03 lb 0.015-0.025 lb	1.28-1.92 oz 0.96-1.60 oz	forage harvest: 1 hay harvest: 7	RESTRICTED USE. Apply as required by scouting. Ground application: use 10 to 20 gal water/A. Aerial application: use 2 to 10 gal water/A. Apply in sufficient water for full coverage. Do not apply >0.12 pt/A/cutting. Do not apply >0.48 pt/A/season.
malathion (Malathion 5EC) only armyworm	1-1.5 lb	2 pt	0	Spray may be applied by air or ground equipment. Dilute application: use 20 to 60 gal water/A. Concentrate application: use ≥5 gal water/A.
methomyl (Lannate LV) (Lannate SP)	0.225-0.9 lb 0.225-0.9 lb	AW 1.5-3.0 pt CW 0.75-3.0 lb AW 0.5-1.0 pt CW 0.25-2.0 pt	hay harvest: 7 grazing: 7	RESTRICTED USE. Do not apply to dormant or semi-dormant alfalfa when minimum daily temp. is ≤50°F. Wait 7 days after application before grazing or feeding livestock.
zeta-cypermethrin (Mustang Maxx)	0.014-0.025 lb	AW 2.8-4.0 oz CW 2.24-4.0 oz	cutting/grazing: 3 seed harvest: 7	RESTRICTED USE. Minimum 7 days between applications. Maximum 0.025 lb AI/cutting. Maximum 0.075 lb AI/season.

Pea Aphid

Sampling/Decision Making

The need to treat for pea aphids is rare (1 year in 10) in Virginia, Maryland, and Delaware because lady bird beetles, wasp parasites, and other beneficial insects usually control this pest. The best sampling technique requires the same 15-inch sweep net used for potato leafhoppers. Ten sweeps at 10 random locations should be used to sample both the aphids and beneficials. If 50 or more aphids per sweep are collected and no beneficials are present, it is recommended that the field be cut early. Avoid spraying first crop because broad spectrum insecticide sprays can eliminate beneficial insects and flare up other pests later, including alfalfa weevil.

Table 4.5 - Recommended Insecticides for Controlling Pea Aphids

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.022 lb	2.8 oz	hay harvest: 7 grazing: 7	RESTRICTED USE. Maximum product allowed per cutting is 5.6 oz/A. Maximum product allowed per crop season is 22.4 oz/A.
dimethoate (Dimethoate 4EC)	0.25-0.5 lb	0.5-1.0 pt	hay harvest: 10 grazing: 10	Make only one application/ cutting.
malathion (Malathion 5EC) (Malathion 57EC)	1.0-1.5 lb	1.5-2.0 pt	0	RESTRICTED USE. Warm weather favors parasites and predators of aphids; thus control may not be required if the weather forecast predicts a warm trend. Spray may be applied by air or ground equipment. Dilute application: use 20 to 60 gal water/A. Concentrate application: use ≥5 gal water/A.
lambda-cyhalothrin (KarateZ [2.08EC]) (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	forage harvest: 1 hay harvest: 7	RESTRICTED USE. Apply as required by scouting. Ground application: use 10 to 20 gal water/A. Aerial application: use 2 to 10 gal water/A. Apply in sufficient water for full coverage. Do not apply >0.12 pt/A/cutting. Do not apply >0.48 pt/A/season.
methomyl (Lannate LV) (Lannate SP)	0.45 - 0.9 lb	1.5-3.0 pt 0.5-1.0 pt	hay harvest: 7 grazing: 7	RESTRICTED USE. Do not apply to dormant or semi- dormant alfalfa when minimum daily temp. is ≤50°F. Wait 7 days after application before grazing or feeding livestock.
zeta-cypermethrin (Mustang Maxx)	0.014-0.025 lb	2.24-4.0 oz	cutting/grazing: 3 seed harvest: 7	RESTRICTED USE. Minimum 7 days between applications. Maximum 0.025 lb AI/cutting. Maximum 0.075 lb AI/season.

4-12 Insect Control in Field Crops: Forages: Alfalfa and Other Legumes

Orchardgrass, Timothy, and Bermudagrass

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The **immature stage** of white grubs (i.e., Japanese beetle grubs and other related species) and billbug grubs (i.e., bluegrass billbug, hunting billbug) are the most important root-feeding pests on orchardgrass hay in Virginia. Karate Z and Warrior II include these insects on their labels, but only for suppression of adult white grubs and billbugs. The products listed below target surface feeders and insects found in the thatch layer.

Billbugs: The conspicuous “paired” feeding-holes seen on young orchardgrass leaves near field borders in late April-early May indicate the presence of billbugs moving into fields. A degree-day (DD) model for bluegrass (and hunting) billbug that accumulates degree days starting March 01 gives a good estimate of when adult billbugs will most likely appear. The DD window for targeting adult billbugs is 280-352 DDs. This DD threshold indicates when it is time to observe along field edges for paired-feeding holes. There is no research-based action threshold for paired-feeding holes, but if holes are observed along field edges or elsewhere in the field you may want to consider using an appropriate insecticide labeled for orchardgrass. The table and map below present DD information for the years 2014-2019, collected from weather stations located in the counties where most of the orchardgrass in Virginia is grown. The table indicates average, earliest, and latest dates reaching 280 DD; and the map shows date ranges for Virginia counties reaching 280 Degree Days.

Table 4.6 - Average, earliest, and latest date reaching 280 Degree Days, 2014-2019, starting March 01 each year

County	Station	Location	Average Date Reaching 280 DD	Earliest Date Reaching 280 DD	Latest Date Reaching 280 DD
Pittsylvania	KDAN	Danville Reg. Airport	20-Apr	7-Apr	4-May
Botetourt	C5112	Buchanan	23-Apr	16-Apr	4-May
Franklin	C6097	Moneta	23-Apr	16-Apr	5-May
Rockbridge	GLNV2	GLENPED	24-Apr	15-Apr	5-May
Bedford	AT859	N4GGC Montvale	24-Apr	16-Apr	5-May
Campbell	K0V4	Brookneal (County Airport)	24-Apr	15-Apr	9-May
Albemarle	KCHO	Charlottesville-Alb. Airport	25-Apr	15-Apr	4-May
Culpeper	KCJR	Culpeper Co. Airport	28-Apr	19-Apr	8-May
Fauquier	KHWY	Warrenton-Fauquier	29-Apr	20-Apr	8-May
Loudoun	KJYO	Leesburg / Godfrey	29-Apr	19-Apr	9-May
Orange	KOMH	Orange Co. Airport	30-Apr	21-Apr	10-May
Rockingham	D7567	Elkton	3-May	26-Apr	12-May
Shenandoah	FVRV2	FORT VALLEY	4-May	27-Apr	11-May
Frederick	D8166	Winchester	4-May	26-Apr	10-May
Smyth	KMKJ	Marion / Wytheville	4-May	27-Apr	13-May
Montgomery	KBCB	Va. Tech Airport	4-May	27-Apr	12-May
Augusta	KSHD	Frank's Mill (Staunton)	5-May	25-Apr	13-May
Wythe	SFRV2	STONY FORK	6-May	29-Apr	14-May

4-14 Insect Control in Field Crops: Orchardgrass, Timothy, and Bermudagrass

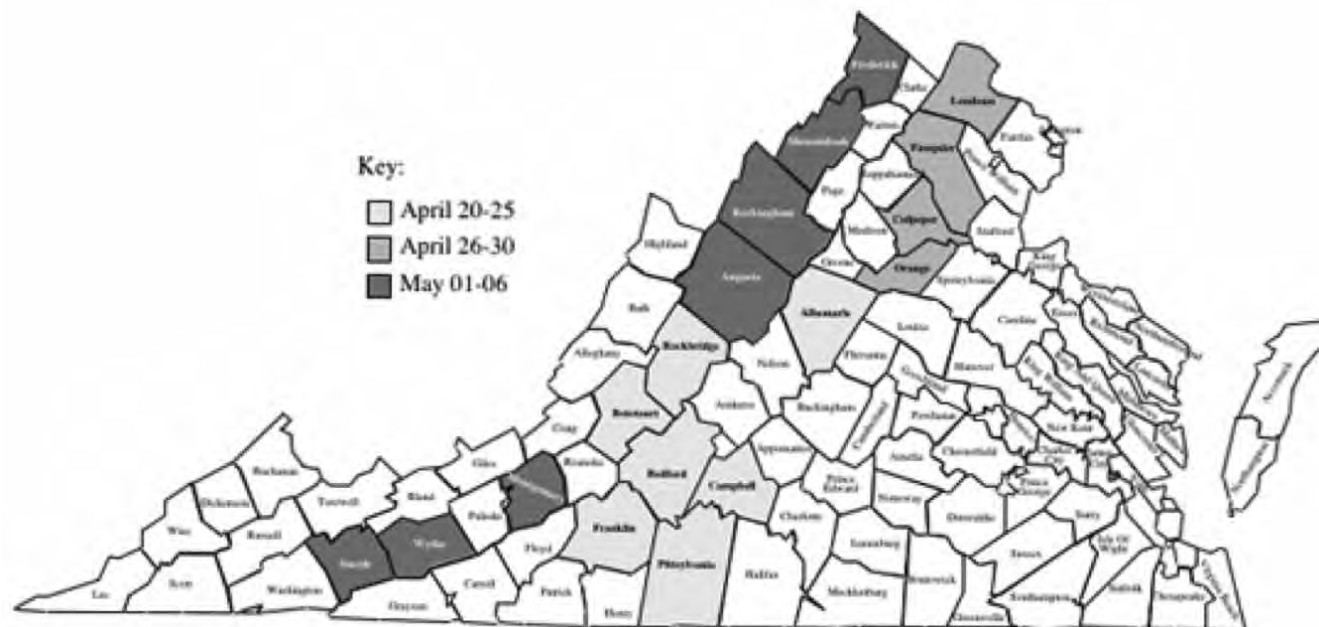


Fig. 4.4. Date range for Virginia counties reaching 280 Degree Days, 2014-2019, starting March 01 each year (Degree days not calculated in unshaded counties).

Fall Armyworm

Fall armyworm does not overwinter in Virginia and arrives each year ahead of summer storms moving from south to north. When moths arrive, they lay a large number of eggs, and the resulting larvae can rapidly defoliate grasses. Injury from fall armyworm can often appear to occur “overnight”, so careful monitoring after weather events which may have pushed moths north can be worth your time. One of the most effective ways to manage larvae is to mow and bale hay. If a field is not ready to be mowed and baled, an insecticide treatment may be effective. A general insecticide treatment threshold of 2-3 fall armyworms per square foot can be used to decide on management. Large worms can be difficult to kill with insecticides. Smaller worms (<3/4 inch) can be effectively managed with broad-spectrum pyrethroid or organophosphate insecticides. If an insecticide treatment is made, pay close attention to the label for the period of time after an application that grazing or harvest is restricted.

Table 4.7 - Orchardgrass, Timothy, Bermudagrass Hay

Pests	Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
armyworms, cutworms, army cutworm, cereal leaf beetle, green cloverworm, meadow spittlebug	beta-cyfluthrin (Baythroid XL)	0.013-0.015 lb	1.6-1.9 oz	grass for pasture, rangeland and seed: 0 grazing	RESTRICTED USE. For grass grown for hay, pasture, seed, or rangeland, the maximum Baythroid XL allowed per 5-day interval is 0.022 lb AI/A (2.8 oz/A). The maximum Baythroid XL allowed per crop season or cutting is 0.089 lb AI/A (11.3 oz/A)
fall armyworm (1st & 2nd instar) yellowstriped armyworm (1st & 2nd instar) Lygus bug, stink bugs, leafhoppers, Japanese beetle (adult), June beetle (adult), grasshoppers, grass thrips, tarnished plant bug (refer to label for additional pests)	beta-cyfluthrin (Baythroid XL)	0.02-0.022 lb	2.6-2.8 oz	grass for hay: 0 harvest grass in mixed stands with alfalfa: 7 harvest 7 grazing	For grass in mixed stands with alfalfa, the maximum Baythroid XL allowed per cutting is 0.022 lb AI/A (2.8 oz/A). The maximum Baythroid XL allowed per crop season is 0.089 lb AI/A (11.3 oz/A). Check label for additional details.
armyworm, fall armyworm, striped grass looper, chinch bugs, thrips, range caterpillar, range crane fly, essex skipper, ticks	carbaryl (Sevin XLR Plus and Sevin SL)	1.0-1.5 lb	1.0-1.5 qt	14 harvest or grazing	Caution. Apply as needed by scouting. Up to 2 applications per year may be made but not more often than once every 14 days. Do not exceed a total of 3 qts/A/year.
	carbaryl (Sevin 80 Solupak)	1.0-1.5 lb	1.25-1.875 lb	14 harvest or grazing	Caution. Up to 2 applications per year may be made but not more often than once every 14 days. Do not exceed a total of 3.75 lbs product/A/year.
army cutworm, cutworms, Essex skipper, range caterpillar, striped grasslooper	lambda-cyhalothrin (Karate Z [2.08EC]) (Warrior II [2.08EC])	0.015-0.025 lb	0.96-1.6 oz	0 grazing 0 cut for forage 7 harvest after last application	RESTRICTED USE. Apply as required by scouting. Timing and frequency of applications should be based on locally determined economic thresholds. Use sufficient water for full coverage. Use ≥2 gal by air and ≥7 gal by ground.
	chlorantraniliprole + lambda-cyhalothrin (Beseige)		5.0 to 8.0 oz.	See label for grazing and PHI 0 grazing 7 days hay	Maximum of 9 fl. oz per cutting and 27 fl. oz per year.

4-16 Insect Control in Field Crops: Orchardgrass, Timothy, and Bermudagrass

Table 4.7 - Orchardgrass, Timothy, Bermudagrass Hay (cont.)

Pests	Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
billbug species (suppression only), beet armyworm, blue stem midge, cereal leaf beetle, chinch bug, crickets, true armyworm, yellowstriped armyworm, fall armyworm, English grain aphid, bird cherry-oat aphid, Russian wheat aphid, sugarcane aphid, greenbug [aphid] (for aphid species best control is obtained before insects begin to roll leaves), flea beetles, leafhoppers, spittlebugs, stink bugs, thrips, grasshoppers, green June beetle (adult), Japanese beetle (adult), webworms	lambda-cyhalothrin (Karate Z [2.08EC]) (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz		Do not apply >0.03 lb AI (1.92 oz product)/A/cutting for pastures, rangeland, and grass grown for seed. A minimum retreatment interval of 30 days is required for pastures and rangeland receiving 0.03 lb AI/A which have not been cut between applications. Do not apply >0.09 lb AI (5.76 oz product)/A/season. Check label for further details.
armyworms, aphids, cereal leaf beetle, grasshoppers, leafhoppers	chlorantraniliprole + lambda-cyhalothrin (Beseige)		6.0 to 10.0 oz	See label for grazing and PHI 0 grazing 7 days hay	Maximum of 9 fl. oz per cutting and 27 fl. oz per year.
cutworms, flea beetles, meadow spittlebug, potato leafhopper, webworms, blue alfalfa aphid, green peach aphid (Refer to label for additional pests.)	malathion (Malathion 5EC)	0.92 lb	1.4 pt	0 harvest or grazing	Warning. REI = 12 hours. Maximum 1 application per cutting
armyworms, cereal leaf beetle, grasshoppers, plant bugs (including <i>Lygus</i> spp. and stinkbugs) (Refer to label for additional pests.)	zeta-cypermethrin (Mustang Max)	0.014-0.025 lb	2.24-4.0 oz	0 forage or hay	RESTRICTED USE. Apply minimum 2 gal/A by air or 10 gal/A by ground. Use sufficient water to ensure thorough coverage of foliage. Applications ≥7 days apart for hay and forage. Maximum of 0.025 lb AI/A/cutting. Maximum 0.10 lb AI/A/season.
armyworms, cereal leaf beetle, grasshoppers, plant bugs (including <i>Lygus</i> spp. and stinkbugs) (Refer to label for additional pests.)	zeta-cypermethrin (Mustang Maxx)	0.0175-0.025 lb	2.8-4.0 oz	0 forage or hay	RESTRICTED USE. Apply minimum 2 gal/A by air or 10 gal/A by ground. Use sufficient water to ensure thorough coverage of foliage. Applications ≥7 days apart for hay and forage. Maximum of 0.025 lb AI/A/cutting and Maximum 0.10 lb AI/A/season.

Table 4.8 - Bermudagrass Pasture

Pests	Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
fall armyworm, armyworm, striped grass looper	methomyl (Lannate LV)	3.6-14.4 oz	0.75-3.0 pt	7 grazing 3 cutting for hay	RESTRICTED USE. (Danger Poison) 48 hour restricted entry interval. Refer to label for proper handling and application instructions. Do not apply more than 3 pt product/A/crop. Do not make more than 4 applications/crop.
Bermudagrass stem maggot	zeta cypermethrin (Mustang Maxx)	0.0175-0.025 lb	2.8-4.0 oz	0 days grazing and hay harvest	RESTRICTED USE. No more than 20 fl oz/A of product per year. Apply after cutting and as grass starts to resprout. Only controls the adult flies, does not control the larvae feeding inside the stem.

Corn

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Bt Corn Usage and Efficacy in Virginia

A Bt corn hybrid refers to a corn plant that has been genetically engineered to express a crystalline protein derived from a common soil bacterium, *Bacillus thuringiensis*. Bt genes are also commonly called “traits.” Although researchers have identified numerous strains of Bt proteins, only a handful have been incorporated into the current lines of commercial corn hybrids. Bt corn hybrids were initially introduced to target stalk boring pests of corn, including the European corn borer. The first single gene hybrids were highly effective for managing corn borers and have remained so for the most part. Resistance to early single Bt traits (I.e. Herculex I (Cry1F)) has recently been documented in Canada and Connecticut. Single gene hybrids are not commonly planted, but should be avoided if available. Additionally, the most modern Bt trait Vip3A has no efficacy for European corn borers, but is the only toxin that remains highly effective for corn earworm.

What pests are controlled by Bt hybrids?

There are a variety of Bt traits that provide control for above and below ground pests of corn. Which insects a given hybrid will control is dependent on the Bt traits expressed and current levels of resistance in the target pest. Many above ground pest Bt traits provide control for multiple caterpillar pests. These traits can be regionally ineffective in areas, including Virginia, where resistance has been documented. The Handy Bt Trait Table published by Chris DiFonzo at Michigan State University provides a full list of corn trait names and their current insect protection benefits - <https://www.texasin-sects.org/bt-corn-trait-table.html>. A selection of commonly used hybrids in Virginia, the Bt toxins they express, which pests they are marketed to provide control for, and efficacy are listed in the table below.

Table 4.9 - Common Bt corn hybrids and efficacy for major pests

Commercial hybrid name	Bt traits	Above-ground pests				
		European Corn Borer (ECB)	Corn Earworm (CEW)	Fall Armyworm (FAW)	Black Cutworm (BCW)	Western corn rootworm (WCR)
Agrisure Artesian 3010A, GT/CB/LL	Cry1Ab	E	P	F	P	—
Agrisure 3000GT, Artesian 3011A	0Cry1Ab, mCry3A	E	P	F	P	G
Agrisure Viptera 3111	Cry1Ab, Vip3Aa20, mCry3A	E	E	E	G	G
Herculex I (HX1)	Cry1F	E	P	G	G	—
Optimum Intrasect (YHR)	Cry1F, Cry1Ab	E	P	G	G	—
Optimum Intrasect XTRA (YXR)	Cry1F, Cry1Ab, Cry34Ab1/Cry35Ab1	E	P	G	G	VG
Optimum Leptra (VYHR)	Cry1F, Cry1Ab, Vip3Aa20	E	E	E	VG	—
Genuity VT Double Pro (VT2P)	Cry1A.105, Cry2Ab2	E	PF	G	P	—
Genuity VT Triple Pro (VT3P)	Cry1A.105, Cry2Ab2, Cry3Bb1	E	PF	G	P	G

Table 4.9 - Common Bt corn hybrids and efficacy for major pests (cont.)

		Above-ground pests					
Commercial hybrid name	Bt traits	European Corn Borer (ECB)	Corn Earworm (CEW)	Fall Armyworm (FAW)	Black Cutworm (BCW)	Western corn rootworm (WCR)	
PowerCore	Cry1A.105, Cry2Ab2, Cry1F	E	PF	VG	G	—	
SmartStax	Cry1A.105, Cry2Ab2, Cry1F, Cry3Bb1, Cry34Ab1/Cry35Ab1	E	PF	VG	G	VG	
Trecepta	Cry1A.105, Cry2Ab2, Vip3A20	E	E	E	VG	—	

Table adapted from 2024 University of Georgia Corn Production Guide with permission of Dr. David Buntin. <https://grains.caes.uga.edu/content/dam/caes-subsite/grains/docs/corn/2023-Corn-Production-Guide.pdf>. Efficacy scores are as follows: P = Poor, PF = Poor to Fair, G = Good, VG = Very good, and E = Excellent.

EPA Refuge Requirements for Planting Bt Corn Hybrids

To delay the development of insect resistance to Bt, a percentage of all Bt corn planted must be planted with non-Bt refuge corn. The percentage required varies between cotton and non-cotton growing counties in Virginia. The refuge requirement also varies dependent on which Bt traits are planted.

In cotton growing counties, for single gene Bt corn hybrids, the refuge requirement is 50% non-Bt corn. For multi-gene Bt hybrids (I.e. VT double pro, Trecepta, etc.) the refuge requirement is 20%. Structured refuge planting is required in cotton growing counties. Counties beholden to these guidelines include: **Dinwiddie, Franklin City, Greensville, Isle of Wight, Northampton, Southampton, Suffolk City, Surry, and Sussex**. In the remainder of non-cotton growing counties in Virginia, the requirement is 20% for single toxin hybrids, and 5% for multigene hybrids. In non-cotton counties, refuge can either be planted using refuge-in-a-bag seed or using structured refuge. Please see the seed label for more information regarding refuge compliance.

Corn Seed Treatments

All commercial corn seed is sold with insecticide applied by the manufacturer. Insecticides target below-ground or early-season pests (seedcorn maggot, wireworms, white grubs, corn rootworms, corn root aphid). Different companies use different trade names for their seed treatments. Please refer to the publication “What’s on your seed?” produced by the University of Wisconsin-Madison to determine which product(s) are applied to your seed. Link to publication - <https://corn.agronomy.wisc.edu/Management/pdfs/IPMWhatsOnYourSeed.pdf>. Although purchasing an insecticide is not optional, higher rates may be ordered. Unless a field has a history of high pest pressure, additional or higher rates are not recommended.

European Corn Borer (ECB)

All Bt cry toxins have historically been effective for managing European corn borer, and have resulted in area-wide suppression of this pest in several crops. Recently, several populations in Nova Scotia, Canada, and Connecticut have demonstrated resistance to single-gene Cry1F and Cry2Ab hybrids and more recently to Cry1A.105 + Cry2Ab2. Best management practices for delaying resistance include planting refuges and planting hybrids that contain two or more genes for above ground insect control. Note that Vip3A does not have any efficacy for European corn borers. The following recommendations are for conventional corn only, as Bt still remains highly effective in Virginia.

European Corn Borer Life Cycle

European corn borer is a moth that has two main generations per year in Virginia. It overwinters as a fifth instar larva inside pieces of corn stalks, and it has a host range of over 200 plant species. The main damage caused by corn borer larvae results from tunnels bored into the stalk about two weeks before silking. A cornfield that averages one or more tunnels per stalk can expect a yield reduction of about 5%. Despite the fact that it is relatively simple to scout for this pest during the growing sea-

son, few growers in Virginia actually do. Their main reasons for not scouting are based on years of observing low levels of stalk breakage and ear drop at harvest.

First Generation

The potential for first-generation damage in field corn during the whorl stage is impossible to predict prior to planting. The best strategy is to scout each field and apply a whorl application of a granular or liquid insecticide if the ECB infestation exceeds the treatment threshold (see Decision Making below). Historically, not all fields need to be treated with insecticides every year. Furthermore, many corn varieties are able to tolerate moderate levels of leaf and stalk injury without economic yield loss. **Also, corn grown for silage rarely needs to be treated for ECB.**

The decision to treat a first generation ECB infestation should be based on the following two criteria: (1) the number of plants exhibiting fresh whorl feeding damage, and (2) the presence of live larvae. ECB mortality typically is very high during the first 3 to 5 days after egg hatch. Plant resistance, natural enemies, and adverse environmental conditions are major causes of ECB larval mortality.

Sampling Begin checking for whorl feeding damage when the plants with extended leaves are 17 inches. Randomly select 5 sets of 20 consecutive plants from throughout the field. Determine the percentage of plants that exhibit fresh whorl feeding. Note: newly hatched larvae feed on the leaves, causing a characteristic “window pane” or “shothole” type of damage that is readily visible as the whorl unrolls. In addition, dissect 2 infested plants from each sample of 20 plants and look for live larvae in the whorl of the stalk. Check weekly or more frequently.

Decision Making. Treatment is suggested if 80 percent or more of the plants exhibit whorl feeding damage and if 80 percent or more of the damaged plants (i.e., 8 out of the 10 dissected plants) have at least 1 live larva per plant.

Second Generation

Although second generation ECB are more likely to attack corn that has been planted late, all corn grown for grain should be scouted when plants with extended leaves are 17 to 24 inches.

Sampling. To assess the potential for economic damage, begin scouting for egg masses when second generation moths emerge and begin egg-laying. The presence of ECB moths in areas bordering a field can be used to indicate a likely infestation. To survey for these moths, walk along the grassy sides of the field and look for large numbers of moths flying when disturbed. However, if no other information is available, it is suggested that scouting for egg masses be initiated the last week of June and continued at 2 to 3 day intervals through the third week of July. Randomly select 5 sets of 20 consecutive plants from throughout the field. Count the number of egg masses found on each plant. ECB moths usually lay their eggs in masses on the undersides of leaves, 2 or 3 leaves below the ear; however, because they can be laid anywhere, it is suggested that every leaf be inspected for egg masses.

Decision Making. To reduce a potential economic loss from second generation ECB in field corn grown for grain, an insecticide treatment is warranted if 35 percent or more of the plants in the pre- to post-tasseling stage of development have at least 1 egg mass per plant.

4-22 Insect Control in Field Crops: Corn

Table 4.10 - European Corn Borer (ECB)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.0125-0.022 lb	1.6-2.8 oz	grain or fodder: 21 Green forages after last application: 0	RESTRICTED USE. Application must be made prior to the larva boring into the plant. Maximum product per 7-day interval: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Maximum number of applications per season: 4.
bifenthrin zeta-cypermethrin (Hero 1.24 EC)	0.04-0.1 lb	4.0-10.3 oz	30 grain and stover, 60 forage	RESTRICTED USE. For grain, silage, and seed. Do not apply more than 0.4 lb AI/A/season for foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application. Do not apply if heavy rainfall is imminent.
chlorantraniliprole (Prevathon 0.43 SC)	0.047-0.067 lb	14-20 oz	14 for ears	
esfenvalerate (Asana XL)	0.04-0.05 lb	7.8-9.6 oz	21	RESTRICTED USE. First generation: Apply when eggs are in blackhead stage or starting to hatch. Ground application suggested— use 20-30 gal carrier/A and direct spray to both sides of leaves. Second generation: Apply when eggs are in blackhead stage or starting to hatch. Good coverage above, below, and in the ear zone is essential.
lambda-cyhalothrin (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	21	RESTRICTED USE. Must be applied before larva bores into stalk. Apply as required by scouting, usually at intervals of 7 or more days. Apply by ground or air using sufficient water for full coverage. Aerial application: use ≥ 2 gal water/A. Do not apply >0.48 pt/A/season. Do not apply >0.24 pt/A after silk initiation. Do not apply >0.12 pt/A after milk stage.
methoxyfenozide (Intrepid 2 F)	0.06-0.25 lb	4-16 oz	21	Must be applied before borers enter stalk.
spinosad (Blackhawk 4 SC)	0.038-0.075	1.67-3.3 oz	28 grain	Must be applied before borers enter stalk. Use 25 GPA minimum and at most 30 psi.
zeta-cypermethrin (Mustang Maxx)	0.017-0.025 lb	2.72-4.0 oz	7 grain, stover, and forage	RESTRICTED USE. Use minimum 10 gal water/A.

Corn Earworm

Corn earworm does not generally cause economic injury in timely planted field corn. If corn is planted late, effective Bt hybrids may have some yield benefit under high corn earworm pressure scenarios. Corn earworm has developed widespread resistance to all available Bt Cry toxins (i.e. Cry1F, Cry1Ab, Cry1A.105, Cry2Ab2). The level of tolerance to various Bt toxins can vary between growing regions. The only Bt trait that remains highly effective for corn earworm is Vip3A20. In cotton growing counties in Virginia, the third generation of corn earworm can move from corn to cotton, where it is known as bollworm. Given that Bt cotton hybrids may express the same or similar toxins found in corn, selection pressure for resistance is increased in these areas. Structured Bt corn refuge planting is required in these counties to limit further development of resistance. In non-cotton

growing counties, either structured refuge or refuge-in-a-bag corn can be planted. See seed label for more information on refuge compliance. Foliar applications of insecticides targeting corn earworm are ineffective and not recommended.

Cutworm

Cutworm Sampling/Decision Making

Late-planted, minimum-till fields with heavy spring weed growth on poorly drained soils are the most likely to encounter cutworms. Corn fields should be checked twice a week from the spike through the 5th-leaf stage. Leaf feeding is the first sign that cutworms are present. Look for small, irregular holes in leaves and cut plants. Note any leaf feeding that may have resulted from cutworms too small to cut plants and check these areas again in 24 to 48 hours. If cutworms are present, examine at least 10 sets of 20 plants throughout the field and record the percentage of cut or damaged plants. At the same time, look under clods and dig 1 to 2 inches deep around the bases of damaged plants to find cutworms. Record the average size and number of cutworms. Most armyworm and cutworms species are active at night and hide under plant residue and soil surface, mud cracks and/or soil clods. Therefore, their presence may go undetected until damage symptoms appear.

As a general guideline, before the 3rd- to 5th-leaf stage, a rescue treatment should be applied if 10% or more of the young plants show fresh leaf feeding and cutworms are present. At the 3rd- to 5th-leaf stage, treatment should be applied if 5% of the plants are cut and there are 4 or more cutworms per 100 plants.

Most commercial Bt corn hybrids express Bt toxins to control cutworm feeding. Plant refuges as required by label instructions. Applying an insecticide with herbicide pre-plant or at-plant has been demonstrated to increase risk from slug feeding. This practice should only be considered in fields with significant history of cutworms.

Table 4.11 - Recommended Postemergence Insecticides to Control Cutworms

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.007-0.022 lb	0.8-2.8 oz	grain or fodder: 21 Green forages after last application: 0	RESTRICTED USE. Rate depends on cutworm species. Maximum product per 7-day interval: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Maximum number of applications per season: 4.
bifenthrin (Brigade, others) 2 EC	0.033-0.10 lb	2.1-6.4 oz	—	RESTRICTED USE. Use at least 10 GPA by ground. Use high rates for heavy infestations and aerial applications.
bifenthrin zeta-cypermethrin (Hero 1.24 EC)	0.025-0.06 lb	2.6-6.1 oz	30 grain and stover, 60 forage	RESTRICTED USE. Use at least 10 GPA by ground. Use high rates for heavy infestations and aerial applications. Do not apply more than 0.4 lb AI/A/season for foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application. Do not apply if heavy rainfall is imminent.
esfenvalerate (Asana XL)	0.03-0.05 lb	5.8-9.6 oz	21	RESTRICTED USE. Use sufficient water to ensure thorough coverage of treated plants.
lambda-cyhalothrin (Warrior II [2.08EC])	0.015-0.025 lb	0.96-1.60 oz	21	RESTRICTED USE. Apply as required by scouting, usually at intervals of 7 or more days. Apply by ground or air using sufficient water for full coverage. Aerial application: use ≥2 gal water/A. Do not apply >0.48 pt/A/season. Do not apply >0.24 pt/A after silk initiation. Do not apply >0.12 pt/A after milk stage.

Table 4.11 - Recommended Postemergence Insecticides to Control Cutworms (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
methoxyfenozide (Intrepid 2F)	0.06-0.25 lb	4-16 oz	21	Western bean cutworm.
zeta-cypermethrin (Mustang Maxx)	0.008-0.0175 lb	1.28-2.8 oz	7 grain, stover, and forage	RESTRICTED USE. Use minimum 10 gal water/A.

Armyworm

Fall Armyworm

Late planted fields are at risk of economic infestations. Fall armyworm does not overwinter in Virginia. Control is recommended for leaf feeding if larvae are present on >50% of plants. Larvae may infest ears if crop matures late. Most commercial Bt corn hybrids express Bt toxins to control fall armyworm feeding. Please note that hybrids containing only Cry1F are not recommended for fall armyworm control in Virginia. Plant refuges as required by label instructions.

True Armyworm Sampling/Decision Making

Armyworm is not commonly an economic pest, but economically damaging infestations can occasionally occur in seedling and whorl stage corn. No-till fields planted into a small grain cover crop, pastures, or weedy fields all have at higher risk for armyworm infestation. Survey field edges where margins border small grains or large grassy areas and watch for damaged plants. If armyworm damage is seen, examine 20 plants at each of 5 locations within the field and record the percentage of damaged plants, the average size, and the severity of injury.

Armyworms usually migrate from small grains starting in late May. Controlling grassy weeds will help prevent infestations. Spot treatments may be warranted if infestations are confined to small areas. Control for armyworms is recommended if 35 percent or more of the plants are infested and 50 percent or more defoliation is seen on the damaged plants, provided that larvae average less than 0.75 inch long. Worms greater than 1.25 inches in length usually have completed their feeding. Soil applied insecticides are not effective against this pest. Transgenic corn varieties control armyworm. Plant refuges as required by label instructions.

Research at Virginia Tech has shown that rotary mowing of the rye cover crop after it has initiated seed heads will not only kill the cover crop, but also will dramatically reduce the number of armyworm larvae early in the growing season when the corn is susceptible to damage from armyworm feeding. If mowing is to be used to kill the winter cover crop, corn planting should follow as soon as possible after mowing to facilitate coulter penetration of the rye mulch.

Table 4.12 - Recommended Postemergence Insecticides to Control Fall Armyworm

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
chlorantraniliprole (Prevathon 0.43 SC)	0.047-0.067	14-20	14 for ears	Use a minimum of 15 GPA for whorl treatment. Less effective against large larvae.

Table 4.13 - Recommended Postemergence Insecticides to Control True Armyworm

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.0125-0.022 lb	1.6-2.8 oz	grain or fodder: 21 Green forages after last application: 0	RESTRICTED USE. Effective against 1st and 2nd instars only. Maximum product per 7-day interval: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Maximum number of applications per season: 4.
bifenthrin (Brigade, others)	0.033-0.10 lb	2.1-6.4 oz	—	RESTRICTED USE.
bifenthrin zeta-cypermethrin (Hero 1.24 EC)	0.04-0.1 lb	4.0-10.3 oz	30 grain and stover, 60 forage	RESTRICTED USE. For grain, silage, and seed use. Do not apply more than 0.4 lb AI/A/season for foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application. Do not apply if heavy rainfall is imminent.
chlorantraniliprole (Prevathon 0.43 SC)	0.047-0.067 lb	14-20 oz	14 for ears	May not effectively control large larvae.
esfenvalerate (Asana XL)	0.03-0.05 lb	5.8-9.6 oz	21	RESTRICTED USE. Use sufficient water to ensure thorough coverage of treated plants.
lambda-cyhalothrin (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	21	RESTRICTED USE. For control of small larvae only. Apply as required by scouting, usually at intervals of 7 or more days. Apply by ground or air using sufficient water for full coverage. Aerial application: use ≥2 gal water/ A. Do not apply >0.48 pt/A/season. Do not apply >0.24 pt/A after silk initiation. Do not apply >0.12/A pt after milk stage.
methomyl (Lannate LV)	0.225-0.45 lb	0.75-1.5 pt	3 forage	RESTRICTED USE. Apply when insects first appear. Use sufficient water to ensure thorough coverage of treated plants.
(Lannate SP)	0.225-0.45 lb	0.25-0.5 lb	21 fodder	
spinosad (Blackhawk 4 SC)	0.038-0.075 lb	1.67-3.3 oz	7 forage and seed, 28 grain	May not effectively control large larvae.
zeta-cypermethrin (Mustang Maxx)	0.02-0.025 lb	3.2-4.0 oz	7 grain, stover, and forage	RESTRICTED USE. Use minimum 10 gal water/A.

Western Corn Rootworm

There is one generation of western corn rootworm (WCR) (<https://www.pubs.ext.vt.edu/ENTO/ENTO-302/ENTO-302.html>) per year. In late summer, adults lay eggs in soil **in cornfields**. Eggs overwinter in the soil and hatch the following late spring through summer. Larvae (grubs) immediately search for corn roots on which to feed, and then pupate in the soil. Adults (beetles) emerge from late June through August and fly to corn plants to feed and mate.

Larvae feed almost exclusively on corn roots, so control is easily accomplished through crop rotation in Virginia. Note that changes in climate and weather patterns can influence the life cycle. However, many farmers do not have the option of rotating out of corn, thus the next best control measures are to plant Bt corn hybrids with rootworm specific traits (Agrisure, Herculex XTRA, Genuity VT Triple Pro, SmartStax), or use a seed treatment. Please note that Bt corn hybrids containing only Cry3 toxins (mCry3A, Cry3Bb1, and eCry3.1Ab) have experienced performance issues in Virginia. No issues have been reported with

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Bt corn hybrids containing Cry34Ab1/35Ab1. Plant refuges as required by label if transgenic varieties are used. As the life cycle indicates, treatment of first year corn to control WCR is not necessary. Also, rootworm populations in subsequent years of continuous corn may not be large enough to warrant treatment. Economic damage thresholds for rootworm beetles have been developed by correlating beetle populations in a particular field with subsequent larval feeding damage occurring the following year.

Sampling

Western corn rootworm beetles can be sampled in July and August to determine whether a control measure is needed the following year. Two methods for scouting corn rootworm beetles are described here.

1. Yellow sticky card method

Place two-sided 4 x 6-in yellow sticky cards (traps), available through various vendors, in cornfields starting in early July. Use the table below to determine how many traps to install. Place traps about 300 feet apart and at least 100 feet in from all field edges. Place a series of traps along the same corn row. When approaching the field edge, cross over about 30 rows and place another series of traps along a row until the entire field is covered. Use flags to mark the location of each trap. Use continuous flagging (forestry tape) when crossing rows and to mark the start of the trap line. Attach traps to corn plants at a height of about 4 feet. Break off any leaves on the plant and adjacent plants that could possibly stick to a trap. Monitor the traps every 9 to 10 days, recording the number of western corn rootworm beetles on each trap. At each site remove the release paper from the unused side of the trap and re-install the trap on the corn stalk with the fresh side exposed. Install new traps every other visit.

Table 4.14 - Determining the Number of Traps to Place in a Field

Field Size (Acres)	Number of Traps per Field
1 to 5	3
6 to 10	6
11 to 15	9
16 to 20	13
21 to 25	16
26 to 30	19
31 to 35	23
36 to 40	26
41 to 45	30
46 to 50	34
51 to 55	37
56 to 60	40

Decision Making

After counting the rootworm beetles on all traps, determine the average number of beetles per trap per week using the following formula:

$$\text{Average beetles per trap per week} = \text{Total Beetles} \div \text{No. of usable traps} \div \text{No. of days since last sampled} \times 7$$

If a field has 20 or more rootworm beetles per trap per week, that field is above threshold and should be rotated out of corn. Once a field exceeds the threshold there is no need to scout it again this year.

If trap catch never reaches 20 beetles per trap per week, the field is below threshold and no treatment is recommended for rootworm control the following year. Scouting can be discontinued if trap counts decline for three consecutive sampling periods.

2. Ear zone count method

Survey fields 4 or 5 times from the second week in July through the third week in August to estimate the number of western corn rootworm beetles in the field. Count the corn rootworm beetles in the ear zone of 50 corn plants throughout each field. The ear zone is the area from the upper surface of the leaf just below the ear to the lower surface of the leaf just above the ear, and includes the ear and ear leaf. Calculate the average number of beetles per ear zone. When scouting fields that have been in corn more than one year, an average count of 1.0 beetle or more per ear zone indicates that the field should be rotated out of corn. When scouting first year corn, control for rootworms the following year if the average count is 0.75 beetles or more per ear zone, because primarily egg-laying females migrate to new cornfields.

Table 4.15 - Western Corn Rootworm

Insecticide (Formulation)	Amount active ingredient per 1,000 row ft	Amount product per 1,000 row ft	Time limits: days before harvest	Remarks
terbufos (Counter 20G SmartBox®)	0.9-1.2 oz	4.5-6.0 oz	30	RESTRICTED USE. Apply at planting in a 4-5-inch band over the row, in front of or behind the press wheel and lightly incorporate. Can also be applied in-furrow. If application is made at planting, do not make postemergence or cultivation time treatments of Counter. Use of Accent or Beacon herbicides following Counter applications may result in crop injury.
tefluthrin (Force 3G)	0.12-0.15 oz	4.0-5.0 oz	–	RESTRICTED USE. Apply at planting in a 7-inch band over the row, in front of or behind the presswheel and incorporate the granules into the top 1 inch of soil. Can also be applied in-furrow. Rotational crops may be planted 30 days after application. Can also be applied at cultivation within 30 days of seedling emergence (must be soil incorporated). Use only once per crop.
clothianidin (Poncho 1250)	1.25 mg AI/ kernel	5.64 oz/80,000 seeds	–	Product is usually applied by manufacturer to seed upon request of grower at the time seed is ordered. Avoid breathing dust and contact with skin.
thiamethoxam (Cruiser 5FS)	1.25 mg AI/ kernel	5.64 oz/80,000 seeds	–	Product is usually applied by manufacturer to seed upon request of grower at the time seed is ordered. Avoid breathing dust and contact with skin.

Table 4.16 - Bt Proteins Active Against Western Corn Rootworm

Protein*	Product	First Marketed
Cry3Bb1	YieldGard	2003
mCry3A	Agrisure	2006
Cry34/35Ab1	Herculex, Optimum	2005
Cry3Bb1 + Cry34/35Ab1	Smartstax	2009
eCry3.1Ab	Duracade	2014

*Resistance by western corn rootworm (WCR) to Bt hybrids expressing either the Cry3 or mCry3A protein has been documented in Midwestern cornfields since 2009 and Virginia cornfields since 2016.

In some locations in Virginia corn rootworm Bt hybrids expressing only Cry3 proteins have experienced considerable root damage and lodging from WCR feeding.

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To preserve the efficacy of Bt traits against western corn rootworm:

Rotate mode of action by planting a hybrid with a different Bt trait or multiple Bt traits for rootworm, or plant a conventional hybrid with a seed treatment.

Rotate out of corn every 3 to 4 years to break the corn rootworm life cycle.

Follow refuge compliance: A refuge (5-20%, depending on hybrid) of non-Bt corn is used to delay the development of resistance to the Bt toxin.

Sampling for Soil Pests of Corn

Compact Method (CM) Soil Sampling Strategy: Fall and spring research-based action thresholds in corn

The CM is a soil sampling strategy for white grubs that provides timely and useful information for pest management decision-making. The CM is based on an 8-inch square by 6-inch deep volume of soil that is hand-sifted for white grubs on a green plastic leaf collection bag placed on the ground next to the sample site. The CM soil sampling strategy was designed for fall sampling as a means to provide producers with a field-specific pest management tool for better managing white grubs on their farms. Using the CM for spring soil sampling of white grubs before planting corn is as useful as fall sampling with the CM. However, keep in mind that sampling in the fall gives you more time to make a decision about white grub management than sampling in the spring.

Definition of Action Threshold (AT): Levels of pest populations at which control should be implemented to avoid significant damage to the crop (determined from research-based relationship of pest levels on yields).

Thresholds: The fall AT is ≥ 1.6 white grubs per CM soil sample. The spring AT is ≥ 1.04 white grubs per CM soil sample.

The following represents the minimum number of compact method samples needed per field to be 95 percent confident your sample average is within the specified percentage of the actual field mean:

25%	3 to 4 samples/field (about 10-15 minutes)
20%	5 to 6 samples/field (about 20-25 minutes)
15%	10 samples/field (about 30-40 minutes)
10%	22 samples/field (about ≥ 1.5 hours)

One point of caution, although soil sampling for white grubs works well in most soils: it is easier to hand sift lighter, sandier soils than heavier soils which do not break apart easily. No data is available for muck soils.

Baited Wire Trap Procedure for Scouting

Seedcorn maggot, wireworms, and white grubs can be scouted before planting

The wire trap itself consists of a 2-ft long by 3-inch wide strip of 0.25-inch hardware cloth (see image below). To strengthen the hardware cloth strip and to facilitate the placement of the corn seed bait, the strip should be bent lengthwise at a 90° angle. Use only corn seeds that have **not been treated** with an insecticidal seed treatment for bait, such as deer corn. About 2 weeks before planting, place 20 seeds about 1 inch apart in each wire trap and then bury the baited wire trap 2 inches deep in the soil. Install at least 1 baited wire trap for every acre of corn to be planted. Remove the traps from the soil after 2 weeks and determine the average number of seeds with feeding damage in the wire traps. The following suggested guidelines may help you determine whether your field is at risk to wireworms, seedcorn maggots, or white grubs.

Suggested Treatment Guidelines Using the Baited Wire Trap Method

Conditions for using the baited wire trap method for field corn

1. Unless continuous corn fields have already been scouted for corn rootworms, baited wire traps should only be used in fields in which corn typically is grown in rotation with soybeans, alfalfa, sorghum, or peanuts (see exceptions below for explanation).

2. Refer to the following suggested treatment guidelines for seedcorn maggots, wireworms, and annual white grubs to determine if a granular insecticide may be needed at planting to prevent serious stand loss.

Seedcorn maggot

A granular insecticide or a higher rate of seed treatment may be needed at planting if the average number of seeds damaged by seedcorn maggots in the baited wire traps is **25 percent** or more; otherwise, an insecticidal seed treatment should be sufficient.

Wireworms

A granular insecticide or a higher rate of seed treatment may be needed at planting if the average number of seeds damaged by wireworms in the baited wire traps is **10 percent** or more; otherwise, an insecticidal seed treatment should be sufficient.

Annual white grubs (i.e., grubs with a 1-year life cycle: Japanese beetle, green June beetle, etc.):

A granular insecticide or a higher rate of seed treatment may be needed at planting if the average number of seeds damaged by annual white grubs in the baited wire traps is **5 percent** or more.

Default

If you are unable to discern which pest is responsible for damaging the corn seeds in the baited wire traps, and if the average number of seeds damaged in the baited wire traps is **5 percent** or more, then a granular insecticide or a higher rate of seed treatment may be needed at planting to prevent serious stand loss.

Exceptions

Cropping situations in which the producer is encouraged to make an in-furrow, T-band, or banded over-the-row application of a granular insecticide or a higher rate of seed treatment when planting field corn (**and not just rely on the base rate of insecticidal seed treatment**) are the following:

- a. when planting corn in old sod or pasture fields, because severe damage from wireworms may occur. Less frequently, damage may occur from true white grubs (i.e., *Phyllophaga* spp. with 2- to 3-year life cycles).
- b. when a field is in continuous corn production, because of the potential for corn rootworm damage, and because the low rate of seed treatments do not control corn rootworms. High rates (e.g., clothianidin applied at the rate of 1.25 mg a.i./seed) provide similar protection against corn rootworm as Bt traits. Soil treatments are not recommended if using a high rate on the seed or two-gene Bt trait hybrids.

Seedcorn Maggot

Seedcorn Maggot Sampling/Decision Making

All commercial corn seed is sold with insecticide applied to the seed coating that control seed corn maggot. The window of protection offered may not overlap with pest pressure and the rate of active ingredient in the plant declines rapidly three weeks post-planting. Seed treatments are less effective in hot/dry and wet/cool conditions when plant growth is slow and uptake is not ideal. Old sod fields, pasture, heavily manured fields and fields with previous histories of seedcorn maggot damage may require a higher rate of insecticide regardless of planting time or type of tillage. Seedcorn maggot cannot be effectively managed after corn is planted. Insecticides labeled are to be applied on the seed coating or in-furrow during planting.

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Table 4.17 - Recommended Pesticides for Controlling Seedcorn Maggot

Insecticide (Formulation)	Amount active ingredient	Amount product	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.022 lb AI/A (based on 30-inch row spacing)	0.12-0.16 oz/1,000 row ft 2.0-2.8 oz/A	grain or fodder: 21 Green forages after last application: 0	RESTRICTED USE. Maximum product allowed at planting: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Row width adjustment: for row spacing <30 inches, adjust rate of product not to exceed 2.8 oz/A. Note: Diminished control may occur when rates are decreased below recommended minimum rates per 1,000 row ft.
bifenthrin (Capture LFR)	0.04-0.2 lb AI/A	3.4-17 oz/A 0.2-0.98 oz/1000 row ft	—	Apply 5- to 7-inch band (T-band) over open furrow or in-furrow with the seed. Maximum 0.2 lb ai/A/season as an at-plant application. Maximum 0.3 lb ai/A/season of at-plant plus foliar applications of other bifenthrin products.
clothianidin (Poncho 600)	0.25-0.50 mg AI/kernel	1.13-2.26 oz/80,000 seeds	—	Product is usually applied by manufacturer to seed upon request of grower at the time seed is ordered. Avoid breathing dust and contact with skin and eyes.
phorate (Thimet 20G)	0.9-1.2 oz	4.5-6.0 oz	30	RESTRICTED USE. Apply at planting in a 7-inch band over the row, in front of or behind the presswheel and lightly incorporate. Granules must be incorporated into the soil. Do not apply Thimet in-furrow. In-furrow application can reduce stand.
thiamethoxam (Cruiser 5FS)	0.25-0.80 mg AI/kernel	1.13-3.62 oz/80,000 seeds	—	Product is usually applied by manufacturer to seed upon request of grower at the time seed is ordered. Avoid breathing dust and contact with skin and eyes.

Wireworms

Wireworm Sampling/Decision Making

First-year corn following established sod is frequently attacked by wireworms. Continuous corn and small grain are also at high risk. Bait stations can be used to determine high-risk fields. Two paired bait stations per acre are made by placing 0.5 cup of an equal mixture of untreated corn/wheat (flour may also be used) in the soil 4 inches deep and covered with dark plastic. Set bait stations in fields to be planted at least 3 weeks before the planting date. Check by digging in about 2 weeks and record the number of wireworms for each station. Economic thresholds for wireworms have not been established on corn; however, if an average of 1 or more wireworms per bait station are found, a soil insecticide or a higher rate of seed treatment should be applied. Wireworms cannot be effectively managed after corn is planted. Insecticides labeled are to be applied on the seed coating or in-furrow during planting. Rates can be found on the bag label. It is also important to note that wireworms are a complex of several species, and knowing the species infesting the field can help predict the time of activity and damage.

Table 4.18 - Recommended at Planting Pesticides for Controlling Wireworms

Insecticide (Formulation)	Amount active ingredient per 1,000 row ft	Amount product per 1,000 row ft	Time limits: days before harvest	Remarks
bifenthrin (Capture LFR)	0.04-0.2 lb/AI/A	3.4-17 oz/A 0.2-0.98 oz/ 1000 row ft	—	Apply as an in-furrow spray, microsteam, or 5 to 7 inch T-band. Maximum 0.2 lb ai/A/season as an at-plant application. Max-imum 0.3 lb ai/A/season of at-plant plus foliar applications of other bifenthrin products.
clothianidin (Poncho 600)	0.25-0.50 mg AI/kernel	1.13-2.26 oz/80,000 seeds	—	Product is usually applied by manufacturer to seed upon request of grower at the time seed is ordered. Avoid breathing dust and contact with skin and eyes.
phorate (Thimet 20G)	0.9-1.2 oz	4.5-6.0 oz	30	RESTRICTED USE. Apply at planting in a 7-inch band over the row, in front of or behind the presswheel and lightly incorporate. Granules must be incorporated into the soil. Do not apply Thimet in-furrow. In-furrow application can reduce stand.
tefluthrin (Force 3G)	0.12-0.15 oz	4-5 oz	30	RESTRICTED USE. Apply in-furrow at planting for best control. Rotational crops may be planted 30 days after application.
terbufos (Counter 20G SmartBox®)	0.9-1.2 oz	4.5-6.0 oz	30	RESTRICTED USE. Apply at planting in 4-5-inch band over the row, in front of or behind the presswheel and lightly incorporate. Can also be applied in-furrow. If application is made at planting, do not make postemergence or cultivation time treatments of Counter. Use of Accent or Beacon herbicides following Counter applications may result in crop injury.
thiamethoxam (Cruiser 5FS)	0.250-0.80 mg AI/kernel	—	—	Product is usually applied by manufacturer to seed upon request of grower at the time seed is ordered. Avoid breathing dust and contact with skin and eyes.

White Grubs

White Grub Sampling/Decision Making

Spring planting into former soybean fields or old sod fields are often at risk for white grubs and, to a lesser extent, wireworms. In most years, white grub species stop feeding to pupate in mid- to late May in Virginia. Late-planted corn and conventional-tilled corn are at lower risk from white grubs.

All commercial corn seed is sold with insecticide applied by the manufacturer. Higher rates are either ordered from the manufacturer at the time the seed order is placed, or may be applied by the dealer. Use higher rates only in high-risk fields. A fall soil sampling method for predicting spring-planted cornfields with economic infestations of white grubs is described below. White grubs cannot be effectively managed after corn is planted. Insecticides labeled are to be applied on the seed coating or in-furrow during planting. Rates can be found on the bag label.

Table 4.19 - Recommended Pesticides for Controlling White Grubs

Insecticide (Formulation)	Amount active ingredient per 1,000 row ft	Amount product per 1,000 row ft	Time limits: days before harvest	Remarks
bifenthrin (Capture LFR)	0.04-0.2 lb AI/A	3.4-17 oz/A 0.2-0.98 oz/1000 row ft	—	Apply 5- to 7-inch band (T-band) over open furrow or in-furrow with the seed. Maximum 0.2 lb ai/A/season as an at-plant application. Maximum 0.3 lb ai/A/season of at-plant plus foliar applications of other bifenthrin products. Provides control alone without addition of seed treatment.
clothianidin (Poncho 600)	0.25-0.50 mg AI/kernel	1.13-2.26 oz/80,000 seeds	—	Product is usually applied by manufacturer to seed upon request of grower at the time seed is ordered. Avoid breathing dust and contact with skin and eyes. Note: High rate is recommended based on VA research.
phorate (Thimet 20G)	0.9-1.2 oz	4.5-6.0 oz	30	RESTRICTED USE. Apply at planting in a 7-inch band over the row, in front of or behind the presswheel and lightly incorporate. Granules must be incorporated into the soil. Do not apply Thimet in-furrow. In-furrow application can reduce stand.
tefluthrin (Force 3G)	0.12-0.15 oz	4.0-5.0 oz	—	RESTRICTED USE. Apply in furrow at planting for best control. Rotational crops may be planted 30 days after application.
terbufos (Counter 20G SmartBox®)	0.9-1.2 oz	4.5-6.0 oz	30	RESTRICTED USE. Apply at planting in a 4-5-inch band over the row, in front of or behind the presswheel and lightly incorporate. Can also be applied in-furrow. If application is made at planting, do not make postemergence or cultivation time treatments of Counter. Use of Accent or Beacon herbicides following Counter applications may result in crop injury.
thiamethoxam (Cruiser 5FS)	0.25-0.80 mg AI/kernel	1.13-3.62 oz/80,000 seeds	—	Note: High rate (0.5-1.25 mg) is recommended based on VA research.
chlorantraniliprole (Lumivia)	0.25-0.75 mg AI/kernel	1.08-3.25 oz/80,000 seeds	—	

Corn Root Aphid

Corn root aphids are a sporadic pest of field corn in Virginia. Currently, only organic corn is at risk from this pest. Planting field corn no-till in fields with a history of corn root aphid problems can lead to serious root injury if a proper soil insecticide has not been applied at planting. Corn root aphids injure corn by piercing the roots with their stylet-like mouthparts and extracting the sap. The growth of infested corn plants often is stunted and, under severe infestations, may be arrested at a height of only 10 inches.

The ability of this aphid to infest corn roots is highly dependent upon certain species of ants commonly known as corn field ants. Shortly after germination, the ants begin carrying the aphids to the developing corn roots. Aphid numbers increase rapidly once in contact with the roots; females are capable of producing 40 to 50 live nymphs each, and generations can be as short as eight days during warm growing conditions. The ants benefit from this relationship by harvesting the droplets of honeydew

produced by the aphids while feeding on the roots.

To determine if a field is at risk to corn root aphids, no-till fields should be scouted for the presence of anthills before planting because, unlike conventionally tilled fields, no-till fields are more likely to have established ant colonies. It should be kept in mind, however, that it is possible for a field to have anthills present without the presence of corn root aphids. Although no specific label reference to corn root aphids has been found among the list of insecticides currently available for use on field corn, application of a granular insecticide at planting to control wireworms or corn rootworms may alleviate a corn root aphid problem. In addition, two cultural practices which can play a role in minimizing corn root aphid infestations are deep tillage every other year to weaken ant colonies, and crop rotation to prevent the buildup of large ant and aphid populations.

Billbug

The southern corn billbug and maize billbug are known to occur throughout the coastal plain of North Carolina and in the Tidewater region of southeastern Virginia. Unlike other areas of Virginia, the relatively higher organic matter content and poorer drainage characteristics of the soils in southeastern Virginia are two factors considered favorable to billbug infestations. In 2017-2019, billbug damage was identified in some northern coastal Virginia no-till fields. Scouting is recommended in all Eastern fields with high organic matter content and/or that are poorly drained.

Both adult and immature stages of billbugs damage corn seedlings. Adult billbugs chew into the side of corn seedlings and feed on the inner plant tissue. Eggs are deposited by females within the feeding cavity and hatch in 4 to 15 days. The legless larvae feed in and around the taproot for several weeks. There is only one generation per year. Damaged seedlings which survive infestation typically are stunted, or otherwise deformed, and may exhibit excessive suckering and rows of transverse holes on the leaves. If billbug injury is suspected early in the season, the crown of affected plants can be split in mid to late-July to look for the presence of billbug larvae.

Rotation is considered the least expensive and most effective method of controlling billbug infestations provided that corn is rotated about 0.25 mile from its previous location. When rotation is not possible, higher rates of neonicotinoid seed treatments (e.g., Poncho 1250) are recommended. Scouting this season will help you make informed decisions in the following year. Billbugs cannot be effectively managed after corn is planted. Insecticides labeled are to be applied on the seed coating or in-furrow during planting. Rates can be found on the bag label.

Table 4.20 - Preemergence Use of Insecticides to Control Billbugs

Note: Continuous corn, corn planted near last year's corn, corn planted mid-April, and corn near good overwintering habitats are at high risk. These products may not provide adequate control in these situations.

Insecticide (Formulation)	Amount active ingredient per 1,000 row ft	Amount product per 1,000 row ft	Time limits: days before harvest	Remarks
clothianidin (Poncho 1250)	1.25 mg AI/ kernel	5.64 oz/80,000 seeds	–	Product is usually applied by manufacturer to seed upon request of grower at the time seed is ordered. Avoid breathing dust and contact with skin.
thiamethoxam (Cruiser 5FS)	1.25 mg AI/ kernel	5.64 oz/80,000 seeds	—	Product is usually applied by manufacturer to seed upon request of grower at the time seed is ordered. Avoid breathing dust and contact with skin.

Slugs and Snails

Slug, Snail Sampling/Decision Making

Slugs can become serious pests in no-till fields during periods of cool, wet weather. Fields with heavy layers of manure, plant residue, or thick weed cover are at higher risk from slugs. Because slugs feed at night and hide during the day in the mulch and surface trash near the seedlings, they often are not seen on scouting trips. Slugs can be found during the day by turning over clods of dirt and surface trash near the seedlings. Corn seedlings that have reached the 3rd-leaf stage of growth generally are able to outgrow feeding damage by slugs.

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Cultural practices which may help reduce slug populations include reduction in the use of manure, shift to conventional tillage practices for at least one season, and minimum tillage to reduce the amount of surface trash. Slugs are not controlled with insecticides. Because slug predators (e.g., ground beetles, harvestmen, and spiders) are killed by insecticide applications, using insecticides prior to or at the time of planting increases the risk and severity of slug feeding.

Table 4.21 - Postemergence Use of Insecticides to Control Slugs and Snails

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
iron phosphate (Sluggo)	0.2-0.44 lb	20-44 lb	0	At the seedling and later stages, apply the bait between the rows and around the perimeter of the field. Use higher rates for heavier infestations.
metaldehyde (Deadline M-Ps)	1 lb maximum	25 lb/A maximum	0	Apply as a broadcast or ground directed. Maximum number of applications per season: 3.

Grasshoppers

Grasshopper Sampling/Decision Making

Damage may occur during mid- to late-summer, especially during periods of drought. Examine fields next to pastures and other grassy areas where grasshoppers overwinter and develop. Treatment of these adjacent breeding sites before the young grasshoppers move into the corn field may reduce the area that must be sprayed later. Treatment of non-cropped areas is suggested when young grasshoppers reach 20 per square yard. Treat field margins when young grasshoppers enter the field from roadsides. Treatment of entire field is seldom necessary; however, field sprays may be justified when 5 to 8 grasshoppers per square yard are present during the silking period.

Table 4.22 - Grasshoppers

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.0165-0.022 lb	2.1-2.8 oz	grain or fodder: 21 Green forages after last application: 0	RESTRICTED USE. Maximum product per 7-day interval: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Maximum number of applications per season: 4.
bifenthrin zeta-cypermethrin (Hero 1.24 EC)	0.025-0.026 lb	2.6-6.1 oz	30 grain and stover, 60 forage	RESTRICTED USE. For grain, silage, and seed. Do not apply more than 0.4 lb AI/A/season for foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application. Do not apply if heavy rainfall is imminent.
esfenvalerate (Asana XL)	0.03-0.05 lb	5.8-9.6 oz	21	RESTRICTED USE. Apply as necessary to maintain control.
lambda-cyhalothrin (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	21	RESTRICTED USE. Apply as required by scouting. Apply by ground or air using sufficient water for full coverage. Aerial application: use ≥ 2 gal water/A.
zeta-cypermethrin (Mustang Maxx)	0.017-0.025 lb	2.72-4.0 oz	7 grain, stover, and forage	RESTRICTED USE. Use minimum 10 gal water/A.

Spider Mite

Spider Mite Sampling/Decision Making

Spider mite populations often seem to explode as plants reach the grain-fill period, especially during extended hot, dry weather when the plants are stressed. Broad-spectrum insecticides applied for other insect pests during mid-summer can devastate the mite predator complex and thus may increase mite populations. If corn has not dented, treatment may be warranted if mite colonies are present along the midribs on the lower surfaces of one-third to one-half of the leaves on 50 percent of the plants. This can also be expressed as 15 to 20 percent of the total leaf area covered with mite colonies, and mites are beginning to colonize significant areas of the field. Do not apply miticides if heavy rainfall is imminent.

Table 4.23 - Spider Mite

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
etoxazole (Zeal)	0.045 to 0.135 oz	1.0 to 3.0 oz	21	Read and follow all label instructions.
fenpyroximate (Portal)	0.10 lb	2.0 pints	14	Read and follow all label instructions.

Corn Leaf Aphid

Corn Leaf Aphid Sampling/Decision Making

Aphids are rarely a problem because infestations either build up too late, or they are controlled by beneficial insects such as lady beetles, lacewings, and parasitic wasps. Economic infestations may occur in mid-summer inside the leaf whorl surrounding the developing tassel. If treatment is considered it should be applied before 50 percent of the tassels emerge to be most effective. Unfold the whorl leaves of 20 plants at each of 5 locations in the field and note the severity of aphid colonies and any natural enemy activity. Treatment may be needed when 25 percent of the plants are heavily infested and natural enemy activity is low. If a broad-spectrum insecticide is applied for aphids, it will also impact natural enemy populations. Corn yield is not affected by the aphid-transmitted barley yellow dwarf virus (BYDV). However, it is important to note that corn can be infected with BYDV and serve as a focal point for the virus to spread into neighboring small grains.

Table 4.24 - Corn Leaf Aphid

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
bifenthrin zeta-cypermethrin (Hero 1.24 EC)	0.04-0.1 lb	4.0-10.3 oz	30 grain and stover, 60 forage	RESTRICTED USE. For grain, silage, and seed. Do not apply more than 0.4 lb AI/A/season for foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application. Do not apply if heavy rainfall is imminent.
lambda-cyhalothrin (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	21	RESTRICTED USE. Suppression only. Apply as required by scouting, usually at intervals of 7 or more days. Apply by ground or air using sufficient water for full coverage. Aerial application: use ≥ 2 gal water/A. Do not apply > 0.48 pt/A/season. Do not apply > 0.24 pt/A after silk initiation. Do not apply > 0.12 pt/A after milk stage.
zeta-cypermethrin (Mustang Maxx)	0.017-0.025 lb	2.72-4.0 oz	7 grain, stover, and forage	RESTRICTED USE. Use minimum 10 gal water/A.

Japanese Beetle

Japanese Beetle (Adult Feeding) Sampling/Decision Making

Damage is caused when the adult beetles prevent pollination by clipping silks during the early stage of silking. Begin scouting in mid-July before pollination to determine the number of beetles present and the potential for silk clipping damage. Pollination takes place during a period of about 36 hours. If the silks are wilted and/or have turned brown, pollination is complete and further silk feeding will not affect yields. Examine 20 plants in each of 5 locations in the field to determine the stage of pollination, the number of beetles per plant, and the percentage of plants with silks cut back to 0.5 inch or less. An insecticide application may be necessary if 50 percent of the plants have silks cut back to 0.5 inch or less, there is an average of more than 3 Japanese beetles per silk, and the plants are still pollinating.

Table 4.25 - Japanese Beetle

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.0125-0.022 lb	1.6-2.8 oz	grain or fodder: 21 Green forages after last application: 0	RESTRICTED USE. Maximum product per 7-day interval: 2.8 oz/A. Maximum product per crop season: 11.2 oz/A. Maximum number of applications per season: 4.
bifenthrin zeta-cypermethrin (Hero 1.24 EC)	0.04-0.1 lb	4.0-10.3 oz	30 grain and stover, 60 forage	RESTRICTED USE. For grain, silage, and seed. Do not apply more than 0.4 lb AI/A/season for foliar applications. Do not graze livestock in treated areas or cut treated crops for feed within 30 days of last application. Do not apply if heavy rainfall is imminent.
lambda-cyhalothrin (Warrior II [2.08EC])	0.02-0.03 lb	1.28-1.92 oz	21	RESTRICTED USE. Apply as required by scouting. Apply by ground or air using sufficient water for full coverage. Aerial application: use ≥ 2 gal water/A.
zeta-cypermethrin (Mustang Maxx)	0.017-0.025 lb	2.72-4.0 oz	7 grain, stover, and forage	RESTRICTED USE. Use minimum 10 gal water/A.

Stink Bugs

There are several species of stink bug which can feed on corn throughout the season including the brown stink bug, brown marmorated stink bug, green stink bug, and southern green stink bug. If the majority of the population is composed of brown stink bugs, the highest labeled rate of bifenthrin will be most effective and will also eliminate other species. If the population is primarily composed of other species any pyrethroid can be effective. No-till fields are at higher risk for seedling injury. Brown stink bugs migrate from wheat fields just prior to, or following, harvest. Stink bug feeding on larger plants can cause developing ears to deform or abort. About two weeks prior to tasseling through pollination, developing ears are particularly susceptible to stink bug feeding. The most common symptom of stink bug feeding during this time, which does not fully develop until later, is a banana-shaped or crooked ear. Virginia Tech recommends a threshold of one stink bug per ten plants from emergence through V6, one stink bug per four plants when the ear is forming, and one stink bug per two plants from pollen shed to blister stage. Treatment past the blister stage is not recommended. Stink bugs will congregate near edges, but infestations of an entire field are possible. Walk at least 15 rows into the field to scout for bugs. Bugs will hide in leaf collars and in the whorl. Scouting efforts for stink bugs during late vegetative and early reproductive stages of corn development can be focused on the area of the plant one leaf above and two leaves below the primary ear. Apply insecticides to stages just prior to tasseling. Results from aerial applications are variable - sprays can be effective or offer very poor control. Communicate with your applicator that you intend to target stink bugs prior to making an application. There is little to no residual with stink bug sprays and bugs can easily reinvade fields following sprays.

Table 4.26 - Recommended Postemergence Insecticides to Control Stink Bugs

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL 1.0 EC)	0.013 - 0.022 lb	1.6 - 2.8 oz	21	
bifenthrin (Brigade 2 EC, others)	0.033-0.1 lb	2.1-6.4 oz	30	
bifenthrin + zeta-cypermethrin (Hero 1.24 EC)	0.03-0.1 lb	4.0-10.3 oz	60 forage 30 grain and stover	
bifenthrin + zeta-cypermethrin (Steed 1.5 EC)	0.041-0.055 lb	3.5-4.7 oz	60 forage 30 grain and stover	
cyfluthrin (Tombstone 1.0 EC)	0.025-0.044 lb	1.6-2.8 oz	21	
lambda-cyhalothrin (Karate Z, Warrior II 2.08CS)	0.02-0.03 lb	1.28-1.92 oz	21	
zeta-cypermethrin (Mustang Maxx 0.8 EC)	0.017-0.025 lb	2.72-4.0 oz	30	

Small Grains

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True Armyworm

Sampling

Armyworms are easier to control when they are small. However, their presence is often noticed when severe damage is noticed and larvae are already larger. Check fields once each week starting the 2nd week of May. It may be necessary to begin scouting earlier following a warm winter and/or early spring. Examine first the debris and undergrowth on the ground surface along field margins and lodged areas. Armyworm frass or droppings also may be found on the soil surface. If small armyworms are present in these areas, obtain 10 to 20 armyworm counts in a 3-foot row at 50-pace intervals throughout the field. Note the average size of the worms, and whether any defoliation of the flag leaf and/or head clipping has occurred.

Decision Making

Natural enemies such as parasites, pathogens, insect predators, and birds usually keep armyworm populations in check in small grains. The effectiveness of these natural control agents is reduced during cool, wet springs and during growing seasons that follow years of drought.

As a general rule, barley should be treated if the number of armyworms exceeds one per linear foot between rows and most of the worms are greater than 0.75-inch long. In wheat, armyworms tend to nibble on the tips of kernels rather than clip heads; thus, populations of two to three worms per linear foot between rows are required to justify control. In high management wheat fields with 4-inch rows, treatment is recommended when armyworm levels exceed 3 to 5 per square foot of surface area, or per linear foot of row.

Note that wheat fields with mixed infestations of armyworms and sawfly caterpillars may need treatment even if worm counts of each pest do not exceed threshold levels. Also, if the grain crop is close to harvest or the majority of armyworms are longer than 1.5 inches and no head clipping has occurred, control may not be needed.

Table 4.27 - Recommended Insecticides for Armyworm Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.014-0.019 lb	1.8-2.4 oz	30	Do not graze or forage within 7 days. (1 st and 2 nd instar)
chlorantraniliprole (Prevathon)	0.047-0.067 lb	14.0-20.0 oz	1	
chlorantraniliprole + lambda-cyhalothrin (Besiege)	0.05-0.098 lb	6.0-10.0 oz	30	RESTRICTED USE.
lambda-cyhalothrin (Warrior II)	0.02-0.03 lb	1.28-1.92 oz	30	RESTRICTED USE. Do not apply more than 3.84 oz per acre per season.
spinetoram (Radiant SC)	0.023-0.047 lb	3.0-6.0 oz	21	Do not apply within 21 days of grain or straw harvest or within 3 days of forage, fodder, or hay harvest.
spinosad (Blackhawk)	0.025-0.075 lb	1.1-3.3 oz	21	Barley, buckwheat, oats, rye, triticale, wheat. Do not apply within 21 days of grain or straw harvest or within 3 days of forage, fodder, or hay harvest.

Table 4.27 - Recommended Insecticides for Armyworm Control (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
zeta-cypermethrin (Mustang Maxx)	0.011-0.025 lb	1.76-4.0 oz	14	RESTRICTED USE.

Aphids

Grain Aphids at Tillering during Fall and Early Spring

Sampling

Grain aphids (several species) usually are held in check by their natural enemies, which include predators, parasites, and fungal diseases. When looking for aphids, it is important to recognize these natural enemies. Check grain fields each week starting in the fall or early spring if damage symptoms are evident. Infestations of aphids, particularly the greenbug and corn leaf aphid, occasionally build up in the fall. Symptoms are often first noticed as circular, yellow to brown spots with dead plants in the center. These spots may increase in size if the infestation is allowed to persist. To determine aphid activity on tillering grain, examine 20 sites throughout the field. Each site should consist of at least 5 linear feet of a row. Look at areas in the field that are showing plant stress symptoms. Aphid damage may be confused with moisture stress and/or nitrogen deficiency. Count the number of aphids on small plants and, if aphids are numerous, estimate the numbers per linear foot of a row of larger plants. Make a tally of the proportion of each species, particularly if greenbugs are present. Bird cherry-oat aphids and English grain aphids have been associated with barley yellow dwarf virus (BYDV) infections in winter wheat in the past few years. Yellowing and reddening of leaves are the most typical BYDV symptoms. However, laboratory testing would be needed to confirm infections, as symptoms resemble those of other conditions in small grains.

Decision Making

Treatment during the fall and early spring is not often necessary, but may be needed if infestations are threatening and the weather is unusually mild. Treatment is suggested if aphid counts exceed 150 per linear foot of row throughout the majority of the field and a low degree of beneficial insect activity is present. The greenbug can be the most destructive because of the toxic substances it secretes during feeding, so maintain close surveillance of fields if this aphid is the predominate species. One exception to the treatment threshold applies to wheat under intensive-management practices grown in Virginia, where the transmission of viral diseases (BYDV, or other cereal viruses) by aphids is more prevalent. Treatment of intensive management wheat in Virginia is suggested based on the following threshold table:

Table 4.28 - Aphid Numbers

Time of year	Suggested number needed to treat
Fall	
Plant until spring growth begins	15-25/row-foot and yellowing areas scattered throughout the field.
Spring	
After spring growth resumes until hard-dough stage	100/row-foot, plants 3-6 inches tall
	200/row-foot, plants 7-10 inches tall
	300/row-foot, plants 11+ inches tall
Heading	20-25/grain head

Grain Aphids During the Grain Head Stage

Sampling

To determine aphid activity after the grain heads form, count the number of aphids on 100 heads throughout the field. Do not bias sampling by checking a few heads along the field margins where infestations usually are higher. Check for natural enemies at the same time that aphids are being counted. Aphids usually are clustered as colonies among bracts of the grain head and may move slightly when disturbed. Anything that actively moves when disturbed is probably a predator. Make a note of the ratio of predators to aphids.

Decision Making

The need for treatment depends primarily on the number of aphids, plant maturity, and the presence of natural enemies. Treatment during the grain head stage is generally considered when aphid numbers exceed more than 25 per head, especially if the crop is late, when cool weather is forecast and the natural enemy complex is lacking. Control is not advised if the crop is approaching the hard dough stage where there is good predator/parasite activity. Ratios of one or more predators to every 50 to 100 aphids are sufficient to achieve biological control.

Table 4.29 - Recommended Insecticides for Aphid Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
<i>Seed Treatments</i>				
imidacloprid (Gaucho XT)	0.43-0.57 oz	3.4-4.5 oz/cwt	N/A	Do not graze or feed livestock on treated areas for 45 days after planting.
(Gaucho 600 FS)	–	0.8-2.4 oz/cwt	N/A	
thiamethoxam (Cruiser 5FS)	–	0.75-1.33 oz/cwt	N/A	
<i>Foliar Treatments</i>				
beta-cyfluthrin (Baythroid XL)	0.014-0.019	1.8-2.4 oz	30	Do not graze or forage within 3 days.
dimethoate (Dimethoate 4EC)	0.25-0.38 lb	0.5-0.75 pt	35	Do not apply within 14 days of grazing. Labeled for use on wheat only. Do not make more than 2 applications/season.
(Dimethoate 2.67EC)	0.25-0.5 lb	0.75-1.5 pt	35	
lambda-cyhalothrin (Warrior II)	0.02-0.03 lb	1.28-1.92 oz	30	RESTRICTED USE. Do not apply more than 3.84 oz per acre per season.
lambda-cyhalothrin + thiamethoxam (Endigo ZC)	0.023+0.03 lb - 0.031+0.04 lb	3.5-4.5 oz	30	RESTRICTED USE. Barley only. Do not allow livestock to graze in treated areas or harvest treated forage as feed for meat or dairy animals within 30 days after treatment.
zeta-cypermethrin (Mustang Maxx)	0.02-0.025 lb	3.2-4.0 oz	14	RESTRICTED USE. Wheat and triticale only. Aids in control.

Cereal Leaf Beetle

Cereal leaf beetle infestations are rare and sporadic in Virginia since at least 2016. Automatic sprays of insecticides tank-mixed with fungicide applications are likely to be unnecessary and or mistimed because of increasing annual temperatures. This practice is accelerating the evolution of pyrethroid resistance in brown stink bug, and other non-economic species in small grains. Broad-spectrum insecticide applications can also remove natural enemies, resulting in other pest outbreaks (e.g., cereal aphids).

Sampling

In many areas of the mid-Atlantic states, cereal leaf beetle eggs are heavily parasitized; thus, the larval stage is the best indicator of the potential yield loss. Cereal leaf beetle development is temperature dependent. Once a week, make field inspections of wheat starting in early May and of spring oats starting by mid-May. It may be necessary to begin scouting earlier following a warm winter and/or early spring. Scouting reports from 2017 and 2018 indicated that sampling is necessary beginning in mid-April. Examine the flag leaf of wheat or the entire tiller of oats on 5 plants at each of 10 locations in the field. Count the number of larvae per flag leaf or tiller and note any defoliation.

Decision Making

A number of introduced parasites have been instrumental in keeping cereal leaf beetle populations below economic damage levels. Also, favorable planting dates may help suppress populations. Wheat planted early in the fall immediately after the Hessian fly-free date will be more advanced in growth the next spring than late-planted small grains. These early plantings will be less attractive to and more tolerant of the beetles when they peak in the spring. Cereal leaf beetle infestations on spring-planted oats cannot be avoided by means of planting date. Generally, barley is more advanced in maturity and thus less attractive when beetles are active.

Adults move into small grain in late February and early March and deposit eggs which hatch into larvae. Larvae feed on grain stripping leaves of valuable photosynthetic tissue. Research indicated that damage to both flag and stem leaves reduces yield. Best control is achieved if treatments are applied when larvae are small. Treatment should be considered if 25, total, eggs and small larvae are found on 100 stems. Of that 25, at least 1/2 should be larvae. Once wheat reaches the hard dough stage, beetle damage has little effect on yield and controls are not needed.

Table 4.30 - Recommended Insecticides for Cereal Leaf Beetle Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
beta-cyfluthrin (Baythroid XL)	0.008-0.014 lb	1.0-1.8 oz	30	Do not graze or forage within 3 days.
lambda-cyhalothrin + thiamethoxam (Endigo ZC)	0.023+0.03 lb - 0.031+0.04 lb	3.5-4.5 oz	30	RESTRICTED USE. Barley only. Do not allow livestock to graze in treated areas or harvest treated forage as feed for meat or dairy animals within 30 days after treatment.
lambda-cyhalothrin (Warrior II)	0.02-0.03 lb	1.28-1.92 oz	30	RESTRICTED USE. Do not apply more than 3.84 oz per acre per season.
spinetoram (Radiant SC)	0.016-0.047 lb	2.0-6.0 oz	21	Do not apply within 21 days of grain or straw harvest or within 3 days of forage, fodder, or hay harvest.
zeta-cypermethrin (Mustang Maxx)	0.011-0.025 lb	1.76-4.0 oz	14	RESTRICTED USE. Wheat and triticale only.

Hessian Fly

The Hessian fly is not a major pest in the mid-Atlantic states because small grains normally are planted after the adult flies occur (“fly-free” date). There are no insecticidal control measures that can be applied once the field becomes infested. Control is based entirely upon prevention and host plant resistance (i.e., resistant varieties). The important components of preventative fly management include: planting wheat only after the fly-safe planting date; destroying volunteer wheat plants by tillage methods; and planting resistant varieties, especially when planting very early. Check the following tables for the fly-safe dates in your area and contact your local Extension agent for information on resistant varieties. In Virginia, it is generally thought that the fly-safe date is around Oct. 20. However, flies can infest fields planted after that date by moving from volunteer grain plants in or from nearby fields.

Brown Stink Bug

Large populations of brown stink bug may develop in small grains during May and June. There is no evidence that their feeding is capable of significantly reducing yields. Migration into surrounding corn may be problematic following harvest. Sprays targeting stink bug in small grains to prevent movement into corn are ineffective and, thus, not recommended.

Sorghum

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Seedling Pests

Sorghum should not be considered a low input crop in terms of insect control. Regular scouting, especially of late-planted fields, is strongly recommended. In addition to spraying for sugarcane aphid, budget one insecticide application for headworms.

Wireworms, billbugs and sugarcane beetles have the potential to infest Virginia sorghum. There are several factors that may predispose your crop to infestation including reduced tillage, soil with high organic matter, lack of rotation from corn/sorghum, presence of nutsedge or other grassy weeds, and planting in late April-early May. Alternative management practices that may help to reduce the risk of infestations and damage include a high-vigor crop, tillage, rotation and weed management.

Note: Seed treatments are generally not recommended for Virginia sorghum due to the lack of early-season pests and short window of product activity.

Table 4.31 - Insecticide Seed Treatments for Sorghum

Insecticide	Active ingredient	Application rate	Target Species
Poncho Votivo	clothianidin + bacillus firmus	6.13 fl oz/100 lb seed (0.08 mg ai/seed) based on 13,500 seed/pound	aphid (including yellow sugarcane aphid and corn leaf aphid), wireworm, chinch bug, white grub
NipsIT INSIDE	clothianidin	5.1 to 6.4 fl oz/100 lb seed	aphid (including yellow sugarcane aphid and corn leaf aphid), wireworm, chinch bug, white grub
Cruiser 5FS	thiamethoxam	5.1 to 7.6 fl oz per 100 pounds of seed (0.062-0.093 mg ai/seed) based on 14,500 seed/pound	aphid (including yellow sugarcane aphid and corn leaf aphid), wireworm, fire ant, seed corn maggot

Aphids

Several aphid species may be found on Virginia sorghum including sugarcane aphid (*Melanaphis sacchari*), a species that was first detected in Virginia in 2015. Heavy infestations can stunt or kill sorghum plants that are in the pre-head stage, and after heading the honeydew can interfere with mechanical harvest by plugging up combines. Resistant varieties provide protection against this pest.

Yellow sugarcane aphid (*Sipha flava*) and corn leaf aphid (*Rhopalosiphum maidis*) can infest sorghum alone or in combination with sugarcane aphid. These aphids are rarely worth concern—they provide food for beneficial natural enemies!

Sampling/Decision Making

All sorghum grown in Virginia is at risk for sugarcane aphid. Late-planted fields, both grain and forage varieties, are at very high risk. Sugarcane aphid typically infests in July and August. It is important to scout sorghum at least weekly for this pest. Scout at least twice a week once this species is found since treatment should be applied quickly once threshold is reached. Start with field edges, especially checking the underside of lower leaves. Aphids will infest borders first. Aphids are seldom evenly distributed across a field, so examine plants from all parts of the field. Leaves that are shiny with honeydew indicate that aphids are present on that plant. Aphids are found on the underside of leaves. A general threshold is 25% of plants infested. Thresholds by growth stage are provided in Table 4.32 based on North Carolina Cooperative Extension recommendations. Good coverage is essential, a minimum spray volume of 10 gal/A is recommended and repeat applications (if needed) should rotate chemistries.

Note: Pyrethroids are not effective against sorghum aphid and are harmful to natural enemy populations, thus should be

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avoided for this species. Sivanto, Sefina, and Transform are all products that are more selective and can preserve some natural enemies when targeting aphids.

Table 4.32 - Economic Thresholds for Treatment of Sugarcane Aphid in Sorghum

Growth stage	Threshold
Pre-boot and Boot	20% infested plants with localized area of honeydew and established aphid colonies
Flowering milk, Soft dough, and Dough	30% infested plants with localized area of honeydew and established aphid colonies
Black layer	Heavy honeydew and established aphid colonies in head (treat to avoid problems at harvest). Note: Check product label for pre-harvest interval.

Thresholds in this table are from *Sugarcane Aphid Now Present in NC-2016* <https://entomology.ces.ncsu.edu/2016/07/sugarcane-aphid-now-present-in-nc-2016/> by Dr. Dominic Reising, Associate Professor and Extension Specialist, NCSU.

Table 4.33 - Insecticides Recommended for the Control of White Sugarcane Aphid in Sorghum

Insecticide	Active ingredient	Application rate (oz/A)	Max annual application rate (oz/A/year)	Pre-harvest interval (days)
Sivanto Prime	flupyradifurone	10-28 (soil) 7-14 (foliar)	28	7 (forage) and 21 (grain)
Sivanto Prime (2ee reduced rate) ¹	flupyradifurone	6-10 (soil) 4-7 (foliar)	28	7 (forage) and 21 (grain)
Sefina	afidopyropen, cyclopropanecarboxylate	6	12	7 (forage) and 14 (grain)
Transform WG	sulfoxaflor	0.75-1.5	3.0	7 (forage) and 14 (grain)

¹Section 2(ee) use recommendation valid until December 31, 2025.

For more information on the sugarcane aphid, please contact your local extension agent. Contact information can be found at <https://ext.vt.edu/offices.html>.

Headworms (corn earworm, fall armyworm, and sorghum webworm)

Sampling/Decision Making

Control of caterpillar pests in pre-headed sorghum is rarely necessary, even with 40-60% leaf injury. Treat only when 75-100% of plants are infested. Headworms (e.g., armyworm, corn earworm, sorghum webworm) routinely infest grain heads. Begin to sample for worms soon after flowering by beating heads of 10 consecutive plants into a 5-gallon bucket or net. Check multiple locations in a field. Recommended thresholds are two corn earworm or fall armyworm per head or five sorghum webworm. Open headed sorghum accumulates less damage than closed-headed types. Coverage can be an issue when spraying sorghum. Pyrethroids offer poor to moderate control of corn earworm and fall armyworm in Virginia. If you decide to spray a pyrethroid, use the highest labeled rate and do not expect good control of heavy infestations or large worms.

Sorghum Midge

Damaging infestations of sorghum midge are rare. However, Virginia is in the known range of this pest and heavy infestations of this pest can be damaging to sorghum in the bloom period. Adult midges are flies that are orange or reddish in color and 1.3-1.6 mm in length. Larvae are spindle-shaped and range in color from colorless (small larvae) to pink to red-orange (full-grown).

Sampling/Decision Making

Adult midges do not damage sorghum, but midge larvae feed on and destroy developing seeds. To determine the presence of sorghum midge, fields should be inspected during midmorning until shortly after noon when midges are most active. During the sorghum bloom period, inspect fields daily or every other day to detect sorghum midges. Scout for midges by clapping the head between your hands and inspecting palms for dead flies (i.e., orange spots). Thresholds are one fly per head. Midge resistant sorghum hybrids are available commercially and, within limits, provide an additional management tool. At similar infestation levels of ovipositing midge females, resistant hybrids generally suffer one-third the damage that susceptible sorghum hybrids suffer. The antibiosis resistance increases the economic threshold level to five adults per head during flowering compared with one midge per head for susceptible hybrids.

Stink Bugs

Several species of stink bug may infest Virginia sorghum including green, brown and potentially the invasive brown marmorated. Stink bugs usually move onto sorghum soon after flowering. Stink bugs have sucking mouthparts and feed on developing seed within the panicle. Their feeding will shrivel seed thereby reducing seed size and quality. They also may feed on stems and other plant parts but the main damage is from kernel (seed) feeding. Sorghum is most susceptible during the milk and soft dough stage. Injury normally is not damaging from hard dough to maturity.

Sampling/Decision Making

Sample for stink bugs along with headworms (method described above). Treat if combined numbers of all stink bugs (large nymphs and adults) exceeds 2-4 bugs per head during milk stage or 4-8 bugs per head during soft dough stage.

Note: Some insecticides recommended for stink bug control may control headworms. In general, pyrethroids will offer poor to moderate control of headworms. Not all insecticides recommended for headworms such as spinosad (Tracer™) are effective against stink bug.

Table 4.34 - Foliar Insecticides for Sorghum

Insecticide	Active ingredient	Application rate	Pre-harvest interval	Target species
Baythroid XL 1EC	beta-cyfluthrin	1.0-1.3 fl oz/A	14	Sorghum midge
		1.3-2.8 fl oz/A		Headworms (armyworm 1 st and 2 nd instar only), stink bugs, flea beetle
Asana XL	esfenvalerate	2.9-5.8 fl oz/A	21	Sorghum midge
		5.8-9.6 fl oz/A Note: Do not apply >29 fl oz (0.15 lb ai)/A/season.		Corn earworm
Tombstone	cyfluthrin	1.0-1.3 fl oz/A	14	Sorghum midge
		1.3-2.8 fl oz/A Note: Do not apply >2.8 fl oz (0.044 lb ai)/10 day interval. Do not apply >8.4 fl oz (0.131 lb ai)/A/season.		Headworms (armyworm 1 st and 2 nd instar only), stink bugs, flea beetle
Warrior II 2.08EC	lambda-cyhalothrin	1.28-1.92 fl oz/A	30	Headworms, stink bugs
		0.96-1.28 fl oz/A		Sorghum midge

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Table 4.34 - Foliar Insecticides for Sorghum (cont.)

Insecticide	Active ingredient	Application rate	Pre-harvest interval	Target species
Mustang Maxx	zeta-cypermethrin	1.76-4.0 fl oz/A	14 grain and stover, 45 forage	Headworms, stink bugs
		1.28-4 fl oz/A		Sorghum midge
Beseige	lambda-cyhalothrin + chlorantraniliprole	6.0 – 10.0 fl oz/A	30	Headworms, stink bugs
		5.0-6.0 fl oz/A		Sorghum midge
Prevathon	chlorantraniliprole	14-20 fl oz/A	1	Headworms
Tracer, Blackhawk	spinosad	Tracer: 1.5-3 fl oz/A	7 grain, 14 forage	Headworms
		Blackhawk: 1.7-3.3 oz/A	21 grain, 3 forage	
Sevin XLR Plus, Sevin 4F	carbaryl	2.0-4.0 pt/A Note: Direct spray into forming heads.	21 grain, 14 grazing or silage	Headworms
Lannate LV, Lannate 90SP, Nudrin LV, Nudrin SP	methomyl	0.75-1.5 pt/A (LV) 0.25-0.5 lb/A (SP)	14	Headworms, Sorghum midge
		1.5 pt/A (LV) 0.5 lb/A (SP)		Sorghum webworm

Soybeans

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Essentials of a Good Soybean Insect Pest Management Program

Know Soybean Insect Pests

It is very important that you know how to identify common soybean insect pests, and when they are most likely to occur. Different pest species have different economic thresholds and can require different insecticides for effective control. Various Virginia Cooperative Extension publications are available that can be useful in identifying insect pests. Also, consult your local Extension agent or state Extension specialist.

Know Pest Economic Thresholds

An economic threshold is the number of a particular insect pest that must be controlled to prevent economic loss to the crop. Thresholds have been established through many scientific studies. Thresholds provide a starting place when making control decisions. Consider health of crop, development stage, profit potential, and insecticide costs before applying insecticides. A treatment before a pest has reached its economic threshold usually will not pay and may cause an increase in other pests, requiring a second insecticide treatment. Sub-threshold populations may cycle out or be controlled by beneficial predators - do not assume threshold populations will be reached when pests are present at low levels.

Know What Crop Growth Stages Are Most Susceptible to Insect Attack

Leaf feeding insects can attack soybeans at almost any time during the season. Full-season and double-crop planting systems react differently to this leaf damage. Yield is highly related to total leaf area, as measured by LAI (leaf area index). To achieve maximum yield potential, soybeans must develop an LAI of 3.5 to 4.0 or above. An easy way to visualize LAI is to think of a field with an LAI of 4 having 4 acres of leaf area for every acre of ground. Any leaf canopy above that can be removed (i.e., by insect leaf feeders) without reducing the yield potential. Most full-season plantings achieve larger leaf canopies and LAIs, regardless of the climatic conditions (temperature, cloud cover, or rainfall) and are tolerant of leaf feeding. Double-crop plantings do not always achieve as large a leaf canopy and can be more sensitive to defoliation. Leaf percent defoliation thresholds (30% prior to bloom, 15% from flowering to pod fill, 35% after pod fill) should only be applied to full-season plantings, or double-crop plantings with large canopies. Be more conservative with double-crop plantings without large canopies due to very late planting, dry conditions, poor soil, or other factors.

Know What Conditions Predispose Soybeans to Insect Injury

Corn earworm damage is typically most severe in fields with open canopies, ones having flowers or young pods, or fields under some degree of drought or nematode stress. Double crop soybeans or soybeans planted in fields affected by drought or nematodes should be watched more closely. In dry seasons, all fields should be watched more closely.

Stay Informed of Current Pest Status

A corn earworm advisory is issued weekly to Virginia Cooperative Extension agents from August through September. These advisories summarize current moth activity as monitored by a system of blacklight and pheromone traps. Earworm infestations, if they occur, will most likely follow peak moth activity periods by 8 to 10 days. Stay informed about the moth situation in your area and intensify your scouting efforts during critical periods.

Scout Field Regularly

Scouting (described below) is an essential part of successful economic management of insect pests. You must know what kind and how many insects are in your fields before making treatment decisions. **Do not apply insecticides unless you have confirmed that a real problem exists in your fields.**

Mexican Bean Beetle, Green Cloverworm, Bean Leaf Beetle

Sampling

Mexican bean beetles, although rare and sporadic, may infest soybeans as soon as the plants emerge, and first examine the field margins next to overwintering areas. Feeding injury usually is not evenly distributed during the early season. Count the number of beetles over a 3-foot section of row in at least five locations in the infested area. Estimate the level of stand reduction if seedlings are killed, or estimate the percentage of defoliation on older plants. Bean leaf beetles also may cause damage to young soybean plants. These insects prefer tender plant tissue and leave rounded holes on leaves. This type of leaf injury is distinguishable from the lacelike injury caused by Mexican bean beetles.

Mexican bean beetle and green cloverworm infestations usually do not reach economic levels before August. Early-planted, full-season soybeans usually attract more colonizing beetles than do later fields. However, double-crop fields may become infested with adults that are moving out of maturing fields late in the season in search of more succulent foliage. Start scouting for both insect pests at least weekly during late July through September. Examine the entire field because larval populations may be localized. Check the undersides of leaves on plants and keep a tally of the number of egg masses, young larvae, older larvae, pupae, and adults. When possible, use a drop cloth to determine numbers in fields with wide rows. Estimate defoliation to the nearest 10 percent on 20 to 30 plants selected throughout the field. Each plant should be pulled up to examine the total leaf area; not just the upper canopy leaves.

When sampling, remember to check for diseased or parasitized larvae because the natural enemies play an important role in controlling these pests. Clover worms are killed by a fungal disease which causes larvae to become hard, mummified, and covered with powdery white to light green spores. The presence of diseased worms usually signals the decline of the pest population.

Decision Making

Spray only when Mexican bean beetles and/or leaf-feeding caterpillars are actively feeding. At seedling, spray when defoliation reaches 40 percent with 2 to 3 beetles per plant throughout the field. At prebloom, spray when defoliation exceeds 30 percent, with 20 or more adults and/or larvae per 3-foot row. At bloom and podset, spray when defoliation exceeds 15 percent, with 16 or more adults and/or larvae per 3-foot of row. Consider the relative size and age composition of the population. If eggs and pupae of the Mexican bean beetle are the predominant stages it is advisable to wait until egg hatch or adult emergence before treating. Also consider the presence of natural controls, such as cloverworms infected with fungal disease or parasitized Mexican bean beetle larvae (mummies).

Table 4.35 - Recommended Insecticides for Mexican Bean Beetle, Green Cloverworm, and Bean Leaf Beetle Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
acephate (Orthene 97)	0.73-0.97 lb	0.75-1.0 lb	14	Do not graze or cut vines for hay or forage. Do not exceed 1.5 lbs/A of product per season.
beta-cyfluthrin (Baythroid XL) (Mexican bean and bean leaf beetle)	0.013-0.022 lb	1.6-2.8 oz	21 (seed)	RESTRICTED USE. Green forage may be fed 15 days after last application.
(green cloverworm)	0.0065-0.0125 lb	0.8-1.6 oz		
beta-cyfluthrin + imidacloprid (Leverage 360)	0.02-0.04 lb	2.8 oz	21 (seed)	RESTRICTED USE. Dry vines (hay) and green forage may be fed 15 days after last application.
bifenthrin (Brigade 2EC)	0.033-0.1 lb	2.1-6.4 oz	18	RESTRICTED USE.
bifenthrin + chlorantraniliprole (Elevest)	0.084-0.167 lb	4.8-9.6 oz	18	RESTRICTED USE. Apply higher labeled rates within the listed range for heavier infestations, larger/denser crops or extreme environmental conditions such as rainy weather and high temperatures.

Table 4.35 - Recommended Insecticides for Mexican Bean Beetle, Green Cloverworm, and Bean Leaf Beetle Control (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
chlorantraniliprole (Prevathon) (green cloverworm)	0.047-0.067 lb	14.0-20.0 oz	1	Not labelled for use against bean leaf beetle or Mexican bean beetle. Apply higher rates within the listed range for heavier infestations, larger/denser crops or extreme environmental conditions such as rainy weather and high temperatures.
(Vantacor)	0.047-0.098 lb	1.2-2.5 oz	1	
esfenvalerate (Asana XL) (bean leaf beetle)	0.015-0.03 lb 0.03-0.05 lb	2.9-5.8 oz 5.8-9.6 oz	21	RESTRICTED USE. Do not feed or graze livestock on treated plants. Do not exceed 0.2 lb ai per acre per season. Extremely toxic to fish.
indoxacarb (Steward EC) (green cloverworm)	0.045-0.11 lb	4.6-11.3 oz	21	Do not feed or graze livestock on treated fields. Not labeled for use against Mexican bean beetle. Suppression only against bean leaf beetle.
(bean leaf beetle)	0.09-0.11 lb	9.2-11.3 fl oz		
lambda-cyhalothrin + chlorantraniliprole (Besiege)	0.016 + 0.033 lb- 0.026 + 0.052 lb	5.0-8.0 oz	30	RESTRICTED USE. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
lambda-cyhalothrin (Warrior II)	0.015-0.025 lb	0.96-1.6 oz	30	RESTRICTED USE. Do not apply more than 7.68 oz per acre per season. Do not graze or harvest treated soybean forage, straw or hay for livestock feed.
methomyl (Lannate LV) (green cloverworm and Mexican bean beetle)	0.12-0.225 lb	0.4-0.75 pt	14 (seed)	RESTRICTED USE. Wait 3 days to feed or graze as forage or 12 days for hay. Up to 2 applications may be used.
(Lannate SP) (green cloverworm and Mexican bean beetle)	0.11-0.225 lb	0.125-0.25 lb	14	
(Lannate LV) (bean leaf beetle)	0.225-0.3 lb	0.75-1.0 pt	14	
(Lannate SP) (bean leaf beetle)	0.225-0.34 lb	0.25-0.375 lb	14	
methoxyfenozide (Intrepid 2F) (green cloverworm)	0.06-0.12 lb	4.0-8.0 oz	7 (hay/forage) 14 (seed)	Not labeled for use against bean leaf beetle or Mexican bean beetle.
spinetoram (Radiant SC) (green cloverworm)	0.15-0.31 lb	2.0-4.0 oz	28	Not labeled for use against bean leaf beetle or Mexican bean beetle.
spinosyn (Blackhawk) (green cloverworm)	0.025-0.05 lb	1.1-2.2 lb	28	Do not feed treated forage or hay to meat or dairy animals. Not labeled for use against bean leaf beetle or Mexican bean beetle.

Table 4.35 - Recommended Insecticides for Mexican Bean Beetle, Green Cloverworm, and Bean Leaf Beetle Control (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
thiamethoxam + lambda-cyhalothrin (Endigo ZC) (bean leaf beetle)	0.064-0.072 lb	4.0-4.5 oz	30	RESTRICTED USE. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
(Mexican bean beetle and green cloverworm)	0.056-0.064 lb	3.5-4 fl oz		
zeta-cypermethrin (Mustang Maxx)	0.0175-0.025 lb	2.8-4.0 oz	21	RESTRICTED USE. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed. Use higher labeled dosage for increased bean leaf beetle pressure, increased residual bean leaf beetle control, or later-season applications.

Thrips

Sampling/Decision Making

Thrips rarely require treatment; however, early season injury to drought-stressed plants may rarely reduce yields. Both nymphs and adults feed on the undersides of the leaves, causing small, silvery streaks and whitish or yellowish discoloration. Treatment may be required when injury appears on drought-stressed plants and more than eight thrips per leaflet are found. Treatment is not recommended in non-stressed fields because soybeans can tolerate thrips injury. Insecticidal seed treatments are not recommended in Virginia because there is no evidence that they protect yield even under high thrips pressure.

Table 4.36 - Recommended Insecticides for Thrips Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
acephate (Orthene 97)	0.24-0.49 lb	0.25-0.5 lb	14	Do not graze or cut vines for hay or forage. Do not exceed 1.5 lbs/A of product per season.
beta-cyfluthrin (Baythroid XL)	0.007-0.013 lb	0.8-1.6 oz	21	RESTRICTED USE. Green forage may be fed 15 days after last application.
bifenthrin (Brigade 2EC)	0.033-0.1 lb	2.1-6.4 oz	18	RESTRICTED USE.
clothianidin + ipconazole + metalaxyl (Nipsit Inside + Rancona Xxtra)	—	4.78 oz/cwt		Seed treatment. Do not graze or feed soybean forage and hay to livestock.
imidacloprid (Gaucho 600)	.78-1.56 oz/cwt	1.6-3.2 oz/cwt	N/A	Seed treatment. Do not apply a neonicotinoid insecticide within 45 days of planting seed treated with Cruiser 5FS.
methomyl (Lannate LV)	0.225-0.3 lb	0.75-1.0 pt	14 (seed)	RESTRICTED USE. Wait 3 days to feed or graze as forage or 12 days for hay. Up to two applications may be used per season. See resistance statement on label under DIRECTIONS FOR USE section.
(Lannate SP)	0.225-0.34 lb	0.25-0.375 lb	14 (seed)	

Table 4.36 - Recommended Insecticides for Thrips Control (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
thiamethoxam (Cruiser 5FS)	0.8 oz/cwt	1.28 oz/cwt	N/A	Seed treatment.
zeta-cypermethrin (Mustang Maxx)	0.02-0.025 lb	3.2-4.0 oz	21	RESTRICTED USE. Aids in control. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.

Potato Leafhopper

Sampling/Decision Making

Leafhoppers attack soybeans during late June through July but rarely reach population levels that affect yields. Using a standard 15-in sweep net, take five sweeps in each of five locations in the field. Count the number of leafhoppers and empty the net before proceeding to the next location. A single sweep consists of a swath of the net along the row in the top one-third of the plant in one direction only.

The symptoms of leafhopper injury include localized stippling, curling, and yellowing of leaf margins. Treatment is suggested when injury appears and infestations exceed four leafhoppers per sweep in stressed beans or eight leafhoppers per sweep in normal growing fields. Dense pubescent varieties are less susceptible.

Table 4.37 - Recommended Insecticides for Potato Leafhopper Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
acephate (Orthene 97)	0.49-0.97 lb	0.5-1.0 lb	14	Do not graze or cut vines for hay or forage. Do not exceed 1.5 lbs/A of product per season.
beta-cyfluthrin (Baythroid XL)	0.007-0.013 lb	0.8-1.6 oz	21	RESTRICTED USE. Green forage may be fed 15 days after last application.
bifenthrin (Brigade 2EC)	0.033-0.1 lb	2.1-6.4 oz	18	RESTRICTED USE.
esfenvalerate (Asana XL)	0.015-0.03 lb	2.9-5.8 oz	21	RESTRICTED USE. Do not feed or graze livestock on treated plants. Do not exceed 0.2 lb ai per acre per season. Extremely toxic to fish.
lambda-cyhalothrin + chlorantraniliprole (Besiege)	0.016 + 0.033 lb – 0.026 + 0.052 lb	5.0-8.0 oz	30	RESTRICTED USE. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
lambda-cyhalothrin (Warrior II)	0.015-0.025 lb	0.96-1.6 oz	30	RESTRICTED USE. Do not apply more than 7.68 oz per acre per season. Do not graze or harvest treated soybean forage, straw or hay for livestock feed.
thiamethozam + lambda-cyhalothrin (Endigo ZC)	0.056-0.064 lb	3.5-4.0 oz	30	RESTRICTED USE. Do not graze or harvest treated soybean forage, straw or hay for livestock feed.
zeta-cypermethrin (Mustang Maxx)	0.0175-0.025 lb	2.8-4.0 oz	21	RESTRICTED USE. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.

Spider Mites

Sampling/Decision Making

Mite outbreaks usually are associated with hot, dry weather, which accelerates reproduction and development. During periods of high humidity and field moisture, a fungal disease can reduce populations but high temperatures can nullify these effects. Outbreaks also are associated with the application of certain insecticides that kill natural enemies and/or seem to make the soybean plant more nutritionally suitable for mites.

Check weekly for mites, starting in early July through August, especially during a hot, dry season. Concentrate on the field borders and look for the early signs of white stippling at the bases of the leaves. Do not confuse mite damage with dry weather injury, mineral deficiencies, and herbicide injury. If feeding injury is evident, press the undersides of a few damaged leaves on white paper to reveal any crushed mites. Determine the extent of the infestation and assess the level of injury by examining 20 to 30 plants in the infested area. Field infestations often show defoliated or injured plants at some localized point, with injury becoming less evident and extending in a widening arc into the field.

If isolated spots of mite activity are confined to the perimeter of the field, spot-treatment using ground equipment is recommended to prevent further spread of mites into the field. If the infestation is distributed throughout the interior of the field, treatment of the entire field is suggested if live mites are numerous (20 to 30 per leaflet) and more than 50 percent of the plants show stippling, yellowing, or defoliation over more than one-third of the leaves. If rains come, mite development and survival will decrease but may not drop to economic levels if heavy populations are developing under high temperatures. Broad-spectrum insecticide applications to control mites (e.g., bifenthrin, and dimethoate) will worsen mite infestations following initial reductions in numbers. Only use these materials when favorable weather (rain and or high humidity) is anticipated. Etoxazole is recommended for this reason.

Table 4.38 - Recommended Insecticides for Spider Mite Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
bifenthrin (Brigade 2EC)	0.08-0.1 lb	5.12-6.4 oz	18	RESTRICTED USE.
dimethoate (Dimethoate 2.67EC)	0.4-0.5 lb	1.3-1.5 pt	21	Do not feed or graze within 5 days of the last application. Do not store above 90° F or below 32° F.
(Dimethoate 4EC)	0.5 lb	1.0 pt	21	
etoxazole (Zeal SC)	0.045-0.135 lb	2.0-6.0 oz	*	*Do not apply after R5 stage. Do not graze or feed forage or hay to livestock after application.

Corn Earworm

Sampling

Outbreaks often follow a midsummer drought, which causes the corn to ripen earlier and become less attractive to the moths. Female moths prefer to lay eggs in open-canopied, late-blooming fields. Drought conditions also delay soybean maturity and prevent normal canopy growth, so peak moth activity is more coincidental with blooming of open-canopied fields.

Sampling for corn earworm should be done on a weekly basis from July through September. If row spacing is 30 inches or greater any of the techniques described below can be used to sample for insects. Narrow-row beans, 21 inches or less, are best sampled with either the sweep net or rigid beat cloth. Concentrate on high-risk fields, such as ones that have open canopies, are late flowering, or were previously treated with insecticides.

Standard Beat or Ground Cloth

For each sample, place a standard 3-foot ground cloth on the ground between rows and shake the plants bordering both sides vigorously. The number of insects shaken onto the cloth will be the number per 6 feet of row, so divide by 6 to get the number per row-foot. About ten samples should be taken in each 40 acre area. Thresholds are based on number of earworms per row-foot.

Rigid Beat Cloth

The RBC works on the same principle as a standard beat cloth but the RBC is not flexible. Samples are taken by placing the sampler on its side between two rows of plants (plants cannot be seriously lodged) and beating or vigorously shaking adjacent plants into the sampler while it is leaned away from those plants at about a 45° angle. Two 7-inch rows are beaten and one 14-inch or 21-inch row is beaten per sample. Thresholds are based on the number of earworms *per sample*.

Sweep Net

Each sample should consist of 15 net sweeps with a 15-inch diameter sweep net done continuously one after the other. Each sweep consists of swinging the net in one direction through the foliage so that the top of the net passes 2 or 3 inches below the tops of plants. Fifteen consecutive sweeps are done from one side to the other while walking down a middle row. Swing the net with enough force to dislodge insects into the net. If some leaves are not broken off and in the net after the sample, the sampler is not using enough force. Each swing should pass through the tops of 5, 3, or 2 rows in 7-inch, 14-inch, or 21-inch row-space plantings, respectively. After each sample, stop and count how many earworms are in the net. Thresholds are based on the number of earworms *per sample*.

Decision Making

Treatment is suggested if sample counts exceed economic thresholds. Thresholds are presented at the end of this chapter. Visit the website <https://soybeans.ces.ncsu.edu/thresholds/> for access to the threshold calculator.

Table 4.39 - Recommended Insecticides for Corn Earworm Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
<i>Bacillus thuringiensis</i> (DiPel ES)	8.0-32.0 BCLUs	1.0-4.0 pts	0	For pyrethroid resistant corn earworms when tank-mixed with a pyrethroid at a labeled rate.
beta-cyfluthrin (Baythroid XL)	0.013-0.022 lb	1.6-2.8 oz	21	RESTRICTED USE. Green forage may be fed 15 days after last application.
beta-cyfluthrin + imidacloprid (Leverage 360)	0.02 + 0.04 lb	2.8 oz	21 (seed)	RESTRICTED USE. Dry vines (hay) and green forage may be fed 15 days after application.
bifenthrin (Brigade 2EC)	0.033-1.0 lb	2.1-6.4 oz	18	RESTRICTED USE.
bifenthrin + chlorantranilprole (Elevest)	0.084-0.167 lb	4.8-9.6 oz	18	RESTRICTED USE. Apply higher labeled rates within the listed range for heavier infestations, larger/denser crops or extreme environmental conditions such as rainy weather and high temperatures.
chlorantranilprole (Prevathon)	0.047-0.067 lb	14.0-20.0 oz	1	Apply higher labeled rates within the listed range for heavier infestations, larger/denser crops or extreme environmental conditions such as rainy weather and high temperatures.
(Vantacor)	0.047-0.098 lb	1.2-2.5 oz	1	
esfenvalerate (Asana XL)	0.02-0.03 lb	5.8-9.6 oz	21	RESTRICTED USE. Do not feed or graze livestock on treated plants. Do not exceed 0.2 lb per acre per season. Extremely toxic to fish.

Table 4.39 - Recommended Insecticides for Corn Earworm Control (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
indoxacarb (Steward EC)	0.045-0.11 lb	4.6-11.3 oz	21	Do not feed or graze livestock on treated fields.
lambda-cyhalothrin + chlorantraniliprole (Besiege)	0.016 + 0.033 lb -0.026 + 0.052lb	5.0-8.0 oz	30	RESTRICTED USE. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
lambda-cyhalothrin (Warrior II)	0.015-0.025 lb	0.96-1.6 oz	30	RESTRICTED USE. Do not apply more than 7.68 oz per acre per season Do not graze or harvest treated soybean forage, straw or hay for livestock feed.
methomyl (Lannate LV)	0.12-0.225 lb	0.4-0.75 pt	14 (seed)	RESTRICTED USE. Wait 3 days to feed or graze as forage or 12 days for hay. Up to two applications may be used/season.
(Lannate SP)	0.11-0.225 lb	0.125-0.25 lb	14 (seed)	
methoxyfenozide + spinetoram (Intrepid Edge)	0.078 + 0.015 0.125 + 0.025	4-6.4 oz	28 (seed)	Begin applications when first signs of feeding damage appear or when threshold levels of feeding damage occur.
spinetoram (Radiant SC)	0.15-0.31 lb	2.0-4.0 oz	28	
spinosyn (Blackhawk)	0.038-0.05 lb	1.7-2.2 oz	28	Do not feed treated forage or hay to meat or dairy animals.
thiamethoxam + lambda-cyhalothrin (Endigo ZC)	0.056-0.064 lb	3.5-4.0 oz	30	RESTRICTED USE. Do not graze or harvest treated soybean forage, straw or hay for livestock feed. Note: thiamethoxam does not add increased activity against corn earworm over lamda-cyhalothrin alone.
zeta-cypermethrin (Mustang Maxx)	0.0175-0.025 lb	2.8-4.0 fl oz	21	RESTRICTED USE. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.

Grasshopper

Table 4.40 - Recommended Insecticides for Grasshopper Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
acephate (Orthene 97)	0.24-0.49 lb	0.25-0.5 lb	14	Do not graze or cut vines for hay or forage. Do not exceed 1.5 lbs/A of product per season.
bifenthrin + chlorantraniliprole (Elevest)	0.084-0.167 lb	4.8-9.6 oz	18	RESTRICTED USE. Time applications to target nymphs. Ensure good coverage. Methylated seed oil at the rate of 1 gallon per 100 gallons improves performance. Apply higher labeled rates within the listed range for heavier infestations, larger/denser crops or extreme environmental conditions such as rainy weather and high temperatures.

Table 4.40 - Recommended Insecticides for Grasshopper Control (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
cloranthraniliprole (Vantacor)	0.027-0.066 lb	0.7-1.7 oz	1	Time applications to target nymphs. Ensure good coverage. Methylated seed oil at the rate of 1 gallon per 100 gallons improves performance.
dimethoate (Dimethoate 4EC)	0.5 lb	1.0 pt	21	RESTRICTED USE. Do not feed or graze within 5 days of the last application. Do not store above 90°F or below 32°F.

Armyworms

Table 4.41 - Recommended Insecticides for Fall, Yellowstriped, and Beet Armyworm

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
acephate (Orthene 97) (except beet)	0.73-0.97 lb	0.75-1.0 lb	14	Do not graze or cut vines for hay or forage. Do not exceed 1.5 lbs/A of product per season.
beta-cyfluthrin (Baythroid XL) (fall armyworm and beet armyworm - 1st and 2nd instars only)	0.0125-0.022 lb	1.6-2.8 oz	21	RESTRICTED USE. Green forage may be fed 15 days after last application.
bifenthrin (Brigade 2EC)	0.033-0.10 lb	2.1-6.4 oz	18	RESTRICTED USE. Pyrethroid resistance is common for Beet Armyworm. Consult your local or state agricultural authority to identify resistance pest populations in your area. Refer to the resistance management statement in the DIRECTIONS FOR USE section on product label.
bifenthrin + chloranthraniliprole (Elevest)	0.098-0.167 lb	5.6-9.6 oz	18	RESTRICTED USE. Apply higher labeled rates within the listed range for heavier infestations, larger/denser crops or extreme environmental conditions such as rainy weather and high temperatures.
chloranthraniliprole (Prevathon) (Vantacor)	0.047-0.067 lb 0.047-0.098 lb	14.0-20.0 oz 1.2-2.5 oz	1 1	Apply higher labeled rates within the listed range for heavier infestations, larger/denser crops or extreme environmental conditions such as rainy weather and high temperatures.
indoxacarb (Steward EC)	0.045-0.11 lb	4.6-11.3 oz	21	Do not feed or graze livestock on treated fields.
lambda-cyhalothrin + chloranthraniliprole (Besiege)	0.026 + 0.052 lb 0.033 + 0.065 lb	8.0-10.0 oz	30	RESTRICTED USE. Use higher listed rates within the rate range for large larvae. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.

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Table 4.41 - Recommended Insecticides for Fall, Yellowstriped, and Beet Armyworm (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
methomyl (Lannate LV) (Lannate SP)	0.225-0.3 lb 0.225-0.34 lb	0.75-1.0 pt 0.25-0.375 lb	14 (seed) 14 (seed)	RESTRICTED USE. Wait 3 days to feed or graze as forage or 12 days for hay. Up to two applications may be used per season.
methoxyfenozide (Intrepid 2F)	0.06-0.12 lb	4.0-8.0 oz	7 (hay/forage) 14 (seed)	
methoxyfenozide + spinetoram (Intrepid Edge)	0.078 + 0.015 0.125 + 0.025	4-6.4 oz.	28 (seed)	Begin applications when first signs of feeding damage appear or when threshold levels of feeding damage occur.
spinetoram (Radiant SC)	0.15-0.31 lb	2.0-4.0 oz	28	With the exception of yellowstriped armyworm and western yellowstriped armyworm.
spinosyn (Blackhawk)	0.038-0.05 lb	1.7-2.2 oz	28	Do not feed treated forage or hay to meat or dairy animals.
thiamethozam + lambda-cyhalothrin (Endigo ZC)	0.064-0.072 lb	4.0-4.5 oz	30	RESTRICTED USE. Do not graze or harvest treated soybean forage, straw or hay for livestock feed. Use higher rates within the listed rate range for large larvae.
zeta-cypermethrin (Mustang Maxx) (beet and fall) (yellowstriped)	0.02-0.025 lb 0.0175-0.025 lb	3.2-4.0 oz 2.8-4.0 oz	21	RESTRICTED USE. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.

Stink Bugs

Stink bugs are an important late-season pest of Virginia soybeans. Populations typically start to build in late-August and may be present in fields through October. Stink bug injury is economic primarily in R4 (full pod) and R5 (beginning seed). From beginning of leaf senescence on, double recommended thresholds. The stink bug complex in Virginia includes brown stink bug, green stink bug, brown marmorated stink bug, and, as of 2016, southern green stink bug. Pyrethroids control most species with the exception of brown stink bug. When brown stink bug is present, use either acephate or the high labeled rate of bifenthrin.

Table 4.42 - Recommended Insecticides for Stink Bug Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
acephate (Orthene 97)	0.49-0.97 lb	0.5-1.0 lb	14	Do not graze or cut vines for hay or forage. Do not exceed 1.5 lbs/A of product per season.
beta-cyfluthrin (Baythroid XL)	0.0125-0.022 lb	1.6-2.8 oz	21	RESTRICTED USE. Green forage may be fed 15 days after last application.
beta-cyfluthrin + imidacloprid (Leverage 360)	0.02 + 0.04 lb	2.8 oz	21	RESTRICTED USE.
bifenthrin (Brigade 2EC)	0.033-0.1 lb	2.1-6.4 oz	18	RESTRICTED USE.

Table 4.42 - Recommended Insecticides for Stink Bug Control (cont.)

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
bifenthrin + chlorantraniliprole (Elevest)	0.084-0.167 lb	4.8-9.6 oz	18	RESTRICTED USE. Apply higher labeled rates within the listed range for heavier infestations, larger/denser crops or extreme environmental conditions such as rainy weather and high temperatures.
clothianidin (Belay)	0.05-0.1 lb ai/A	3.0-6.0 oz	21	Do not graze or feed soybean forage and hay to livestock.
esfenvalerate (Asana XL)	0.03-0.05 lb	5.8-9.6 oz	21	RESTRICTED USE. Do not feed or graze livestock on treated plants. Do not exceed 0.2 lb ai/A/season. Extremely toxic to fish.
lambda-cyhalothrin + chlorantraniliprole (Besiege)	0.026 + 0.052 lb – 0.033 + 0.065 lb	8.0-10.0 oz	30	RESTRICTED USE. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
lambda-cyhalothrin (Warrior II)	0.025-0.03 lb	1.6-1.92 oz	30	RESTRICTED USE. Do not apply more than 7.68 oz/A per season. Do not graze or harvest treated soybean forage, straw or hay for livestock feed.
thiamethozam + lambda-cyhalothrin (Endigo ZC)	0.064-0.072 lb	4.0-4.5 oz	30	RESTRICTED USE. Do not graze or harvest treated soybean forage, straw or hay for livestock feed.
zeta-cypermethrin (Mustang Maxx)	0.02-0.025 lb	3.2-4.0 oz	21	RESTRICTED USE. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.

Soybean Looper

Soybean loopers can completely defoliate a field in a short period of time, in as few as 5-7 days if numbers are extremely high (i.e., 1 or more larvae per sweep). Large populations of soybean looper may develop in mid-August through September. Adult moths migrate from the southern US and can be pushed ahead of weather fronts or arrive earlier following higher than normal temperatures. We do not have a threshold specific to loopers in Virginia, but lump them into a general leaf defoliators ‘guild’ which can include many leaf feeders (Japanese beetles, green cloverworms, grasshoppers, bean leaf beetles and others). Base a treatment decision on the total leaf area destroyed by the guild. We recommend not treating fields with fully developed seed unless 35-40% of the leaf area is eaten and bugs are still present. Defoliation thresholds are based on whole plant sampling, and the percent defoliation is easy to over-estimate. Reference this publication from Ohio State Extension for a visual guide to estimating defoliation (<https://agcrops.osu.edu/newsletter/corn-newsletter/22-2021/soybean-defoliation-it-takes-lot-really-matter>).

Do not use a pyrethroid to treat for soybean loopers. These products will only worsen infestations. Spray trial results and resistance screening assays indicate that products containing chlorantraniliprole are becoming less effective. As of 2022, products containing indoxacarb, methoxyfenozide, spinosyn, and spinetoram provide the most consistent control.

4-60 Insect Control in Field Crops: Soybeans

Table 4.43 - Recommended Insecticides for Soybean Looper Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
bifenthrin + chlorantraniliprole (Elevest)	0.098-0.167 lb	5.6-9.6 oz	18	RESTRICTED USE. Apply higher labeled rates within the listed range for heavier infestations, larger/denser crops or extreme environmental conditions such as rainy weather and high temperatures.
chlorantraniliprole (Prevathon)	0.047-0.067 lb	14.0-20.0 oz	1	Apply higher labeled rates within the listed range for heavier infestations, larger/denser crops or extreme environmental conditions such as rainy weather and high temperatures.
(Vantacor)	0.047-0.098 lb	1.2-2.5 oz	1	
emamectin benzoate (Denim)	0.01 lb-0.015 lb	8.0-12.0 fl oz	28	
indoxacarb (Steward EC)	0.045-0.11 lb	4.6-11.3 oz	21	Use lower rate (4.6 fl oz/A) for low to moderate populations of soybean looper. Use higher rates (5.6 fl oz/A to 11.3 fl oz/A) for higher populations or when crop canopy is dense.
lambda-cyhalothrin + chlorantraniliprole (Besiege)	0.033 + 0.065 lb	10.0 oz	30	Refer to Resistance Management section on product label. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
methoxyfenozide (Intrepid 2F)	0.06-0.12 lb	4.0-8.0 oz	7 (hay/forage) 14(seed)	
methoxyfenozide + spinetoram (Intrepid Edge)	0.078 + 0.015 0.125 + 0.025	4-6.4 oz.	28 (seed)	Begin applications when first signs of feeding damage appear or when threshold levels of feeding damage occur.
spinetoram (Radiant SC)	0.15-0.31 lb	2.0-4.0 oz	28	
spinosyn (Blackhawk)	0.025-0.05 lb	1.1-2.2 oz	28	Do not feed treated forage or hay to meat or dairy animals.

Soybean Aphid

The current economic threshold for aphids is an average of 250 aphids per plant, on two consecutive field visits spaced about 5-7 days apart. This is because aphid populations can “crash” quickly due to heavy pressure by natural enemies like lady beetles, parasitic wasps, and fungal diseases. When scouting, choose a “Z” or “W” shaped pattern to cover the entire field and sample at least 20 to 30 plants per field by examining the entire plant, including stems and upper and lower leaf surfaces. Use the aphid/plant average for determining the need for treatment. The threshold applies to soybeans through the R5 growth stage (3 mm long seed in the pod at one of the four uppermost nodes on the main stem), after which time plants can tolerate 1,000+ aphids with no threat to yield. If an insecticide is applied for aphids, choosing a more selective insecticide can preserve natural enemy populations and limit future flare ups of aphids or other pests.

Table 4.44 - Recommended Insecticides for Soybean Aphid Control

Insecticide (Formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
acephate (Orthene 97)	0.73-0.97 lb	0.75-1.0 lb	14	Do not graze or cut vines for hay or forage. Do not exceed 1.5 lbs/A of product per season.
bifenthrin (Brigade 2EC)	0.033-0.1 lb	2.1-6.4 oz	18	RESTRICTED USE.
clothianidin (Belay)	0.05-0.1 lb ai/A	3.0-6.0 fl oz	21	Do not graze or feed soybean forage and hay to livestock. Soybean aphids need to be targeted when populations are less than or equal to 250 aphids/plant. Populations above threshold may need more than one treatment to achieve control. Choose lower rate for light infestation and higher rate for heavy infestation.
cyfluthrin (Baythroid XL)	0.044 lb	2.0-2.8 oz	21	RESTRICTED USE. Green forage may be fed 15 days after last application.
esfenvalerate (Asana XL)	0.03-0.05 lb	5.8-9.6 oz	21	RESTRICTED USE. Do not feed or graze livestock on treated plants. Do not exceed 0.2 lb per acre per season. Extremely toxic to fish. Tank mix with methomyl (e.g., Lannate) to achieve rapid knockdown of soybean aphids.
flupyradifurone (Sivanto 200SL)	0.09-0.137 lb	7.0-10.5 oz	21 (seed)	7 day PHI for forage and hay.
imidacloprid (Gaucho 600)	0.78-1.56 oz/cwt	1.6-3.2 oz/cwt	N/A	Seed treatment.
lambda-cyhalothrin + chlorantraniliprole (Besiege)	0.016 + 0.033 lb – 0.026 + 0.052 lb	5.0-8.0 oz	30	RESTRICTED USE. Use lower rates for early-season applications and/or lighter populations. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
lambda-cyhalothrin (Warrior II)	0.015-0.025 lb	0.96-1.6 fl oz	30	RESTRICTED USE. Do not apply more than 7.68 oz per acre per season. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed. Use lower rates for early season applications and/or lighter populations.
thiamethoxam (Cruiser 5FS)	0.61 fl oz ai/cwt	1.28 oz/cwt	N/A	Seed treatment.
thiamethozam + lambda-cyhalothrin (Endigo ZC)	0.056-0.064 lb	3.5-4.0 oz	30	RESTRICTED USE. Do not graze or harvest treated soybean forage, straw or hay for livestock feed. Use lower rates for early season applications and/or lighter populations.
zeta-cypermethrin (Mustang Maxx)	0.0175-0.025 lb	2.8-4.0 oz	21	RESTRICTED USE. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.

4-62 Insect Control in Field Crops: Soybeans

Threecornered alfalfa hopper (3CAH)

Adults are small (1/4-inch-long), green, wedge shaped insects that overwinter in plant debris, cover crops, and wooded areas. Nymphs are wingless, brown to green, and have spines along the top of their body. Adults may move to soybean as early as plant emergence. This insect feeds on plant sap and feeds around the mainstem of plants during the seedling state (<12 inches tall). Feeding occurs at the soil level. Resulting injury includes warts, calluses, and girdling of the stem. Girdled plants are highly susceptible to breaking and lodging during reproductive stages although some stand loss occurs in the seedling stage.

Early-season injury from 3CAH is more common in no-till fields following cover crops and or wheat. High organic matter soils are also associated with higher risk. Injury has been most severe in Virginia's piedmont region. Neonicotinoid seed treatments (i.e., thiamethoxam, clothianidin, imidacloprid) may provide some protection, but their benefit depends on growing conditions (faster growing plants will move through susceptible stages faster), insect pressure, and field size (smaller fields are at higher risk, larger fields may have injury confined to field borders). Seed treatments can also encourage slug populations by limiting natural enemy activity. Good agronomic practices are recommended to prevent or mitigate economic injury including early planting, burning down cover crops two to four weeks prior to planting, high seeding rates, and good plant stands.

There is no evidence that 3CAH can cause economic damage in plants taller than 12-inches. Scouting is based on visual examination and treatment is recommended when 10% of plants are infested. Populations can be high throughout the growing season and there are multiple generations per year in Virginia.

Table 4.45 - Recommended Insecticides for Threecornered Alfalfa Hopper Control

Insecticide (formulation)	Amount active ingredient per acre	Amount product per acre	Time limits: days before harvest	Remarks
acephate (Orthene 97)	0.75-1.0 lb	0.75-1.0 lb	14	Do not graze or cut vines for hay or forage. Repeat treatment as necessary to maintain control, but do not exceed 1.5 lbs/A of product per season.
pyrethroids – beta-cyfluthrin, bifenthrin, esfenvalerate, lambda-cyhalothrin, zeta-cypermethrin (various generic and non-generic products)	-	-	-	Reference table 4.44 for specific products and rates.

Pest Thresholds

Table 4.46 - Other Soybean Insect Pest Thresholds

Pest species	# per row-foot row-spacing		# per 15 sweeps row-spacing		Other comments
	7"-21"	above 21"	7"-21"	above 21"	
<i>Full-season plantings</i>					
Mexican bean beetle	4	6	24	36	40% defoliation - pre-bloom, 15% defoliation - pod-fill, 35+% defoliation - fully developed seeds.
Spider mite	Damage occurring and live mites present				Live mites on 50% of leaves and 50% leaves showing white spotting or premature leaf drop.
Other defoliators ¹					40% defoliation - pre-bloom, 15% defoliation - pod-fill, 35+% defoliation - fully developed seeds.
<i>Double-crop plantings with poor growth</i>					
Mexican bean beetle	2	4	12	24	20% defoliation - pre-bloom, 15% defoliation - fully developed seeds.
Spider mite	Damage occurring and live mites present				Live mites on 50% of leaves and 50% leaves showing white spotting or premature leaf drop.
Other defoliators ¹					20% defoliation - pre-bloom, 10% defoliation - pod-fill, 15% defoliation - fully developed seeds.
¹ Other defoliators include any combinations of green cloverworm, bean leaf beetle, blister beetle, Japanese beetle, soybean looper, yellowstriped armyworm, grasshoppers, or fall armyworm.					

Table 4.47 - Revised Stink Bug Thresholds for Soybean (all stink bug species combined)

Row spacing	# per row foot		# per 15 sweeps	
	7-21" rows	Above 21"	7-21" rows	Above 21"
For grain	1-2	1-2	5	5
For seed or edible	0.5	0.5	2.5	2.5

Apply from R3-4 to R7, double when leaves begin to senesce.

Peanuts

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Thrips

Seedling peanut plants are usually attacked by thrips within the first six to eight weeks after planting. Risk of economic damage from thrips injury is increased whenever poor growing conditions occur early in the season (May-June). These tiny, spindle-shaped insects feed primarily within the developing, unfolded leaflets causing crinkling of the leaflets and stunting of the plants. Blackening of the small leaflets occurs with severe infestations and can be mistaken for chemical injury. Under favorable conditions, plants outgrow this injury with no reduction in yield or grade. However, the delay in vine growth from early season thrips injury may delay maturity. This, in combination with other injury, such as herbicide burn, can reduce yield.

Thrips can be controlled with systemic insecticides. Systemics are incorporated in the furrow with the seed at planting. Foliar treatments can be applied as needed after crop emergence. Foliar insecticides alone are not recommended for thrips control. During dry seasons or seasons with excessive rains, systemic insecticides may not give adequate thrips control due to poor uptake by the plants or leaching of chemicals from the soil. Foliar treatments may be warranted if systemics are ineffective, or if injury appears excessive. Foliar treatment is recommended when 25 percent of the leaves show thrips damage and pest populations are still active.

Table 4.48 - Recommended Insecticides for Thrips Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	acephate (Orthene 97)	6.0-12.0 oz	14	Do not feed treated forage or hay to livestock or allow animals to graze treated areas. Apply 10 to 50 gallons of spray solution to per acre to foliage.
	Cyazypyr (Exirel)	13.5-20.5 oz	14	Suppression only. Should be used in conjunction with an effective thrips and tomato spotted wilt virus management program.
	Spinetoram (Radiant SC)	1.5-3.0 oz	3	See registration for suppression of thrips in Virginia. Use of an adjuvant may increase level of thrips control.
In-furrow	aldicarb (AgLogic 15G, AgLogic 15GG)	7 lb	90	RESTRICTED USE. Do not hog-off treated fields or allow livestock to graze in treated areas before harvest. Do not feed hay or vines to livestock. Immediately deep-disk any spills at row ends or elsewhere to ensure the granules are covered with a layer of soil.
	imidacloprid (Admire Pro)	7.0-10.5 oz	14	Apply as an in-furrow spray during planting directed on or below seed.
	phorate (Thimet 20G)	5.5 oz /1000 ft row or maximum of 7.5 lb/A	90	RESTRICTED USE. Distribute granules evenly in the furrow. Do not graze or feed treated hay or forage to livestock.

Potato Leafhopper

The potato leafhopper is a common pest of peanuts in Virginia. This small, wedge-shaped, light green to yellow insect damages the peanut plant by feeding on the undersides of leaves in a piercing-sucking manner. Injured leaf tips turn yellow first then brown and tend to curve downward. Toxins are also passed into plants at feeding sites. If enough damage is done, toxins can stop vine growth resulting in reductions in yield and grade. Injury may occur at any time from early June until the middle of August or later in some years. It is important to note that although late-season damage appears worse in some years, damage done early in the season probably affects plant vigor and yield more. Systemic insecticides applied at planting time will usually control potato leafhoppers that occur early.

Foliar treatments should be made only if needed. When 25% of the leaves show tip yellowing typical of leafhopper damage, and active adult and immature leafhoppers are seen, treat with an effective chemical. When foliar treatments are required, the first application usually is made about the middle of July, and the second about the first of August (if needed). If scheduled treatments are being made for control of leafspot, insecticides may be tank mixed. Do not include insecticides with all leafspot treatments. Too many insecticide applications, or applications later in the season, could cause spider mite populations to increase, especially in dry years after adjacent corn and weedy areas have been cut. Make leafhopper applications only when problems have been identified.

Table 4.49 - Recommended Insecticides for Potato Leafhopper Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	acephate (Orthene 97)	12.0-16.0 fl oz	14	Do not feed treated forage or hay to livestock or allow animals to graze treated areas. Apply 10 to 50 gallons of spray solution to per acre to foliage.
	beta-cyfluthrin + imidacloprid (Leverage 360)	2.8 oz	14	RESTRICTED USE.
	bifenthrin (Brigade 2EC)	2.1-6.4 oz	14	RESTRICTED USE. Do not feed immature plants and peanut hay to livestock. Apply in a minimum of 10 gallons of finished spray per acre with ground equipment or 2 gallons of finished spray per acre by aircraft.
	esfenvalerate (Asana XL)	2.9-5.8 oz	21	RESTRICTED USE. Do not feed or graze livestock on treated vines. Do not exceed 29 oz/ season.
	fenpropathrin (Danitol 2.4EC)	6.0-10.6 oz	14	RESTRICTED USE. Do not graze or feed treated peanut vine forage or dried hay within 14 days of the last application. Do not exceed 2.6 pints total application/A/season.
	lambda-cyhalothrin (Warrior II)	0.96-1.6 oz	14	RESTRICTED USE. Do not apply more than 7.68 fl oz/A/season. Do not graze livestock in treated areas, or use treated vines or hay for animal feed.
	methomyl (Lannate LV)	0.75- 3.0 pt	21	RESTRICTED USE. Do not feed treated vines. Use higher rate for severe infestations.
	(Lannate SP)	0.25- 1.0 lb	21	
	zeta-cypermethrin (Mustang Maxx)	1.76-4.0 fl oz	7	RESTRICTED USE. Do not graze livestock in treated areas. Do not use treated vines or hay for animal feed.

Southern Corn Rootworm

Southern corn rootworm larvae, which is the immature stage of the spotted cucumber beetle, can cause extensive injury to the Virginia peanut grown under certain conditions. Rootworm larvae develop in the soil and feed directly on pegs and pods. Finding rootworms in the soil is very difficult and injury is often not detected until after peanuts are dug. Field selection and early-planting are the best strategies. Determining risk for southern corn rootworm should be done on a field-by-field basis. Decisions can be based on both field characteristics (soil type, irrigation) and past history of peanut fields. Adult beetles can be readily detected in peanut fields. Their presence in moderate to high numbers from mid-July to early August should be a warning that a problem could develop. Fields planted after May 15 are at highest risk. Fields at lowest risk are planted before May 2. Factors that delay peanut maturity (thrips and or herbicide injury, poor growing conditions) increase risk.

Knowledge of the past history of rootworm injury can also be useful in determining risk level. If injury has ever occurred in a field, it will likely occur in other years. Keep field records on the extent of pod and peg injury noticed at harvest time. Pay particular attention to fields with higher levels of organic matter and clay. Rootworms have a higher survival rate in those soils due to higher moisture holding capacity, and injury will typically be more severe than in “light” soils. Use the “Southern Corn Rootworm Risk Index” (<https://peanut.ces.ncsu.edu/2022/03/southern-corn-rootworm-index-peanut-notes-no-37-2022/>) to aid you in deciding which fields are at high risk.

There are no labeled chemical treatments for rootworm larvae in peanut. Insecticides that include “southern corn rootworm” on the label are referring to the adult beetle only. Targeting adult beetles is unlikely to provide effective control of this pest.

Corn Earworm and Fall Armyworm

Annual infestations of the corn earworm and fall armyworm occur in most Virginia peanut fields. Usually there is a single generation of each species per season. Worms feed on leaf tissue causing peanuts to look ragged; however, research has shown that one-third of peanut foliage can be lost at the normal time of corn earworm infestations (mid-August to early September) without loss of yield or grade. Scouting fields is the only way to determine if treatment is needed. Scout by reaching halfway across 2 row-feet of plants and shaking foliage vigorously towards the row middle. Repeat on the opposite row. Count the worms on the ground and repeat the sample in several spots in the field. Treatment is recommended if an average of 8 or more worms are found per sample, or 4 per row-foot.

If treatment is necessary, apply sprays using systems that provide good canopy penetration and coverage. If spider mites are already present in the field, use of some insecticides may allow for rapid build-up. Scout fields for treatment effectiveness and for possible increases in spider mite activity soon after applications. Pyrethroids may offer poor to moderate control of corn earworm in Virginia, but this is often adequate economic control. If you decide to spray a pyrethroid, use the highest labeled rate and do not expect good control of heavy infestations or large worms.

Table 4.50 - Recommended Insecticides for Corn Earworm Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remark
Foliar ¹	acephate (Orthene 97)	12.0-16.0 oz	14	Do not feed treated forage or hay to livestock or allow animals to graze treated areas. Apply 10 to 50 gallons of spray solution to per acre to foliage.
	<i>Bacillus thuringiensis</i> (DiPel ES)	1.0-4.0 pt	0	For pyrethroid resistant corn earworm when tank mixed with a pyrethroid at a labeled use rate. Apply recommended rate when small larvae first appear and good coverage can be achieved.
	beta-cyfluthrin + imidacloprid (Leverage 360)	2.8 oz	14	RESTRICTED USE.

¹General - Treat only if foliage loss is heavy (1/3 or more). Earworms are easier to control when they are less than 1/2 inch long.

4-68 Insect Control in Field Crops: *Peanuts*

Table 4.50 - Recommended Insecticides for Corn Earworm Control (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remark
Foliar ¹ (cont.)	bifenthrin (Brigade 2EC)	2.1-6.4 oz	14	RESTRICTED USE. Do not feed immature plants and peanut hay to livestock. Apply in a minimum of 10 gallons of finished spray per acre with ground equipment or 2 gallons of finished spray per acre by aircraft.
	bifenthrin + chlorantraniliprole (Elevest)	5.6-9.6 fl oz	14	RESTRICTED USE. Do not feed green immature plants and peanut hay to livestock.
	chlorantraniliprole (Prevathon)	14.0-20.0 oz	1	Vantacor is a more concentrated product than Prevathon.
	(Vantacor)	1.2-2.5 oz	1	
	chlorantraniliprole + lambda- cyhalothrin (Besiege)	6.0-10 oz	14	RESTRICTED USE.
	esfenvalerate (Asana XL)	2.9-5.8 oz	21	RESTRICTED USE. Do not feed or graze livestock on treated vines. Do not exceed 29.0 oz/season.
	fenpropathrin (Danitol 2.4EC)	10.6-16.0 oz	14	RESTRICTED USE. Do not graze or feed treated peanut vine forage or dried hay within 14 days of the last application. Do not exceed 2.6 pints total application/A/season.
	indoxacarb (Steward EC)	6.7-11.3 oz	14	Do not feed or graze livestock on treated fields.
	lambda- cyhalothrin (Warrior II)	1.28-1.92 oz	14	RESTRICTED USE. Do not apply more than 7.68 fl oz/A/ season. Do not graze livestock in treated areas, or use treated vines or hay for animal feed.
	methomyl (Lannate LV)	0.75-3.0 pt	21	RESTRICTED USE. Do not feed treated vines. Lannate LV and SP has ovicidal and larvicidal control on corn earworm. Use higher rate for severe infestations.
	(Lannate SP)	0.25-1.0 lb	21	
	methoxyfen- ozide + spinetoram (Intrepid Edge)	4.0-8.0 OZ	7	Do not exceed 3 applications/season. Do not allow grazing of peanut hay.
	spinetoram (Radiant SC)	3.0-8.0 oz	3	Do not allow grazing of peanut hay.
	spinosyn (Blackhawk)	1.7-3.3 oz	3	Do not allow grazing of crop residue or harvest of crop residue for hay until 14 days after the last application.
	zeta- cypermethrin (Mustang Maxx)	3.2-4.0 oz	7	RESTRICTED USE. Do not graze livestock in treated areas. Do not use treated vines or hay for animal feed.

¹**General** - Treat only if foliage loss is heavy (1/3 or more). Earworms are easier to control when they are less than 1/2 inch long.

Table 4.51 - Recommended Insecticides for Fall Armyworm Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remark
Foliar ¹	acephate (Orthene 97)	12.0-16.0 oz	14	Do not feed treated forage or hay to livestock or allow animals to graze treated areas. Apply 10 to 50 gallons of spray solution to per acre to foliage.
	<i>Bacillus thuringiensis</i> (DiPel ES)	2.0-4.0 pt	0	For pyrethroid resistant corn earworm when tank mixed with a pyrethroid at a labeled use rate. Apply recommended rate when small larvae first appear and good coverage can be achieved.
	beta-cyfluthrin + imidacloprid (Leverage 360)	2.8 oz	14	RESTRICTED USE. Controls 1st and 2nd instar armyworms.
	bifenthrin (Brigade 2EC)	2.1-6.4 oz	14	RESTRICTED USE. Do not feed immature plants and peanut hay to livestock. Apply in a minimum of 10 gallons of finished spray per acre with ground equipment or 2 gallons of finished spray per acre by aircraft.
	bifenthrin + chlorantraniliprole (Elevest)	5.6-9.6 oz	14	RESTRICTED USE. Do not feed green immature plants and peanut hay to livestock.
	chlorantraniliprole (Prevathon)	14.0-20.0 oz	1	Vantacor is a more concentrated product than Prevathon.
	(Vantacor)	1.2-2.5 oz	1	
	chlorantraniliprole + lambda-cyhalothrin (Besiege)	6.0-10.0 oz	14	RESTRICTED USE. Use higher listed rates within the rate range for large larvae.
	esfenvalerate (Asana XL)	9.6 oz	21	RESTRICTED USE. Suppression only. Do not feed or graze livestock on treated vines. Do not exceed 29.0 oz/season. For heavy infestations methomyl (e.g., Lannate) is recommended. See methomyl product label for instructions.
	fenpropathrin (Danitol 2.4EC)	10.6-16.0 oz	14	RESTRICTED USE. Do not graze or feed treated peanut vine forage or dried hay within 14 days of the last application. Do not exceed 2.6 pints total application/A/season.
	indoxacarb (Steward EC)	9.2-11.3 oz	14	
	lambda-cyhalothrin (Nufarm Lambda-Cyhalothrin 1EC)	2.56-3.84 fl oz	14	RESTRICTED USE. Use higher rate for larger larvae. Do not graze or harvest treated soybean forage, straw, or hay for livestock feed.
	methomyl (Lannate LV)	0.75-3.0 pt	21	RESTRICTED USE. Do not feed treated vines.
	(Lannate SP)	0.25-1.0 lb	21	

¹**General** - Treat only if foliage loss is heavy (1/3 or more). Earworms are easier to control when they are less than 1/2 inch long.

4-70 Insect Control in Field Crops: *Peanuts*

Table 4.51 - Recommended Insecticides for Fall Armyworm Control (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remark
Foliar ¹ (cont.)	methoxyfen- ozide + spinetoram (Intrepid Edge)	4.0-8.0 oz		Do not exceed 3 applications/season. Do not allow grazing of peanut hay.
	methoxyfeno- zide (Intrepid 2F)	6.0-10.0 oz	7	Apply when first signs of feeding damage appear or when threshold levels of feeding damage occur.
	spinetoram (Radiant SC)	3.0-8.0 oz	3	Do not allow grazing of peanut hay.
	spinosyn (Blackhawk)	1.7-3.3 oz	3	Do not allow grazing of crop residue or harvest of crop residue for hay until 14 days after the last application.
	zeta- cypermethrin (Mustang Maxx)	3.2-4.0 oz	7	RESTRICTED USE. Do not graze livestock in treated areas. Do not use treated vines or hay for animal feed. Aids in control. See resistance statement in DIRECTIONS FOR USE section of product label.

¹**General** - Treat only if foliage loss is heavy (1/3 or more). Earworms are easier to control when they are less than 1/2 inch long.

Spider Mite

Mites, which have become more numerous during the past several years, are especially injurious during hot, dry weather. While insecticides are very valuable in controlling leafhoppers, thrips, and worms, they may be responsible for destroying some of the natural enemies of spider mites and thus promoting the build-up of mite populations. Insecticides should be used **only when needed** for insect control.

Spider mites feed mainly on the undersides of the leaves. They suck the juice from the foliage and cause the leaves to turn brown and eventually drop off. Heavy infestations usually occur first around the borders of peanut fields; then they spread inward throughout the fields. Avoid harvesting spider mite infested cornfields or mowing weedy areas next to peanut fields until peanuts are harvested. Spider mites will readily move into peanuts when corn dries down or is harvested. Be prepared to treat peanuts if adjacent corn is infested.

Broad spectrum applications of insecticides labeled for spider mite control (e.g., bifenthrin, fenprothrin) will flair populations after a initial reduction in numbers. Use these products with caution and only when favorable weather (i.e., rainfall, high humidity) are forecast.

Important: If you are going to treat, calibrate your equipment to deliver the right amount of pesticide per acre. Arrange and adjust the nozzles or spouts in a manner that will direct the chemical into the desired area to be treated. Adequate sprayer pressure (40 to 60 psi) will aid in getting chemicals in contact with the undersides of leaves and within denser foliage. Penetration of foliage with 20 to 30 gallons of water per acre is very important for the control of spider mites.

Table 4.52 - Recommended Insecticides for Spider Mite Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	bifenthrin (Brigade 2EC)	5.12-6.4 oz	14	RESTRICTED USE. Do not feed immature plants and peanut hay to livestock. Apply in a minimum of 10 gallons of finished spray per acre with ground equipment or 2 gallons of finished spray per acre by aircraft.
	fenpropathrin (Danitol 2.4EC)	10.6-16.0 oz	14	RESTRICTED USE. Do not graze or feed treated peanut vine forage or dried hay within 14 days of the last application. Do not exceed 2.6 pints total application/A/season.
	fenpyroximate (Portal)	1.0-2.0 pt	1	
	propargite (Comite) (Omite 30WS)	2.0 pt 3.0-5.0 lb	14 14	Use a minimum of 20 gallons/A with ground equipment or 5 gallons by air. Make no more than 2 applications/year (either Comite OR Omite). Do not plant rotational crops within 6 months of last application. Do not feed hay to livestock.

Lesser Cornstalk Borer

Lesser cornstalk borer is typically not a problem in Virginia peanut fields. However, it does thrive under hot dry conditions and can become a problem when those conditions continue for 3-4 weeks. Infestations will be most severe where soils are sandy and in high, well drained areas within fields. Larvae are 0.5 to 0.75 inch long and are banded with alternating brown and blue stripes. They wiggle vigorously when disturbed. Larvae feed by burrowing into main stems, lateral limbs, plant crowns, and pods and can do extensive damage, even kill plants. Larvae produce silk-and-sand web tubes, which are attached to pods or stems at the point of feeding. Evidence of web tubes is a sure sign of borer activity.

Grasshopper

Table 4.53 - Recommended Insecticides for Grasshopper Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	acephate (Orthene 97)	4.0-8.0 oz	14	Do not feed treated forage or hay to livestock or allow animals to graze treated areas. Apply 10 to 50 gallons of spray solution to per acre to foliage.
	bifenthrin (Brigade 2EC)	2.1-6.4 oz	14	RESTRICTED USE. Do not feed immature plants and peanut hay to livestock. Apply in a minimum of 10 gallons of finished spray per acre with ground equipment or 2 gallons of finished spray per acre by aircraft.
	"bifenthrin + chlorantraniliprole (Elevest)	4.8-9.6 oz	14	RESTRICTED USE. Performance is improved with the addition of Methylated Seed Oil (MSO) at 1 gallon per 100 gallons of spray volume. Do not feed green immature plants and peanut hay to livestock.
	esfenvalerate (Asana XL)	5.8-9.6 oz	21	RESTRICTED USE. Do not feed or graze livestock on treated vines. Do not exceed 29.0 oz/season.
	zeta-cypermethrin (Mustang Maxx)	3.2-4.0 oz	7	RESTRICTED USE. Do not graze livestock in treated areas. Do not use treated vines or hay for animal feed.

Pesticide Usage Charts

Many pesticides control more than one pest. The two tables below summarize the effectiveness of some popular pesticides used at time of planting, at time of pegging, or as foliar treatments for the control of major insect pests which attack peanuts.

Table 4.54 - Insecticide Activity of Products Applied at Time of Planting

Chemical	Pests			
	Thrips	Leafhopper	Rootworm	Spider Mite
Orthene	E	Early	No	No
Thimet	G	Early	No	No

P=poor control, F=fair control, G=good control, E=excellent control, No=not labeled or no activity expected.

Table 4.55 - Insecticide Activity of Foliar Treatments Applied when Pests Are Present

Insecticide	Formulation ¹	Pest Species Controlled						
		Thrips	Leaf-hopper	Root-worm	Corn earworm	Fall army-worm	Lesser corn stalk borer	Spider mite
Asana	XI	No	E	No	F/P	G	No	No ²
Comite, Omite	6.5EC, 30W	No	No	No	No	No	No	E
Danitol	2.4EC	No	E	No	E	G	No	E
Karate	Z	E	E	No	F/P	G	No	F
Lannate	L	P	G	No	E	G	No	No ²
Orthene	97	E	E	No	G	F	No	No ²
Sevin	4F, 80s, XLR Plus	P	E	No	F	F	No	No ²
Steward	1.25SC	No	No	No	E	E	No	No
Blackhawk		No	No	No	E	E	No	No

P=poor control, F=fair control, G=good control, E=excellent control, No=not labeled or no activity expected.

¹There are other insecticides and other formulations which have federal registration for use on peanuts.

²Use of these insecticides may allow rapid build-up of spider mites. Use with caution during extended periods of dry weather.

Cotton

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Thrips

Thrips affect cotton in the early stages of development. These tiny, spindle-shaped insects complete several generations per season under favorable conditions and feed primarily by puncturing and rasping the outer cells of the young leaves and buds. Injury results in ragged looking plants with crinkled or “possum-eared” leaves. The injury associated with thrips feeding can stunt growth resulting in fruiting at higher positions and delayed maturity. Injury is most severe if young cotton is subjected to adverse growing conditions or when alternate thrips hosts such as small grains dry down prematurely, forcing large numbers of thrips to seek other hosts. Adverse growing conditions during the early stages of cotton development may reduce the uptake of systemic insecticides, therefore early inspection of the crop is important. Our research indicates that cotton varieties with ThryvOn Technology, which received full commercialization in 2023, do not require in-furrow or foliar insecticide applications for thrips control.

There is no formal threshold for thrips based on insect numbers or plant injury. Treatment is thought to be justified if the following conditions are met: 1) thrips injury is common, 2) 10% or more plants show extensive bud damage, 3) immature thrips can be easily found, and 4) plant growth is poor.

Table 4.56 - Recommended Insecticides for Thrips Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
In-furrow or seed	acephate (Orthene 97)	8.0-16.0 oz	21	Apply as a liquid into the seed furrow in 3-5 gal of water/A with a system that ensures good seed coverage. Do not feed treated forage or hay to livestock or allow animals to graze treated areas.
	aldicarb (AgLogic 15G, AgLogic 15GG)	3.5-5.0 lb	90	Do not feed cotton forage to livestock or allow livestock to graze in treated area. Immediately deep-disk any spills at row ends or elsewhere to ensure the granules are covered with a layer of soil. Application rate may be reduced by 1/2 if seeds and granules are hill dropped.
	imidacloprid (Admire Pro)	7.4-9.2 oz	—	Apply as an in-furrow spray during planting directed on or below seed. Do not graze treated fields after any application of Admire Pro.
	imidacloprid (Gaucho Grande, Aeris)	0.375 mg ai/ seed	—	—
	phorate (Thimet 20G)	6.0-9.0 oz/1,000 row ft (36" row minimum)	—	RESTRICTED USE. Do not graze or feed treated hay or forage to livestock.
	thiamethoxam (Cruiser 5FS, Avicta CP)	0.30-0.375 mg ai/seed	—	—

Table 4.56 - Recommended Insecticides for Thrips Control (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	acephate (Orthene 97)	2.5-3.0 oz	21	—
	spinetoram (Radiant SC)	4.25-8.0 oz	28	2 (ee) Recommendation lists 1.5-3.0 oz for early season suppression. Use with an adjuvant to improve control.

Plant Bugs

Prebloom: Prior to bloom, tarnished plant bugs, or lygus bugs, injure cotton by feeding on tender terminals and small squares causing squares to turn black and abort. Excessive square loss can reduce yields and slow plant maturity. Plant bugs are found across Virginia's entire cotton growing region throughout the pre-bloom and bloom period (late May-August). Fields adjacent to corn, weed fields, and other sources of plant bugs in eastern counties may be at relatively higher risk of plant bug injury. Frequent scouting during pre-bloom and flowering is advised. Plant bug adults can rapidly infest fields and re-infest following treatment. Multiple applications may be required. Rotation between modes of action is recommended. The best way to determine the need for pre-bloom plant bug control is to assess square retention rates (percent missing squares) in addition to scouting for insects. Treatment should be considered if square retention drops below 80% (see threshold table below) and plant bugs are active.

After blooming: Once blooming begins, plant bugs continue feeding on smaller squares and blooms, both of which can cause 'dirty blooms' (white blooms with brown pollen anthers or brown-streaked petals). The presence of dirty blooms indicates that plant bugs are, or have very recently been, active. Levels at or above 15% dirty bloom indicate a large and active plant bug population and the need for sampling of bolls for injury (see threshold table below). Do not spray insecticides based on dirty blooms alone. Neonicotinoid insecticides (i.e., products containing imidacloprid, thiamethoxam, or clothianidin) are less effective during bloom and are prohibited because of pollinator guidelines. Read and follow label instructions with all pesticide applications. Most insecticides labeled for plant bug control are toxic to bees and beneficial predators. Only spray insecticides when necessary. Pyrethroids lose efficacy over the season and should not be used alone past the second week of bloom.

Boll injury: Once bolls are formed, plant bugs prefer feeding on small bolls up to 3 weeks old. Injury to bolls can range from warts or calluses on the insides of boll walls, to small areas of stained lint, to deformed and rotting fruit that is due to direct feeding on seed. This is identical to injury caused by stink bugs.

Table 4.57 - Sampling for Plant Bugs and Thresholds in Cotton

Pre-bloom	below 80% square retention and plant bugs active
During bloom	15% injured bolls or dirty blooms indicates the presence of an active population 8 plant bugs per 100 sweeps (use sweep net thresholds during the first two weeks of bloom only) or 2.5 or more plant bugs per drop cloth sample (use drop cloth thresholds following the second week of bloom) indicate a large, active population

Table 4.58 - Recommended Insecticides for Plant Bug Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	acephate (Orthene 97)	4.0-16.0 oz	21	
	acetamiprid (Assail 70WP)	1.1-2.3 oz	28	Do not apply to blooming cotton.

Table 4.58 - Recommended Insecticides for Plant Bug Control (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar (cont.)	beta-cyfluthrin (Baythroid XL)	1.6-2.6 oz	0	RESTRICTED USE. May not provide adequate control in blooming cotton.
	bifenthrin (Brigade 2EC)	2.6-6.4 oz	14	RESTRICTED USE. May not provide adequate control in blooming cotton.
	bifenthrin + chlorantraniliprole (Elevest)	4.8-9.6 oz	21	RESTRICTED USE. This product is used to target both plant bugs and caterpillar pests.
	dicrotophos (Bidrin 8)	4.0-8.0 oz	30	Labeled only for late-season use.
	dinotefuran (Venom 20SG)	1.0-3.0 oz	14	
	esfenvalerate (Asana XL 0.66EC)	5.8-9.6 oz	21	RESTRICTED USE. May not provide adequate control in blooming cotton.
	imidacloprid (Admire Pro)	0.9-1.7 oz	14	Do not apply to blooming cotton.
	lambda-cyhalothrin (Warrior II)	1.28-1.92 oz	21	RESTRICTED USE. May not provide adequate control in blooming cotton.
	lambda-cyhalothrin + thiamethoxam (Endigo ZC)	4.5-5.5 oz	21	RESTRICTED USE. Do not graze livestock in treated areas. Do not apply to blooming cotton. .
	chlorantraniliprole + lambda-cyhalothrin (Besiege)	6.5-12.5 oz	21	RESTRICTED USE. Do not graze livestock in treated areas. May not provide adequate control in blooming cotton. This product is used to target both plant bugs and caterpillar pests.
	methomyl (Lannate LV)	1.5 pt/A (early season), 1.5-2.25 pt/A (late season)	15	RESTRICTED USE. Refer to label for rates to conserve natural enemies.
	(Lannate SP)	0.5 lb/A (early season), 0.5-0.75 lb/A (late season)	15	
	novaluron (Diamond)	6.0-12.0 oz	30	Targets immature stages. Use with an adult knockdown product such as acephate or a pyrethroid.
	oxamyl (Vydate C-LV)	4.25-17.0 oz	14	RESTRICTED USE. Follow label directions on number of applications and rates.
	sulfoxaflor (Transform WG)	1.5-2.25 oz	14	
	thiamethoxam (Centric 40WG)	1.25-2.5 oz	21	Do not use if squares, blooms, or bolls present..
	zeta-cypermethrin (Mustang Maxx)	2.64-3.6 oz	14	RESTRICTED USE.

Tobacco Budworm/Bollworm

Bollworms (AKA corn earworms) occur primarily on field corn during their first two generations. Third generation moths usually emerge in large numbers from mid-July to early August when corn is drying and fly to more attractive blooming cotton.

Regular weekly scouting for the bollworm should begin in early to mid-June. Weekly scouting is adequate until egg laying or light-trap catches increase. Fields should then be scouted twice a week, with the emphasis placed upon finding eggs, until insecticide treatments begin. After that, a 4- to 7-day scouting schedule will usually suffice. Once the egg threshold has been met and treatments made, the primary focus of scouting shifts toward finding small bollworms feeding on squares and bolls, including those under bloom tags. Pyrethroids offer poor to moderate control of corn earworm in Virginia and poor to no control of tobacco budworm (at this time, tobacco budworm is controlled by Bt toxins expressed in two- and three-gene transgenic cotton). If you decide to spray a pyrethroid, use the highest labeled rate and do not expect good control of heavy infestations or large worms.

Tobacco budworm adults are not readily attracted to black light traps and sometimes begin laying eggs on cotton prior to the time at which the bollworm egg threshold has been met; occasional fields may reach a 3 percent larval threshold prior to bollworm treatment initiation. Under these circumstances, tobacco budworm pheromone trap deployment and correct sight identification of adult tobacco budworms can assist in recognition of this situation. Unlike bollworm, tobacco budworm are controlled by currently available Bt cotton varieties. It is not possible to visually distinguish budworm and bollworm eggs. Conservatively, base treatment decisions on the assumption that all eggs found in cotton are bollworm.

After the upper bolls that will be harvested have become difficult to cut with a pocket knife (approximately three weeks after bloom), they are normally safe from bollworm attack. Bollworm scouting can normally be stopped at that time—usually in late August to early September.

Table 4.59 - Bollworm and Tobacco Budworm Thresholds in Cotton

Cotton Type	Threshold	Remarks
<i>Conventional Cotton</i>		
Prebloom	8 bollworms/100 terminals or 6 bollworms/100 squares	Limiting this treatment to one well-timed pyrethroid application is strongly recommended.
Egg	10+ eggs/100 terminals or 2 eggs/100 fruiting forms	After the onset of the major (third generation) bollworm moth flight.
Post-bloom larval	3 live worms/100 terminals, or 3 percent fresh damage to squares, blooms, or bolls	Usually after the egg threshold has been employed; also used after blooming begins and before major bollworm flight, particularly if tobacco budworms are present.
<i>Two-gene cotton (Widestrike, Bollgard II, and TwinLink varieties)</i>		
Egg	25 eggs/100 terminals or leaves	Sample both terminals and leaves. Check leaves at multiple levels throughout the canopy. If applying product at egg threshold, use Prevathon.
Larval	3 second-stage (1/8 inch or larger) bollworms/100 squares or bolls or 2 second-stage bollworms on 2 consecutive scouting trips or 1 second-stage bollworm on 3 consecutive scouting trips	Use against the major bollworm generation. Pay particular attention to bollworms in or under yellow, pink, or dried blooms, but only sample in proportion to their occurrence. No product will provide good control of larvae in bloom tags or bolls.
Damage	3 to 6 percent significantly damaged squares (would cause squares to abort) or bolls	
<i>Three-gene cotton (Widestrike 3, Bollgard III, and TwinLink Plus varieties)</i>		

Table 4.59 - Bollworm and Tobacco Budworm Thresholds in Cotton (cont.)

Cotton Type	Threshold	Remarks
Larval	3 second-stage (1/8 inch or larger) bollworms/100 squares or bolls or 2 second-stage bollworms on 2 consecutive scouting trips or 1 second-stage bollworm on 3 consecutive scouting trips	Use against the major bollworm generation. Pay particular attention to bollworms in or under yellow, pink, or dried blooms, but only sample in proportion to their occurrence. No product will provide good control of larvae in bloom tags or bolls.

Table 4.60 - Recommended Insecticides for Bollworm Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar (pyrethroids)	beta-cyfluthrin (Baythroid XL)	1.6 ¹ -2.6 ² oz	0	RESTRICTED USE.
	bifenthrin (Brigade 2EC)	2.6 ¹ -6.4 ² oz	14	RESTRICTED USE.
	bifenthrin + chlorantraniliprole (Elevest)	4.8-9.6 oz	21	RESTRICTED USE.
	esfenvalerate (Asana XL 0.66EC)	5.8 ¹ -9.6 ² oz	21	RESTRICTED USE.
	fenpropathrin (Danitol 2.4EC)	10.6 ¹ -16.0 ² oz	21	RESTRICTED USE.
	lambda-cyhalothrin (Warrior II)	1.6 ¹ -2.56 ² oz	21	RESTRICTED USE.
	chlorantraniliprole + lambda-cyhalothrin (Besiege)	6.5-12.5 oz	21	RESTRICTED USE. Do not graze livestock in treated areas.
	zeta-cypermethrin (Mustang Maxx)	2.64 ¹ -3.6 ² oz	14	RESTRICTED USE.
Foliar (others)	<i>Bacillus thuringiensis</i> (DiPel ES)	1.0-6.0 pt	0	For pyrethroid resistant corn earworms (bollworms) when tank mixed with a pyrethroid at a labeled use rate.
	indoxacarb (Steward EC)	11.3 oz	14	
	methomyl (Lannate LV)	1.5 pt/A (early season), 1.5-2.25 pt/A (late season)	15	RESTRICTED USE. Refer to label for rates to conserve natural enemies.
	(Lannate SP)	0.5 lb/A (early season), 0.5-0.75 lb/A (late season)	15	
	methoxyfenozide + spinetoram (Intrepid Edge)	6.0-8.0 oz	28	
rynaxypyr (Coragen)	3.5-7.5 oz	21	See label for instructions for non-Bt and Bt cotton varieties.	

¹Standard rate

²High rate

Table 4.60 - Recommended Insecticides for Bollworm Control (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar (others) (cont.)	spinetoram (Radiant SC) (prebloom)	2.8-8.0 oz	28	
	(postbloom)	4.25-8.0 oz		
	spinosyn (Blackhawk)	1.6-3.2 oz	28	For second-generation tobacco budworms, 1.6 oz is adequate; for post-bloom bollworms, use the 3.2 oz rate.
	chlorantraniliprole (Prevathon)	14.0-27.0 oz	21	See label for instructions for non-Bt and Bt cotton varieties.
	(Vantacor)	1.2-2.5 oz	21	See label for instructions for non-Bt and Bt cotton varieties.

¹Standard rate
²High rate

European Corn Borer

European corn borer (ECB) is controlled by two- and three-gene Bt cotton varieties. The following recommendations are for conventional cotton only. Larvae damage cotton by feeding on large bolls from early August through mid-September. In rank or late-maturing cotton, this damage can be significant. An earlier tunneling type of damage may occur within stems and leaf petioles, usually in mid-July through late August. Although this damage looks serious, with wilting and eventual death of the tissue above the feeding site, it causes no known economic loss. The major moth flight for the ECB often occurs a few days to three weeks later than the major bollworm flight. The female moths lay egg masses that contain 15-75 eggs each. These small, flat, scale-like masses are deposited on the underside of cotton leaves deep within the canopy. At first, early instars feed within the leaf petioles and stems, but they begin to enter and feed upon large bolls, sometimes within 48 hours, particularly after mid-August. Although the caterpillars of this species generally do not feed as extensively within the bolls as do bollworms, most bolls are destroyed. European corn borer is controlled by currently available Bt cotton varieties.

Controlling ECB damage in conventional cotton presents an unusual problem. The flat egg masses are almost impossible to find, even by the trained scouts searching heavily infested fields. By the time the larvae are found feeding on or within bolls, insecticide treatments are usually ineffective. Thus scouting for this pest benefits the producer little during the present year. However, scouting to detect the caterpillars is advised. If small larvae are present (3 percent or more), treatment may be prescribed if an active flight is confirmed. This situation may indicate a late, rank cotton crop that should be avoided in the future.

No control threshold has been developed since finding the egg masses is virtually impossible, and live caterpillars are spotted too late to achieve effective control. Growers must depend on another observation as a trigger for directing insecticide against the pest. Fortunately, because egg laying of the corn earworm usually occurs somewhat earlier than the ECB flight, employing the egg threshold for bollworm control usually works well for ECB if treatments are extended into the ECB infestation period. An insecticide should be selected that is effective against both insects. If the major part of the ECB flight occurs after the bollworm flight has subsided and spraying has been completed, fields can be particularly susceptible. Under this condition, 3-6 total applications may be required for adequate suppression. This approach is recommended only where late rank growth points toward a high probability of ECB damage. Finding moths of this species in local light or pheromone traps, or flushing the adults from around or within cotton fields can help confirm the need for this extended treatment.

Table 4.61 - Recommended Insecticides for European Corn Borer Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	beta-cyfluthrin (Baythroid XL)	1.6-2.6 oz	0	RESTRICTED USE.
	bifenthrin (Brigade 2EC)	1.3-6.4 oz	14	RESTRICTED USE.
	lambda-cyhalothrin (Warrior II)	1.6-2.56 oz	21	RESTRICTED USE.
	chlorantraniliprole + lambda-cyhalothrin (Besiege)	6.5-12.5 oz	21	RESTRICTED USE. Do not graze livestock in treated areas.
	spinetoram (Radiant SC)	2.8-8.0 oz	28	
	zeta-cypermethrin (Mustang Maxx)	2.64-3.6 oz	14	RESTRICTED USE.

Stink Bugs

Stink bugs typically begin invading cotton fields in mid-July and build to damaging levels in August. Stink bugs injure cotton by puncturing the carpal walls of bolls and feeding on the soft developing seeds. If bolls are small when feeding occurs, the boll will dry up, turn brown and either remain on the plant or be shed. Bollrot pathogens are sometimes introduced when feeding is concentrated on medium and larger bolls, resulting in portions of the boll being destroyed, hard-lock, and lower grades. External feeding damage appears as small round purplish depressions about the size of a pencil point. The feeding sites are slightly larger but closely resemble the spots that naturally appear on maturing bolls. Stink bug feeding sites can be confirmed by slicing the bolls open under the depressions. The damaged bolls will have a brown stain (bollrot organisms) in the seed area under these spots.

Stink bugs often occur in a clumped distribution within a cotton field; therefore, at least 10 samples should be taken throughout a field to determine if a problem exists. Both sweep nets and shake cloths can be used to sample for stink bugs, but our research showed that of the two, shake cloths tend to do a better job. A sweep net sample should consist of 25 hard sweeps using a pendulum-like motion with enough speed and force to end up with some leaves and small bolls in the net. An average of one stink bug per 25 sweeps could indicate a problem. A shake cloth sample should consist of placing a 3-foot long cloth on the ground between the rows, bending the bordering plants on either side (first one side, then the other) and vigorously shaking those plants to dislodge any insects. An average of one stink bug per 6 row feet (one 3-foot long shake cloth sample, both sides of the cloth) could indicate a problem.

Research in the southeast has resulted in a dynamic threshold based on percent of bolls injured by stink bug feeding, that changes with week after first bloom (see below). Stink bug and plant bug injury is indistinguishable. Scouting using a sweep net or beat cloth should be conducted in addition to internal boll injury to determine which species is causing the problem.

Table 4.62 - Sampling for Stink Bugs and Thresholds in Cotton

Indicates presence	an average of 1 per 6 row feet using a 3-foot shake cloth
	an average of 1 per 25 sweeps using a 15-inch diameter sweep net
Boll damage	Week of bloom 1 = 50% internal boll damage; week 2 = 30%; weeks 3, 4 and 5 = 10%; week 6 = 20%; week 7 =30%; week 8 = 50%.

Table 4.63 - Recommended Insecticides for Stink Bug Control

Treatment	Insecticide (Formulation)	Amount per acre product	Time limits: days before harvest	Remarks
Foliar	acephate (Orthene 97)	12.0 oz	21	Do not feed treated forage or hay to livestock or allow animals to graze treated areas. For brown and green stinkbugs.
	dicrotophos (Bidrin 8)	4.0-8.0 oz	30	Labeled only for late-season use.
	chlorantraniliprole + lambda-cyhalothrin (Besiege)	6.5-12.5 oz	21	RESTRICTED USE. Do not graze livestock in treated areas.
	chlorantraniliprole + bifenthrin (Elevest)	4.8-9.6 oz	21	RESTRICTED USE. This product is used to target both stink bugs and caterpillar pests.
	pyrethroids (see product labels)			RESTRICTED USE.

Aphids

A number of beneficial insects and fungal diseases can hold aphid numbers below economic threshold levels. By limiting early season insecticide applications, the grower is allowing beneficial insect populations to build, decreasing the chances of developing resistant aphid populations (observed in North Carolina and Virginia), and possibly reducing or eliminating the need for insecticide applications later in the season. An aphid rating level of four or more just before boll opening, plus the presence of honeydew, is probably a good indicator of the need to treat. Aphid control with insecticides should be attempted only as a last resort, particularly in early season (before major bollworm moth flight).

Table 4.64 - Aphid Rating Scale

0	No aphids
1	Occasional plants with low numbers of aphids
2	Plants with low numbers common; heavily infested plants rare; honeydew visible occasionally
3	Most plants with some aphids; occasional plants heavily infested; honeydew easily visible in most areas of the field
4	Heavily infested plants common; aphids clumped on upper leaves
5	Many heavily infested plants

Table 4.65 - Recommended Insecticides for Aphid Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	acetamiprid (Assail 70WP)	0.6-1.1 oz	28	Do not use on blooming cotton.
	bifenthrin (Brigade 2EC)	2.6-6.4 oz	14	RESTRICTED USE.
	dicrotophos (Bidrin 8)	1.6-3.2 oz (early season) 4.0-8.0 oz (late season)	30	RESTRICTED USE. Suppression only.

Table 4.65 - Recommended Insecticides for Aphid Control (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
	flupyradifurone (Sivanto 200 SL)	7.0-10.5 oz	14	
	imidacloprid (Admire Pro)	0.9-1.7 oz	14	Do not use on blooming cotton.
	thiamethoxam (Centric 40WG)	1.25-2.5 oz	21	Do not use on blooming cotton.

Spider Mites

Spider mites can occur during any time of the season, but are favored by dry weather and/or the removal of alternative hosts (e.g., corn). Mite damage first appears as a slight yellowing of the leaves, which later changes to a purplish or bronze color and is usually associated with webbing. Damage occurs especially in spots or on field edges but widespread defoliation is not uncommon if favorable conditions persist.

Spider mites can be checked while scouting for other insect pests. Active mite populations should be confirmed before applications are made. Delaying treatment should also be considered if rainy, humid conditions are predicted in the near future. Rainy, humid conditions favor a fungus that preys upon mites and may greatly reduce mite numbers.

Table 4.66 - Recommended Miticides for Spider Mite Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	etoxazole (Zeal)	0.66-1.0 oz	28	
	fenpropathrin (Danitol 2.4EC)	10.6-16.0 oz	21	RESTRICTED USE. Populations will rebound after application if dry weather persists.
	propargite (Comite 6.55EC)	1.0-2.0 pt	50	Apply only before bolls open.
	spiromesifen (Oberon 4SC)	3.0 oz (early season) 4.0-8.0 oz (mid-late season)	30	

Fall Armyworms

Fall armyworm is controlled by two- and three-gene Bt cotton varieties. The following recommendations are for conventional cotton only. The presence of fall armyworms (FAW) and their damage is recorded as part of bollworm scouting. Additional samples are unnecessary. FAW migrate into Virginia from the south. FAW prefer blooms and bolls of all sizes. These caterpillars can be extremely damaging if present in moderate numbers and can become established late in the season. They can feed on mature bolls normally resistant to bollworm penetration. Because FAW are not always controlled effectively by the same insecticides as bollworms, it is very important that they be identified correctly. Also, because fall armyworms are difficult to control with insecticides, treatments are best applied at an early boll bract feeding stage.

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Table 4.67 - Recommended Insecticides for Fall Armyworm Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	bifenthrin + chlorantraniliprole (Elevest)	5.6-9.6 oz	21	RESTRICTED USE.
	chlorantraniliprole + lambda-cyhalothrin (Besiege)	6.5-12.5 oz	21	RESTRICTED USE. Do not graze livestock in treated areas.
	indoxacarb (Steward EC)	9.2-11.3 oz	14	
	methomyl (Lannate LV)	1.5 pt/A (early season), 1.5-2.25 pt/A (late season)	15	RESTRICTED USE.
	(Lannate SP)	0.5 lb/A (early season), 0.5-0.75 lb/A (late season)	15	
	methoxyfenozide (Intrepid 2F)	4.0-10.0 oz	14	Suppression only.
	methoxyfenozide + spinetoram (Intrepide Edge)	6.0-8.0 oz	28	
	rynaxypyr (Coragen)	3.5-7.5 oz	21	
	spinetoram (Radiant SC)	4.25-8.0 oz	28	
	spinosyn (Blackhawk)	2.4-3.2 oz	28	
	chlorantraniliprole (Prevathon)	14.0-27.0 oz	21	
	(Vantacor)	1.2-2.5 oz	21	

Table 4.68 - Recommended Insecticides for Beet Armyworm Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
	dicrotophos + bifenthrin (Bidrin XP11)	8.0-10.5, 12.8* oz	30	RESTRICTED USE. Do not graze livestock, cut treated crops for feed, or feed gin trash. Do not apply as a ULV application. *Use higher rate with heavy infestations.
	indoxacarb (Steward EC)	9.2-11.3 oz	14	
	methoxyfenozide (Intrepid 2F)	4.0-10.0 oz	14	
	methoxyfenozide + spinetoram (Intrepide Edge)	4.0-8.0 oz	28	
	rynaxypyr (Coragen)	3.5-7.5 oz	21	

Table 4.68 - Recommended Insecticides for Beet Armyworm Control (cont.)

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
	spinetoram (Radiant SC)	4.25-8.0 oz	28	
	chlorantraniliprole + lambda-cyhalothrin (Besiege)	6.5-12.5 oz	21	RESTRICTED USE. Do not graze livestock in treated areas. For control of 1 st and 2 nd instar only.
	spinosyn (Blackhawk)	2.4-3.2 oz	28	
	chlorantraniliprole (Prevathon)	14.0-27.0 oz	21	
	(Vantacor)	1.2-2.5 oz	21	
	chlorantraniliprole + bifenthrin (Elevest)	5.6-9.6 oz	21	RESTRICTED USE.

Table 4.69 - Recommended Insecticides for Cutworm Control

Treatment	Insecticide (Formulation)	Amount product per acre	Time limits: days before harvest	Remarks
Foliar	acephate (Orthene 97)	12.0 oz	21	Control is most effective when ground application is made in the evenings and sprays are directed toward the base and lower portion of plants.
	beta-cyfluthrin (Baythroid XL)	0.8-1.6 oz	0	RESTRICTED USE.
	bifenthrin (Brigade 2EC)	2.6-6.4 oz	14	RESTRICTED USE.
	bifenthrin + chlorantraniliprole (Elevest)	4.8-9.6 oz	21	RESTRICTED USE.
	esfenvalerate (Asana XL 0.66EC)	5.8-9.6 oz	21	RESTRICTED USE.
	fenpropathrin (Danitol 2.4EC)	10.6-16.0 oz	21	RESTRICTED USE.
	lambda-cyhalothrin (Warrior II)	0.96-1.28 oz	21	RESTRICTED USE.
	zeta-cypermethrin (Mustang Maxx)	1.28-1.92 oz	14	RESTRICTED USE.

Beneficial Insects

About a dozen beneficial insects are common in Virginia cotton. Ambush bugs, big-eyed bugs, minute pirate bugs, green lacewings, two species of ladybird beetles, and several types of spiders are examples. They are of two types: 1) predators that prey upon an insect pest, or 2) parasites that live within the host insect. These insects, particularly the predators, reduce the number of eggs and larvae of bollworms, caterpillars and aphids. Because these allies lessen the impact of pest insects, common sense dictates that producers use them as a management tool. Their presence often means that growers can delay and, on occasion, eliminate some insecticide applications. While many people would hesitate to call fire ants beneficial, they are excellent predators of caterpillars and bollworm eggs.

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Many complex factors are involved in determining just how many of each beneficial insect species are needed to influence a given level of pests. Therefore, it is usually not possible to assess the value of these insects except in a very general way. If relatively high numbers of beneficial insects are eating a large portion of aphids or bollworm eggs and larvae, the treatment threshold will be reached later than would otherwise be the case, reducing the number of insecticide applications needed. However, the rapid increase in pest populations, the third generation of bollworms, will often overwhelm the beneficial population and applications become necessary. The careful observation of sound economic thresholds offers the producer the best odds of balancing beneficial insect numbers against damaging insects.

Introduction to Weeds and Weed Management

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Proper weed management is critical to maintain crop yield potential, harvestability, economic return. A full discussion on weed management, including classification, management techniques, herbicides, and herbicide-resistance is in the Virginia Cooperative Extension Agronomy Handbook.

Table 5.1 - Selected Glyphosate (Group 9) Products and Premixes for Agronomic Use

Currently, numerous products contain glyphosate. Most of them are labeled for “burndown”/preemergence and/or spot applications. The majority, but not necessarily all, of the products below are labeled for over-the-top application in Roundup Ready crops (namely, RR corn and RR soybean). Refer to the product label for additional information on crop use, formulation, application rates, and other use restrictions. Other glyphosate-containing products may be available in your area. Contact your local dealer for more details.

Product and Amount of Glyphosate/Gallon ¹	Company	Product Rate (fl oz) Equivalent to:				Formulation	
		0.375 lb ae	0.56 lb ae	0.75 lb ae	1.13 lb ae	Salt ²	Adjuvant Load ³
5 lb ae/6 lb ai							
Refuge	Syngenta	10	14	19	29	Potassium	none
Roundup Powermax 3	Bayer CropScience	10	14	19	29	Potassium	fully loaded
4.5 lb ae/5.5 lb ai							
Abundit Edge	Corteva	11	16	22	32	Potassium	fully loaded
Bullzeye HL-K	Growmark	11	16	22	32	Potassium	fully loaded
Credit K6	Nufarm	11	16	22	32	Potassium	fully loaded
Credit Xtreme	Nufarm	11	16	22	32	IPA + Potassium	fully loaded
Duplicator 6 (5.4 ai)	Drexel	11	16	22	32	diammonium	partial
Gly Star K-Plus	Albaugh/AgriStar	11	16	22	32	Potassium	partial
Honcho K6	Bayer CropScience	11	16	22	32	Potassium	fully loaded
Mad Dog K6	Loveland	11	16	22	32	Potassium	fully loaded
Roundup PowerMax	Bayer CropScience	11	16	22	32	Potassium	fully loaded
Roundup WeatherMax	Bayer CropScience	11	16	22	32	Potassium	fully loaded

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Table 5.1 - Selected Glyphosate (Group 9) Products and Premixes for Agronomic Use (cont.)

Product and Amount of Glyphosate/Gallon ¹	Company	Product Rate (fl oz) Equivalent to:				Formulation	
		0.375 lb ae	0.56 lb ae	0.75 lb ae	1.13 lb ae	Salt ²	Adjuvant Load ³
4 lb ae/5 lb ai							
Accord XRT II	Corteva	12	18	24	36	DMA	fully loaded
Buccaneer 5	Tenkoz	12	18	24	36	IPA	partial
Buccaneer 5 Extra (5.4 ai)	Tenkoz	12	18	24	36	IPA	partial
Cornerstone 5 Plus	WinField	12	18	24	36	IPA	partial
Credit 5.4 Extra	Nurfarm	12	18	24	36	IPA	fully loaded
Durango DMA/Duramax	Corteva	12	18	24	36	DMA	fully loaded
Gly Star 5 Extra	Albaugh/AgriStar	12	18	24	36	IPA	partial
Helosate 5	Helm Agro	12	18	24	36	IPA	partial
Mad Dog 5.4	Loveland	12	18	24	36	IPA	partial
Tomahawk 5 (5.4 ai)	WinField	12	18	24	36	potassium	partial
Sunphosate 5 Max	Wynca	12	18	24	36	IPA	partial
3 lb ae/4 lb ai							
Buccaneer	Tenkoz	16	24	32	48	IPA	partial
Buccaneer Plus	Tenkoz	16	24	32	48	IPA	partial
Cornerstone Plus	WinField	16	24	32	48	IPA	partial
Credit 41 Extra	Nufarm	16	24	32	48	IPA	fully loaded
Envy	Innvictis	16	24	32	48	IPA	partial
Envy Intense	Innvictis	16	24	32	48	IPA	partial
Four Power Plus	Loveland	16	24	32	48	IPA	fully loaded
Gly Star Original	Albaugh/AgriStar	16	24	32	48	IPA	partial
Gly Star Plus	Albaugh/AgriStar	16	24	32	48	IPA	partial
Glyphogan	Adama	16	24	32	48	IPA	partial
Glyphogan Plus	Adama	16	24	32	48	IPA	fully loaded
Helosate Plus Advanced	Helm Agro	16	24	32	48	IPA	fully loaded
Hoss Ultra	Helena	16	24	32	48	IPA	fully loaded
Imitator DA	Drexel	16	24	32	48	diammonium	
Imitator Plus	Drexel	16	24	32	48	IPA	partial
Mad Dog	Loveland	16	24	32	48	IPA	partial
Mad Dog Plus	Loveland	16	24	32	48	IPA	fully loaded
Makaze	Loveland	16	24	32	48	IPA	fully loaded
Rascal	WinField	16	24	32	48	IPA	partial
Razor	Nufarm	16	24	32	48	IPA	partial
Showdown	Helena	16	24	32	48	IPA + monoammonium	partial
Sunphosate 41%	Wynca USA	16	24	32	48	IPA	fully loaded

Table 5.1 - Selected Glyphosate (Group 9) Products and Premixes for Agronomic Use (cont.)

Product and Amount of Glyphosate/Gallon ¹	Company	Product Rate (fl oz) Equivalent to:				Formulation	
		0.375 lb ae	0.56 lb ae	0.75 lb ae	1.13 lb ae	Salt ²	Adjuvant Load ³
Tomahawk 4	Winfield	16	24	32	48	IPA	partial

¹ Glyphosate products can be formulated to have different concentrations of glyphosate acid per gallon of product. To improve handling, performance, and concentration, the glyphosate acid is formulated as a salt compound. Acid equivalent (ae) is only the weight of the glyphosate acid, which is herbicidally active. Active ingredient (ai) is the weight of the glyphosate acid plus the salt. It is best to refer to ae when comparing glyphosate products and rates.

² Glyphosate can be formulated as different salts: isopropylamine (IPA), monoammonium, diammonium, dimethylamine (DMA), or potassium.

³ Some glyphosate products contain all the necessary adjuvants (i.e., fully loaded). Others contain only a limited amount and additional surfactants must be added to the tank before application. All brands of glyphosate recommend adding ammonium sulfate (AMS), if using hard water as a carrier or under other challenging conditions. If using AMS, always add it to the spray solution before glyphosate. Refer to product label for more information.

Table 5.2 - Common Herbicide Safeners Used as Commercial Products

Safener	Approximate date of introduction	Herbicide(s)	Crop	Other
1,8-naphthalic anhydride (NA)	1971	EPTC and butylate	Corn	Seed treatment
benoxacor	1985	metolachlor	Corn	Premixed with herbicide
cloquintocet-methyl	2006	pinoxaden	Wheat, cereals	Premixed with herbicide
cyposulfamide	2009	numerous (Groups 4 and 27)	Corn	Premixed with herbicide
dichlormid	1972	EPTC, butylate, acetochlor	Corn	Premixed with herbicide
fenchlorazole-ethyl	1992	fenoxaprop	Wheat, cereals	Premixed with herbicide
fluxofenim	1986	alachlor, metolachlor	Sorghum	Seed treatment
furilazole	1991	acetochlor	Corn	Premixed with herbicide
isoxadifen	2001	numerous (Groups 2 and 4)	Corn	Premixed with herbicide
mefenpyr-diethyl	1989	pyrosulfotole	Wheat	Premixed with herbicide

Table 5.3 - Selected Generic (or Post-Patent) Alternative Herbicides for Agronomic Uses

Active ingredient(s)	Trade name	Manufacturer	Labeled crops*	Alternative to:
acetochlor	Arrest	Sharda	Corn	Harness
	Arrest Plus			
	Asset-S Plus			
	Essensa			
atrazine	Atrazine 4L	Sipcam	Corn, sorghum	Aatrex
	Atrazine 90 DF	Winfield		
bentazon	Bashazon	Sharda	Corn, sorghum, soybean	Basagran
	Broadlook	UPL		

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Table 5.3 - Selected Generic (or Post-Patent) Alternative Herbicides for Agronomic Uses (cont.)

Active ingredient(s)	Trade name	Manufacturer	Labeled crops*	Alternative to:		
acetochlor + atrazine	Acellus	Growmark	Corn	Harness Xtra, Degree Xtra, Keystone (NXT)		
	ATZ*/Xcelerate ATZ 5.6L					
	Cadence ATZ* NXT	Loveland				
	Confidence Xtra*	WinField Solution				
	Electra*	Sharda				
	Etcetra					
	Fearless Xtra*	Helm Agro				
	Overtime ATZ* NXT	Helena				
acetochlor + fomesafen	Tremor ATZ*	WinField				
	Volley ATZ* (NXT)	Tenkoz				
	Forrest	Sharda	Soybean			
	acetochlor + mesotrione	Recite	Sharda	Corn		
		acetochlor + flumetsulam + clopyralid	Definite	Sharda	Corn	SureStart, SureStart II, Tripleflex
			Smackdown	Loveland		
			Staunch II	Tenkoz		
	Threesidual/Trisidual		WinField			
acifluorfen	True Set II	Atticus				
	Acifin 2L	SummitAgro	Soybean	Ultra Blazer		
	Avalanche Ultra	WinField				
	Derecho	Atticus				
	Levity	Innvictis				
	Sharda Acifluorfen	Sharda				
bromoxynil	Uproar	WinField				
	Deadbolt	Willbur-Ellis	Corn, sorghum, small grains			
carfentrazone-ethyl	Maestro 2EC, 4EC	Nufarm				
	Longbow	Nufarm	Corn, soybean, cotton, sorghum, small grains	Aim		
Antik	Atticus					
chlorimuron	Curio	NuFarm	Soybean	Classic		
	Sheridan 25 WG	Helm Agro				
chlorimuron + metribuzin	Cloak	NuFarm	Soybean	Canopy*		
	Metrixx Plus	Sharda				
	Resist	Tenkoz				
chlorimuron + metribuzin	Cloak	Nufarm	Soybean	Canopy*		
	Metrixx Plus	Sharda				
	Resist	Tenkoz				

Table 5.3 - Selected Generic (or Post-Patent) Alternative Herbicides for Agronomic Uses (cont.)

Active ingredient(s)	Trade name	Manufacturer	Labeled crops*	Alternative to:
chlorimuron + tribenuron	Cloak EX	NuFarm	Soybean	Canopy EX
	FallOut	Corteva		
clethodim	Arrow 2EC	Adama	Soybean, alfalfa	Select, Select Max, Prism
	Avatar*	Innvictis		
	Ceridan 2 EC	Atticus		
	Clense*/Section*	WinField		
	Dakota	Rotam North Amer.		
	Envoy Plus	Valent		
	Intensity	Loveland		
	Shadow*/Trizenta*	UPL		
	TapOut	Helena		
	Vaquero	Willbur-Ellis		
clopyralid	Bite	Sharda	Corn, pasture, small grains	Stinger
	Clean Slate	Nufarm		
	Savant	Innvictis		
	Sonora	Alligare		
	Spur	Albaugh/Agri-Star		
	Stigmata	Atticus		
clopyralid + flumetsulam	Jacket	Sharda	Corn	
cloransulam	Ankur	Sharda	Soybean	FirstRate
	FrontRunner	Atticus		
	Traject 4 dimeSC	SummitAgro		
	Willowood Cloran DF	Generic Crop Science		
carfentrazone-ethyl	Longbow	Nufarm	Corn, Soybean, Cotton, Sorghum, small grains	Aim
	Antik	Atticus		
dicamba	Topeka	Rotam	Corn, small grains, sorghum	Clarity
	Detonate	Tenkoz		
	Clarifier	Winfield		
	Clash	Nufarm		
	Sterling Blue	Winfield		
dimethenamid + atrazine	Commit ATZ*	WinField	Corn, sorghum	Guardman Max
	Sortie ATZ*	Helena		

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Table 5.3 - Selected Generic (or Post-Patent) Alternative Herbicides for Agronomic Uses (cont.)

Active ingredient(s)	Trade name	Manufacturer	Labeled crops*	Alternative to:
flumioxazin	Flumigard	Alligare	Soybean (or alfalfa, depending on label)	Valor*, Chateau
	Outflank	Adama		
	Panther*/Tuscany*	NuFarm		
	Varsity*	Innvictis		
	Zaltus SX	Atticus		
fluroxypyr	Comet	NuFarm	Corn, small grains, pastures	Starane
	Fancy/Flurox	Sharda		
	Flagstaff	Alligare		
	Stark Ultra	Atticus		
	Stave	Invictis		
fomesafen	Agent 1.88	WinField	Soybean	Reflex, Flexstar
	Andros*	Rotam North Amer.		
	Battle Star	Albaugh/Agri-Star		
	Foma*	Drexel		
	Forsyte 1.88 SL	Atticus		
	Rumble	Adama		
	Shafen/Shafen Star	Sharda		
	Sinister	Helena		
	TopGun/Top Gun Flex	Loveland		
Vamos	Invictis			
fomesafen + imazethapyr	Camo	Albaugh	Soybean	—
	Torment	Adama		
fomesafen + S-metolachlor	MetalliS PFX	Atticus	Soybean	Prefix
	Sharp	Sharda		
	Quake	Tenkoz		

Table 5.3 - Selected Generic (or Post-Patent) Alternative Herbicides for Agronomic Uses (cont.)

Active ingredient(s)	Trade name	Manufacturer	Labeled crops*	Alternative to:
glufosinate	Autonomy	Tenkoz	LibertyLink	Liberty
	Cheetah*	NuFarm	Corn, soybean, others	
	Fever	Innvictis		
	Forfeit 280	Loveland		
	Inflame 280	Atticus		
	Interline	UPL		
	Lifeline	UPL		
	Opportunity	Sharda		
	Para Shot	Sharda		
	Reckon 280 SL	Solera		
	Refer	SummitAgro		
	Scout	Valent		
	Surmise	Albaugh/Agri Star		
	Total*	WinField		
halosulfuron	Halomax 75	Aceto	Corn, sorghum	Permit, Sandea
	Herbivore	WinField		
	Profine 75	Aceto		
	Promote/Stadia	Atticus		
	Proventix 75 WDG	Innvictis		
imazethapyr	Imazethapyr 2 SL	ADAMA	Soybean, alfalfa	Pursuit
	Pemex	Atticus		
	Praxis	Sharda		
	Thunder	Albaugh/Agri-Star		
imazethapyr + glyphosate	Extreme	Helm Agro	Soybean	Extreme
	Praxis Plus	Sharda		
	ThunderMaster	Albaugh/Agri-Star		
lactofen	Boa	Sharda	Soybean	Cobra
	Phoeniz	UPL		

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Table 5.3 - Selected Generic (or Post-Patent) Alternative Herbicides for Agronomic Uses (cont.)

Active ingredient(s)	Trade name	Manufacturer	Labeled crops*	Alternative to:
mesotrione	Argos	Helm Agro	Corn, sorghum	Callisto
	Bellum	Rotam		
	Bridle/Incinerate	WinField		
	Cavallo 4 SC	Atticus		
	Incinerate	WinField		
	MesoStar	Sharda		
	Mesotrione	Albaugh/AgriStar		
	MesoTryOne	Drexel		
	Motif	UPL		
	Quartz	Sicam		
	Sotrion	Growmark		
	Undercover	Innvictis		
mesotrione + acetochlor	Optero	Rotam	Corn, sorghum	
mesotrione + metolachlor	Evinco	Rotam	Corn, sorghum	
	Stalwart 2W	Sipcam		
	Coyote	UPL		
mesotrione + metolachlor + atrazine	Ravine	Altitude Crop Innov.	Corn, sorghum	
	Rixa/Vilify	Rotam		
	Stalwart 3W	Sipcam Agro		
	TrizMax	Drexel		
	TriZar	Drexel		
mesotrione + S-metolachlor + atrazine	Entrax EZ	Growmark	Corn, sorghum	Lexar, Lumax
	Omni Xar	Helena		
mesotrione + metolachlor + glyphosate	Me-O-Sate	Drexel	Corn	
mesotrione + rimsulfuron	Equip	Rotam	Corn	
metolachlor	Helmet	Helm Agro	Corn, soybean, sorghum	
	Metalica	Sharda		
	Me-Too-Lachlor*	Drexel		
	Meto Star	Sharda		
	Parallel*	ADAMA		
	Stalwart*	Sipcam		
	Visor*	Innvictis		

Table 5.3 - Selected Generic (or Post-Patent) Alternative Herbicides for Agronomic Uses (cont.)

Active ingredient(s)	Trade name	Manufacturer	Labeled crops*	Alternative to:
metolachlor + atrazine	Parallel Plus	ADAMA	Corn, sorghum	
	Payback ATZ	Real Farm		
	Stalwart Xtra*	Sipcam		
	Triangle	Tenkoz		
	Trizmet II	Drexel		
	Visor ATZ	Innvictis		
metolachlor + imazethapyr	Pummel	ADAMA	Soybean	—
metolachlor + metribuzin	Galvan	Innvictis	Soybean	Boundary
	Headwin	Sharda		
	Ledger	Tenkoz		
	Me-Too-Lachlor	MTZ		
	Stalwart MTZ	Sipcam		
	Tailwind	ADAMA		
metribuzin	Derive 75*	Innvictis	Soybean, corn, alfalfa	formerly Sencor
	Dimetric*	WinField		
	Glory	ADAMA		
	Mauler	Valent		
	Metribuzin 75*	Loveland		
	Metriclude*	Winfield		
	Metricor*	UPL		
	Metrixx*	Sharda		
	Me-Try-Buzin*	Drexel		
	Omni Metribuzin	Helena		
	Rancor*	Atticus		
metsulfuron-methyl	Ally XP	FMC	Pasture	Cimarron* (DuPont no longer sells the single ai product for pastures)
	Clean Pasture DF	Control Solutions		
	MSM 60	Alligare		
	Patriot	NuFarm		
	Plotter/Romestol	Rotam North Amer.		
	Rometsol	Rotam		
	Tide MSM 60	Tide Int.		
nicosulfuron	Primero*	Rotam North Amer.	Corn	Accent Q

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Table 5.3 - Selected Generic (or Post-Patent) Alternative Herbicides for Agronomic Uses (cont.)

Active ingredient(s)	Trade name	Manufacturer	Labeled crops*	Alternative to:
paraquat	Bonedry	Sinon	All	Gramoxone
	Devour	Innvictis		
	Helmquat	Helm		
	Para-Shot 3.0	Sharda		
	Paraquat	Axill Solutions/RedEagle		
	Paraquat 3SL	Willowood		
	Paraquat concentrate	Solera Source Dynamics		
	Parazone 3 SL	ADAMA/AMVAC		
	Purgatory 3 SL	Atticus		
	Quik-Quat	Drexel		
pendimethalin	Acumen	Tenkoz	Corn, soybean	Prowl 3.3EC, (Prowl H ₂ O)
	AquaPen 3.8/ Pin-dee 3.3 EC	Drexel		
	Framework	WindField		
	Pavilion	Innvictis		
	Satellite*	UPL		
	Stealth	Loveland		
quinclorac	Prize	Sharda	Pasture	Paramount/Facet
	Quinstar 4L	Albaugh/Agri-Star		
rimsulfuron	Grapple	NuFarn	Corn	Resolve, Matrix
	Hinge/Inflict	Rotam North Amer.		
	Pruvin	ADAMA		
	Tetris SG	Atticus		
rimsulfuron + nicosulfuron	Sparrow	Rotam	Corn	
rimsulfuron + thifensulfuron	Stringent	Rotam	Corn	
S-metolachlor	Brawl*/Charger*	Tenkoz	Corn, soybean, sorghum	Dual Magnum
	Charger Max	Winfield		Dual II Magnum
	Everprex	Corteva		
	Moccasin	UPL		
	StreliuS II	Atticus		
	Visor S-MOC*	Innvictis		
S-metolachlor + atrazine	Brawl II ATZ	Tenkoz	Corn, sorghum	Bicep II Magnum
	Charger MAX ATZ*	WinField		
	Visor S-MOC ATZ	Innvictis		

Table 5.3 - Selected Generic (or Post-Patent) Alternative Herbicides for Agronomic Uses (cont.)

Active ingredient(s)	Trade name	Manufacturer	Labeled crops*	Alternative to:
S-metolachlor + metribuzin	Ledger	Tenkoz	Soybean	Boundary
	MetalliS MTZ	Atticus		
	Moccasin MTZ	UPL		
	Presidual	WinField		
	Tyrant	Helena		
sulfentrazone	Antares*	Helena	Soybean	Authority 75DF, Spartan
	Aquesta	Atticus		
	Blanket 4F	Tenkoz		
	Boycott	UPL		
	Intensa	Sharda		
	Shutdown	UPL		
	Sulfin 4SC	SummitAgro		
	Surepyc	Amvac		
	Vandal 4SC	Innvictis		
Zone 4F	Helm Agro			
sulfentrazone + imazethapyr	Compensa	Sharda	Soybean	
thifensulfuron	Thief	Loveland	Corn, soybean, small grains	Harmony*
	Treaty	NuFarm		
	Volta	Rotam North Amer.		
thifensulfuron + rimsulfuron	Crusher	FMC	Field corn, cotton, peanut, soybeans	LeadOff
	Leopard	Nufarm		
	Stringent	Albaugh		
thifensulfuron + tribenuron	Audit*	UPL	Corn, soybean, small grains	Harmony Extra SG
	Civility Extra	Innvictis		
	Rapport*	NuFarm		
	Treaty Extra	NuFarm		
	Volta Extra	Rotam North Amer.		
tribenuron	Taqua	Rotam	Barley, oats, wheat	Express

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Table 5.3 - Selected Generic (or Post-Patent) Alternative Herbicides for Agronomic Uses (cont.)

Active ingredient(s)	Trade name	Manufacturer	Labeled crops*	Alternative to:
triclopyr	Boulder 6.3	Alligare	Pasture	Garlon*/Remedy Ultra
	Relegate	NuFarm		
	Triclopyr*	Albaugh/Agri-Star/Alligare		
	Tahoe 3A	NuFarm	Pasture and Noncrop	
triclopyr + 2,4-D	Candor	NuFarm	Pasture	Crossbow
	Chaser 2 Amine	Loveland		
	Crossroad	Albaugh/Agri-Star		
trifluralin	Trust	Winfield	Corn, soybean, wheat	Treflan

*Products contain multiple formulations.

Table 5.4 - Herbicide Rotational Restrictions for Cash Crops

The information listed in this rotation restriction table is our interpretation of label statements. Consult the label if two or more of these materials are applied during the same season. Herbicide labels are constantly changing; therefore, this list is not a substitute for the most recent herbicide label.

Trade Name	Rotational Crops (months after application) ¹																										
	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat	
2,4-D ¹	3	3	3	1	3	0.25-1	1	3	3	3	1	3	3	3	3	0.25-1 ¹	1	3	1	3	3	3	1	1	1	1	1
Accent/Accent Q	12 ¹	10 ²	12	10	10 ²	NR	10-18 ¹	10-18 ¹	10 ²	10 ²	10	10 ²	10	10 ²	10	0.5	8	10 ²	10	10 ²	10 ²	10 ²	10 ¹	4	4	4	4
Acuron	18	18	18	10	18	NR	10	18	18	10	18	18	18	18	18	10	4	18	NR	18	18	18	10	4	4	4	4
Acuron Flex ²³	10	18	18	10	18	NR	10	18	18	10	18	18	18	18	18	10	4	18	NR	18	18	18	10	4	4	4	4
Acuron GT	10 ¹	18	18	10	18	NR	10	18	18	10	18	18	18	18	18	10	4.5	18	NR	18	18	18	10	4.5	4.5	4.5	4.5
Afforia (2.5 oz)	4 ²⁴	4 ²⁴	4 ²⁴	1	4 ²⁴	0.5 ²⁴	1	4 ²⁴	4 ²⁴	1.5	3	4 ²⁴	4 ²⁵	4 ²⁵	3	NR ²⁴	4 ²⁴	4 ²⁴	3	1.5	4 ²⁴	4 ²⁴	4 ²⁴	3	3	3	1 ²⁴
Aim	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Antares Complete	12	18B	18B	12-18 ¹	18B	4-10 ¹	12-18 ¹	18B	18B	12	18B	18B	18B	18B	18B	18B	18B	18B	18B	18	4 ⁹	18B	12	4.5	18B	4.5	
Anthem Flex(5.46-7.27 oz)	10	18	18	4	18	NR	10 ⁵	11	18	4	4	NR	18	18	11	NR	11 ²⁵	18	NR	9	9	18	NR	11 ²⁵	11 ²⁵	4 ²⁵	4 ²⁵
Anthem Maxx (4.87 oz)	10	18	18	4	18	NR	10 ⁵	11	18	4	4	1	18	18	11	NR	11 ²⁵	18	NR	9	9	18	1	11 ²⁵	11 ²⁵	4 ²⁵	4 ²⁵
Armezon/Impact (0.75 oz)	9	18	18	9	18	NR	9	9	18	18	9	9	18	18	9	9	3	18	NR	18	18	18	9	3	3	3	3
Armezon PRO (16-20 fl oz/A)	9	18	18	9	18	NR	9	18 ³	18	18	9	9 ³	18	18	9 ³	9	4	18	NR	18	18	18	9	4	4	4	4
Assure II	4	4	4	NR	4	4	4	4	4	4	4	NR	4	4	NR	NR	4	4	4	4	4	4	4	4	4	4	4
Atrazine	SY	SY	SY	SY	SY	NR	NR	SY	SY	NY	SY	SY	SY	SY	SY	NY	SY	SY	NR	SY	SY	SY	SY	SY	NY	NY	NY
Authority Edge (8.9 -15 oz)	12	18 ⁹	18	12 ¹	18	4	10-18 ¹	9	18	4	4	9	18	18	9	NR ¹	12-18 ¹	18	12	18	18	18	4	11-18 ¹	11-18 ¹	4-10 ¹	4-10 ¹
Authority Elite/Broadaxe XC	12	2 ⁹	12B	12-18 ⁴	12B	4	10	12B	12B	4	8	12B	12B	12B	12B	NR	12	12B	12	10	4	12B	4	4.5	4.5	4.5	4.5
Authority First/Sonic	12	30B	30B	12-18 ¹	30B	10-18 ¹	12	12	30B	12	9	30B	30B	30B	12	NR	12	30B	10-18 ¹	30 ¹	30B	18	18	12	12	4	
Authority MTZ	12	18	18	18 ⁴	18	10	12-18 ¹	18	18	12	18	18	18	18	18	NR	18	18	18	12	NR ⁹	18	12	4	4	4	

Table 5.4 - Herbicide Rotational Restrictions for Cash Crops (cont.)

The information listed in this rotation restriction table is our interpretation of label statements. Consult the label if two or more of these materials are applied during the same season. Herbicide labels are constantly changing; therefore, this list is not a substitute for the most recent herbicide label.

		Rotational Crops (months after application) ¹																								
Trade Name	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
Authority Supreme	12	18 ⁹	18	12-18 ¹	18	4	10 ¹	9	18	18	4	9	18	18	9	NR ¹	12 ¹	18	10	18	18	18	4	11 ¹	11 ¹	4 ¹
Authority XL	12-18 ¹	18	18	18	18	10-18 ¹	10-18 ¹	36	36	36	18	36	36	18	36	NR	12-18 ¹	36	18	10-18 ¹	12-18 ^{1,9}	10 ¹	36	4	4	4
Autumn Super ¹	18B	18B	18B	10	18B	1	18B	18B	18B	18B	18B	18B	18B	18B	18B	2	18B	18B	9	18B	18B	18B	18B	9	18B	3
Axial Bold	3	1	3	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	1	NR	3	NR
Axial Star	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	NR	4	NR
Axial XL	3	1	3	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	1	NR	3	NR
Axiom	12	12B	12	8	12B	NR	12	12B	12B	18	12B	12B	12B	12B	12B	NR	12	12B	12B	12B	12B	12B	1	12	12	0.23-4
Balance Flexx ¹	10 ¹	18	18	10 ¹	18	NR	6	18	18	18	11	18	18	18	18	6	18	18	6	12	18	18	6	6	4	4
Basagran	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Basis	10	18	10	1 ⁶	10	NR	10 ⁶	18	18	18	18	10	18	18	10	10 ⁶	9	18	10	18	1	18	NR	3	3	3
Basis Blend ⁶	10 ⁶	18	10 ⁶	1 ⁶	10	NR	10 ⁶	18	18	18	1.5	10	18	18	10	10 ⁶	9	18	10	1.5	1	18	1	3	3	3
Beyond/																										
Beyond Extra	3	9	18	9	9	8.5 ⁸	9	NR	9	9	9	NR	9	9	NR	NR	9	9	8.5	9	9	9	9	9	4	3 ⁸
Bicep products	SY	SY	SY	NY	SY	NR	NR ¹⁰	SY	SY	SY	NY	SY	SY	SY	SY	NY	SY	SY	NY	SY	SY	SY	SY	SY	NY	NY
Boundary	4.5	12	12	12	12	4	12	12	12	18	12	8	12	12	12	12	12	12	4	12	12	12	12	NR	4.5	12
Buciril/Maestro	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cadet	AH	AH	AH	AH	AH	NR	AH	AH	AH	AH	AH	AH	AH	AH	AH	NR	AH	AH	AH	AH	NR	AH	AH	AH	AH	AH
Caibra	10	18	18	10	18	NR	NR	18	18	18	10	18	18	18	18	10	18	18	18	10	18	18	10	4.5	4.5	
Callisto	10	18	18	10	18	NR	NR	18	18	18	10	10 ¹	18	18	10 ¹	10	NR	18	18	10	18	18	10	4	4	
Callisto Xtra	10	18	18	10	18	NR	NR	18	18	18	10	10 ¹	18	18	10 ¹	10	NR	18	18	10	18	18	10	4	4	
Canopy ¹	10	18	12	10	18	10	12	30	30	30	18	12	30	18	12	NR	30	30	18	10 ¹⁰	10 ¹⁰	18	30	4	4	
Canopy Blend	10	18	18	18	18	10 ²⁶	18	30	30	30	18	12	30	18	18	NR	4	30	18	18 ⁹	10 ⁹	18	30	4	4	
Canopy EX	10	18	12	10	18	10 ¹	10 ¹	30	30	18 ¹	8	12	30	18	12	0.25 ¹	4	30	18	10 ⁹	10 ⁹	18	18 ¹	4	4	
Caparol	12	5	12	5 ¹	12	5	12	12	12	8	12	5	12	12	12	12	12	12	5	12	12	12	12	12	12	12
Capreno ¹	10-18	18	18	10	18	NR	10	18	18	18	11	18	18	18	18	10	10	18	10	12	18	18	18	10	18	4
Chaparral	SYB	SYB	SYB	SYB	SYB	NY	NY	SYB	SYB	SYB	SYB	SYB	SYB	SYB	SYB	NY	NY	SYB	SYB	SYB	SYB	SYB	SYB	NY	NY	NY
Chateau (up to 3 oz) ¹¹	5 ¹¹	12B	5 ¹¹	2 ¹¹	12B	0.5-1	1 ¹	12B	12B	12B	NR	4	12B	12B	4	NR	5 ¹¹	12B	4	2	12B	12B	5 ¹¹	4	4	2

Table 5.4 - Herbicide Rotational Restrictions for Cash Crops (cont.)

The information listed in this rotation restriction table is our interpretation of label statements. Consult the label if two or more of these materials are applied during the same season. Herbicide labels are constantly changing; therefore, this list is not a substitute for the most recent herbicide label.

Trade Name	Rotational Crops (months after application) ¹																													
	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat				
Cimarron Max/metsulfuron ¹	12 ¹	NYB	12 ¹	NYB	NYB	NYB	NYB	NYB	NYB	NYB	NYB	NYB	NYB	NYB	NYB	NYB	10	NYB	NYB	NYB	NYB	NYB	NYB	NYB	10	NYB	10	NYB	1	
Cimarron Plus	4	B	4-12 ¹	B	B	12 ¹	B	B	B	B	B	B	B	B	B	12 ¹	10	B	B	B	B	B	B	B	10	NY	10	NY	1	
Clarity	4	4	4	0.75-1.5 ⁵	4	NR	NR	4	4	4	4	4	4	4	4	0.5-1.5 ⁵	4	4	4	4	4	4	4	4	0.5-1.5 ⁵	0.5-1.5 ⁵	0.5-1.5 ⁵	0.5-1.5 ⁵	1.5 ⁵	
Classic ¹	12	18	12	9	18	9	9	30	30	15	9	30	30	18	9	NR	3	30	18	9 ⁹	9 ⁹	NR	NR	NR	NR	NR	NR	NR	3	
Cobra	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Command/Up-stage	12	9	12	NR ¹²	9	9	9	12	9	9	NR ¹	NR	NR	NR ¹	9	NR	12	NR ¹	9	NR	9 ⁹	9	9	12	12	12	12	12	12	
Convus	17	17B	17B	10	17B	NR	17B ¹	17B	17B	11 ¹	17B	17B	17B	17B	17	9	17	17B	9	12 ¹	17B	17B	17B	17	9	4	4	4	4	
Crossbow ²⁰	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	
Curbit	AH	AH	AH	AH	NR	AH	AH	AH	NR	NR	AH	AH	AH	NR	AH	NR	AH	NR	AH	AH	AH	AH	NR	AH	AH	AH	AH	AH	AH	
Curtail	10.5-18 ¹	10.5B	10.5B	10.5B	1	18 ¹	10.5B	B	18 ¹	10.5B	18	10.5B	B	10.5B	18 ¹	1	B	18 ¹	10.5B	10.5B	10.5B	10.5B	18	1	10.5B	1	10.5B	1	1	
Degree Xtra	SY	SY	SY	NY	SY	NR	NR ¹⁰	SY	SY	SY	SY	SY	SY	SY	SY	NY	SY	SY	NR	NY	SY	SY	SY	SY	SY	SY	SY	SY	SY	AH
Devrinol	12	NR	12	12	12	12	12	12	12	12	12	12	NR	12	12	12	6	12	12	12	NR	NR	12	12	6	6	6	6	6	
DiFlexx	4	4	4	2	4	NR	2	4	4	4	4	4	4	4	4	2 ¹	2	4	4	4	4	4	4	4	2	4	4	4	2	
DiFlexx Duo	10	18B	18B	10	18	NR	10	18B	18	18 ²⁷	11	10	18B	18	10	8	4	18	4	12	10	18	10	4	4	4	4	4	4	
Distinct ¹	1	4	4	1	4	0.25	1	4	4	4	4	4	4	4	4	1	1	4	4	4	4	4	4	4	1	1	1	1	1	
Dual products	4	2 ¹	9	NR	12	NR	NR ¹⁰	NR	12	2 ¹	NR	NR	2	2 ¹	NR	NR	4.5	12	NR	NY	2 ¹	12	NR	4.5	4.5	4.5	4.5	4.5	4.5	
DuraCor	24B	24B	24B	24B	24B	12	24B	24B	24B	24B	24B	24B	24B	24B	24B	24B	12	24B	12	24B	24B	24B	24B	24B	24B	12	12	12	12	12
Elevore	9	15B	9	1	15B	0.5	15B	15B	15B	9	9	15B	15B	15B	15B	0.5	15B	15B	15B	15B	15B	15B	15B	24B	0.5	0.5	0.5	0.5	0.5	
Erlist Duo	NI	NS	NS	132	NS	0.532	NS	NS	NS	NS	NS	NS	NS	NS	NS	132	NS	NS	0.5	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
Enversa ¹	9	NY	NY	NR	NY	NR	NR	NY	NY	NR	NY	NY	NY	NY	NY	NR	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	NY	4
Envive	10	18	12	10	18	10	12	30	30	8	12	30	18	12	12	NR	10	30	18	10 ⁹	12 ⁹	18	30	4	4	4	4	4	4	4
Eptam	NR	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	NR	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	NR	AH	AH	AH	AH
Evik	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	3	11	11	11	11	11	11	10	3	3	3	3	3	
Expert	SY	SY	SY	NY	SY	NR	NR ¹⁰	SY	SY	SY	NY	SY	SY	SY	SY	NY	SY	SY	NY	SY	SY	SY	SY	SY	NY	NY	NY	NY	NY	

Table 5.4 - Herbicide Rotational Restrictions for Cash Crops (cont.)

The information listed in this rotation restriction table is our interpretation of label statements. Consult the label if two or more of these materials are applied during the same season. Herbicide labels are constantly changing; therefore, this list is not a substitute for the most recent herbicide label.

Trade Name	Rotational Crops (months after application) ¹																											
	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat		
Extreme	4	18	4	18	18	8.5 ⁹	18	NR	18	40B	NR	NR	40B	40B	2	NR	18	40B	18	9.5	40B	18	26	4	4	3		
Facet L	24B	10	24B	10	10	10	NR	10	10	10	10	24B	24B	10	10	10	10	10	10	24B	24B	10	24B	10	10	NR		
Fierce/ Fierce EZ	10	18	18	1-2'	18	0.25-1'	18	11	18	18	4	11	18	18	11	NR	12'	11-	18	12	18	4	4	12'	11-	11-12'	1-2'	
Fierce XLT ¹	18	18-30	18	18-30	18-30	10-18	18	18-30	18-30	18-30	18-30	18-30	18-30	18-30	18-30	NR	18-30	18-	18-30	18 ⁹	18 ⁹	18-30	18-	18	18	18	4	
Finesse	B	B	B	18	B	18	4-18'	B	B	B	B	B	B	B	B	18 ¹⁴	10	B	B	B	B	B	10	10-16'	0-4'	0-4'		
Cereal & Fallow (0.4 oz)																												
FirstRate	9	18	18	9	18	9	9	9	18	18	9	9	18	18	9	NR	9	18	18	18 ¹⁵	18	18	18	12	18	4		
Flexstar/ Flexstar GT	18	18	18	NR	12	10	18	4	12	18	4	4	10 ⁹	10	NR	NR	18	12	10	18	10 ⁹	10	NR	4	4	4		
Fulltime/ Keystone	15	SY	SY	NY	SY	NR	NY	SY	SY	SY	NY	15	SY	SY	SY	NY	15	SY	NR	15	SY	SY	15	15	15	SY	4	
Fusilade/ Fusion	NR	NR	NR	NR	NR	2	2	NR	NR	NR	NR	NR	NR	NR	NR	NR	2	NR	2	NR	NR	NR	NR	NR	2	2	2	
Glyphosate products	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Goal/ GoalTender	2	3	2	0.25	3	10	10	1-2	2-3'	6'	2	2	3 ⁹	3	2	0.25	10	3	10	2	1 ⁹	2	2	10	10	10		
Gramoxone/ paraquat	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
GrazonNext HL	24B	24B	24B	24B	24B	12	24B	24B	24B	24B	24B	24B	24B	24B	24B	24B	12	24B	12	24B	24B	24B	24B	24B	12	12	12	
Grazon P+D	B	B	B	B	B	B	8	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	2	2	2	
Halex GT	10	18	18	10	18	NR	NR ¹⁰	18	18	18	10	10'	18	18	10'	10	4.5	18	NR	10	18	18	10	4.5	4.5	4.5		
Harmony Extra SG	1.5	1.5	1.5	0.75	1.5	0.75	0.75	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	NR	1.5	NR	
Harmony SG	1.5	1.5	1.5	0.25	1.5	NR	NR	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	NR	NR	1.5	1.5	1.5	1.5	1.5	1.5	NR	1.5	NR		
Harness	9	SY	SY	NY	SY	NR	NR ¹⁰	SY	SY	SY	NY	NY	SY	SY	SY	NY	NY	SY	NR	NY	SY	SY	NY	NY	NY	4		
Harness Xtra	SY	SY	SY	NY	SY	NR	NY	SY	SY	SY	NY	NY	SY	SY	SY	NY	NY	SY	NR	SY	SY	SY	SY	SY	SY	SY	NY	

Table 5.4 - Herbicide Rotational Restrictions for Cash Crops (cont.)

The information listed in this rotation restriction table is our interpretation of label statements. Consult the label if two or more of these materials are applied during the same season. Herbicide labels are constantly changing; therefore, this list is not a substitute for the most recent herbicide label.

Trade Name	Rotational Crops (months after application) ¹																										
	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat	
Hornet WDG	10.5 ¹	26B	26B	18	26B	1B	12	10.5 ¹	26B	26B	18	18 ¹⁶	26B	26B	18 ¹⁶	10.5	4	26B	18 ¹⁶	18	26B	26B	18	4	4	4	4
Huskie	4 ¹	1B	1B	10	1B	4	0.25	1B	1B	9 ¹	1B	9	1B	1B	9	4	1	1B	1B	1B	1B	1B	18	4	4	4	0.25
Impact Core	9	18	18	10	18	NR	9	18	18	18	10	18	18	18	18	10	9	18	NR	18	18	18	10	9	9	4	4
Instigate	18	18	18	10	18	NR	10	18	18	18	10	10 ¹	18	18	10 ¹	10	9	18	10	10	10	18	10	4	4	4	4
Karmex	24	24	24	NR	24	NY	NY	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	4
Kerb ¹	NR	3-6	NR	3-5	3-6	12	12	3	3-6	3-6	12	3-4	3-6	3-6	3-4	3-4	12	3-6	12	12	3-6	3-6	3	12	12	12	12
Keystone NXT	SY	18	SY	NY	18	NR	NY	SY	18	18	SY	SY	18	18	18	NY	SY	18	NR	NR	SY	18	SY	15	15	15	15
Kyro	10.5	18	18	12	18	NR	10.5	18	18	18	18	18	18	18	18	10.5	10.5	18	NR	18	18	18	18	10.5	10.5	4	4
Laudis	10	18	18	10	18	NR	10	18	18	8 ¹	11	10	18	18	10	8	4	18	NR	12	10	18	10	4	4	4	4
Leadoff (1.5 oz)	10	18	10 ¹	1	10	NR	10	18	18	18	1.5	10	18	18	10	1 ¹	9	18	10	1.5	1	18	1	3	3	3	3
Lexar/Lexar EZ	18	18	18	NY	18	NR	NR ¹⁰	18	18	18	NY	18	18	18	18	NY	NY	18	NR	18	18	18	18	18	NY	NY	NY
Liberty	6	2.3	6	NR	6	NR	6	6	6	2.3	6	6	6	6	6	NR	2.3	6	NR	6	6	6	2.3	2.3	2.3	2.3	2.3
Lorox/Linex	4	4	4	4	4	NR ¹	NR ¹	4	4	4	4	4	4	4	4	NR ¹	4	4	4	4	4	4	NR	12	4	4	4
Lumax/Lumax EZ	18	18	18	NY	18	NR	NR ¹⁰	18	18	18	NY	18	18	18	18	NY	NY	18	NR	18	18	18	18	4.5	4.5	4.5	
Marvel	18	18	18	NR	18	10	18	18	18	18	10	10	4 ⁹	18	NR	NR	4	18	18	18	4 ⁹	18	NR	4	4	4	
Matrix	4	12	18	10	10	NR	18	10	18	10	18	8	12	12	10	4	9	18	10	18	NR	12	NR	12	12	4	
Maverick	18	18	18	18	18	NR	18	18	18	18	18	18	18	18	18	10.5	18	18	NR	18	18	18	18	18	18	18	4-6
Metribuzin products	4	18	18	18	18	4	18	18	18	18	8	8	18	18	18	4	18	18	4	18	4	18	12	4 ¹	18	4 ¹	
Milestone	24B	24B	24B	24B	24B	12	24B	24B	24B	24B	24B	24B	24B	24B	24B	24B	12	24B	24B	24B	24B	24B	24B	24B	12	12	12
Optill ¹	4	40B	4	18	18	8.5 ⁶	18	4	40B	40B	4	4	18	40B	4	0-1	18	40B	18	9.5	18	40B	26	9.5	4-18	4 ⁸	
Option	2	2	2	2	2	0.25	2	2	2	2	2	2	2	2	2	0.5	2	2	2	2	2	2	2	2	2	2	2
Osprey	10	10	10	3	10	3	3	10	10	10	3	3	10	10	10	3	10	10	10	10	10	10	10	1	10	0.25	
Outlook ¹	4-6	6-9	6-9	4	6-9	NR	NR ¹⁰	6-9	6-9	6-9	NR	4	6-9	6-9	6-9	NR	4	6-9	NR	6-9	6-9	6-9	6-9	4	4	4	
Outrider	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	NR
Overdrive	1	4	4	1	4	0.25	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	1	1	1	
PastureGard HL	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	4	NI	NI	NI	NI	NI	NI	NI	4	NI	4
Peak (0.25 oz) ¹	22	22	22	10	22	1 ⁸	1	22	22	22	10	10	22	22	10	10	NR	22	10	10	10	22	22	NR	NR	NR	

Table 5.4 - Herbicide Rotational Restrictions for Cash Crops (cont.)

The information listed in this rotation restriction table is our interpretation of label statements. Consult the label if two or more of these materials are applied during the same season. Herbicide labels are constantly changing; therefore, this list is not a substitute for the most recent herbicide label.

Trade Name	Rotational Crops (months after application) ¹																										
	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat	
Permit	9	15	9	4	2	1 ⁸	2	NI	9	18	6	9	10	9	2	9 ¹	2	9	3	36	2	9	9	2	2	2	2
Permit Plus	9	15	9	4	2	1	2	NI	9	18	6	9	10	9	2	9 ^{1,14}	2	9	3	36	2 ⁹	9	9	2	2	2	
Perpetuo	10	18	18	2-4	18	NR	6-8 ¹	11	18	18	2-4 ¹	9-11 ¹	18	18	11	NR	18	18	8	18	18	18	4	18	18	1-4	
Poast	NR	NR	NR	NR	NR	1	1	NR	NR	NR	NR	NR	NR	NR	NR	NR	30	NR	17	NR	NR	NR	NR	NR	1	1	
Powerflex HL	9	12	12	3 ¹	12	9	3	12	12	12	9	9	12	12	12	3 ¹	9	12	9	12	12	12	12	9	9	12	
Prefar ¹	4	NR	4	4	NR	4	4	4	NR	NR	4	4	NR	NR	4	4	4	NR	4	4	NR	NR	4	4	4	4	
Prefix	18	18	18	1	12	10	18	4	12	18	4	4	10 ⁹	10	NR	NR	4.5	12	10	18	10 ⁹	10	1	4.5	4.5		
Princep 4L	SY	SY	SY	NY	SY	NR	NY	SY	SY	SY	NY	SY	SY	SY	SY	NY ¹⁷	SY	SY	NY	SY	SY	SY	SY	SY	NY	NY	
Prowl H ₂ O	6 ¹	NY	NY	NR	NY	NR ¹⁸	NY	NR	NR	NY	NR	NR	NR ¹	NY	NR	NR	NY	NR	NR ¹⁸	NR ¹	NR ¹	NR	NR ¹	4 ¹	NY	4 ¹	
Pursuit ¹	4	40B	4	18 ¹⁹	40B	8.5 ⁹	18	NR	40B	40B	NR	NR	18 ⁹	40B	2	NR	18	40B	18	9.5	40B ⁹	40B	26 ¹	9.5 ¹	4	4	
Python	4	26B	9	9 ¹	26B	NR	12	4	26B	26B	4	4	26B	26B	4 ¹	NR	4	26B	18 ¹	9	26B	12	4	4	4	4	
Quelex ¹	9	15	15	3	15	3	3	9	15	15	9	9	15	15	9	3	3	15	3	15	15	15	15	NR	15	NR	
Raptor	3	9	18	9	9	8.5 ⁹	9	NR	9	9	9	NR	9	9	NR	NR	9	9	8.5	9	9	9	9 ¹	9 ¹	4	3	
Realm Q	10	18	18 ¹	10	18	NR	10	18	18	18	10	10 ¹	18	18	10 ¹	10	9	18	10	10	10	18	10	4	4	4	
Reflex	18	18	18	NR	12	10	18	4	12	18	4	4	10 ⁹	10	NR	NR	18	12	10	18	10 ⁹	10	NR	4	4	4	
Remedy Ultra ²⁰	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	
Resicore/Resicore XL	10.5 ²⁸	18	18	12	18	NR ²⁸	10.5 ²⁸	18	18	18	18	18	18	18	18	10.5 ²⁸	10.5 ²⁸	18	10.5	18	18	18	18	10.5 ²⁸	10.5 ²⁸	4	
Resolve SG (1 oz)	10	18	10 ¹	1	10	NR	10	18	18	18	18	10	18	18	10	10 ¹⁴	9	18	10	18	1	18	NR	9	18	3	
Resolve Q (1.25 oz)	10	18	10 ¹	1	10	NR	10	18	18	18	1.5	10	18	18	10	2 ¹	9	18	10	1.5	1	18	NR	3	3	3	
Resource	1	1	1	1	1	NR	1	1	1	1	1	1	1	1	1	NR	1	1	1	1	1	1	1	1	1	1	
Reviton (2 oz)	5	5	5	0.5	5	NR	5	5	5	5	5	5	5	5	5	0.25	5	5	5	5	5	5	5	5	5	NR	
Revolin Q	10 ¹	18	18	10	18	NR	10 ¹	18	18	18	18	18	18	18	18	10	8	18	10 ²⁰	18	18	18	10 ¹	4	4		
Ro-Neet	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	
Sandea	9	15	9	4	2	1 ⁸	2	36	9	18	6	9	10	9	2	9 ¹	2	9	3	36	2	9	9	2	2	2	
Scepter ¹	18	18	18	18	18	9.5 ¹³	11	11	18	18	11	18	18	18	11	NR	11	18	18	9.5	18	18	18	11	18	3	

Table 5.4 - Herbicide Rotational Restrictions for Cash Crops (cont.)

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Trade Name	Rotational Crops (months after application) ¹																										
	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat	
Select/Select Max	NR	NR	NR	NR	NR	0.2	1	NR	NR	NR	NR	NR	NR	NR	NR	NR	1	NR	1	1	NR	NR	NR	NR	1	1	1
Sentrallas	4	4	4	4	4	NR	NR	4	4	4	4	4	4	4	4	4 ¹	NR	4	4	4	4	4	4	NR	4	NR	
Sequence	4	NY	9	NR	NI	NR	NR	NR	NI	NI	NI	NR	NY	NI	NR	NR	4.5	NI	NI	NY	6 ¹	NI	NY	4.5	4.5	4.5	
Sharpen (1 oz) ¹	4	4	4	1.5	4	NR	NR	4	4	4	4	NR	4	4	4	0-1	NR	4	0.5	4	4	4	4	NR	NR	NR	
Shieldex	9	9	12	9	9	NR	9	9	9	12	9	9	12	9	9	3	9	NR	12	9	9	9	9	NR	3	NR	
Sinate	9	18	18	9	18	NR	9	18	18	18	9	9-18 ¹	18	18	9-18 ¹	9	3	18	NR	18	18	18	9	3	3	3	
Sinbar	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	
Solicam	16	24B	24B	1-16 ¹	24B	24B	24B	24B	24B	24B	1-16 ¹	24B	24B	24B	24B	24B	1.5-16 ¹	24B	24B	24B	24B	24B	24B	24B	24B	24B	24B
Sonalan	AH	AH	AH	AH	AH	AH	AH	AH	AH	NR	NR	AH	AH	AH	AH	NR	12	AH	AH	AH	AH	AH	AH	AH	AH	AH	
Spartan	12	NR	12B	18	12B	10	10 ¹	NR	12B	12B	12B	12B	12B	12B	12B	NR	12	12B	18	NR	NR ⁸	12B	12B	4	4	4	
Spartan Charge	12	NR ⁸	12B	12-18 ¹	12B	NR	10 ¹	12B ¹	12B	12B	NR	12B	12B	12B	12B	NR	12	12B	12	NR	NR ⁸	12B	NR ¹	4	4	4	
Spin-aid	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	4	AH	AH	AH	AH	AH	AH	AH	4	4	
Spirit	18	10	18	10	18	1 ⁸	10	18	18	18	18	10	18	18	10	10	3	18	8	10	10	18	10	3	3	3	
Spur	12-18	NR	10.5B	10.5-18B	10.5-18B	NR	12	10.5B	10.5	12	10.5B	18B	10.5B	10.5B	10.5B	12-18	NR	10.5B	NR	10.5B	10.5B	10.5	10-	NR	10.5B	NR	
Starane Ultra	4	4	4	4	4	NR	NR	4	4	4	4	4	4	4	4	4 ³¹	NR	4	NR	4	4	4	4	4	NR	NR	
Status	1 ⁵	4	4	1 ⁵	4	0.25	1 ⁵	4	4	4	4	4	4	4	4	1 ⁵	1 ⁵	4	4	4	4	4	4	1 ⁵	1 ⁵	1 ⁵	
Steadfast Q	10 ¹	18	10 ¹	10	10-18	NR	10-18	10-	10-	10-	10-18	10	10-18	10-	10-	0.5	4	10-	10 ²⁰	10-18	10-18	10-18	10 ¹	4	4	4	
Stinger	10.5	NR	18	B	18B	NR	10.5	18B	18B	10.5	18B	18B	18B	18B	18B	10.5 ¹	NR	18B	NR	18B	18B	18B	18B	NR	NR	NR	
Storm	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	NR	3.3	3.3	3.3	3.3	NR	1.3	3.3	3.3	3.3	3.3	3.3	3.3	1.3	1.3	1.3	
Storen	10	18	18	10	18	NR	10	18	18	18	10	18	18	18	18	10	11	18	NR	18	18	18	10	11	11	4.5	
Stout	10 ¹	18	10 ¹	10	18	NR	10	18	18	18	18	10	18	18	10	0.5	8	18	10 ²⁰	18	18	18	10 ¹	4	4	4	
SureStart/ TripleFLEX	NY ¹	26B	NY ¹	26B	26B	NR	12	26B	26B	26B	26B	NY	26B	26B	26B	NY ¹	NY	26B	18 ¹	18	26B	26B	18	NY	NY	4	
Surpass NXT	9	NI	9	NY	NI	NR	NR ¹⁰	NY	NI	NI	NI	NY	NI	NI	NY	NY	NY	NI	NR	NY	NY	NY	NY	NY	NY	4	

Table 5.4 - Herbicide Rotational Restrictions for Cash Crops (cont.)

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Trade Name	Rotational Crops (months after application) ¹																									
	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
Surtain (14 fl oz)	10	18	4	4	18	NR	6	11	18	18	7	4	18	18	11	3	11	18	2	18	18	18	10 ¹	4	4	4
Surveil	10	30B	30B	9	30B	9	9	9	30B	30B	9	9	30B	30B	9	NR	9	30B	18	10 ²¹	30B	30B	18	30B	30B	3
Synchrony XP ¹	12	18	12	9	18	9	9	30	30	30	15	9	30	18	9	NR	3	30	18	9 ⁹	9 ⁹	18	30	3	3	
Targa	4	4	4	NR	4	4	4	4	4	4	4	NR	4	4	NR	NR	4	4	4	4	4	4	4	NR	4	NR
Tavium	6	6	9	1.4 ¹	12	NR	6	6	12	6	6	6	6	6	6	1 ¹	4.5	12	NR	NY	6	12	6	4.5	4.5	
Treflan	NR	NR	5	NR	5	12-14	NR	5	5	5	NR	NR	NR ⁹	5	NR	NR	12-14 ³³	5	12-14 ³³	5	5	NR	5	NR	NR	NR
Trivence	10	18	18	18	18	10 ¹	18	30	30	30	18	12	30	18	30	NR	18	30	18	18 ⁹	12 ⁹	18	30	4	30	4
TriVolt	17	17	17	10	17	NR	17	17	17	17	12	17	17	17	17	9	17	17	9	17	17	17	17	12	12	4
Ultra Blazer	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	NR	3.3	3.3	3.3	3.3	NR	1.3	3.3	3.3	3.3	3.3	3.3	3.3	1.3	1.3	
Valor SX/Valor EZ (up to 3 oz)	5 ¹¹	6-12B	5 ¹¹	2 ¹¹	6-12B	0.5-1 ¹	1	6-12B	6-12B	6-12B	NR	4	6-12B	12B	4	NR	5 ¹¹	12	4	2 ¹¹	6-12B	6-12B	5 ¹¹	4	4	2 ¹¹
Valor XLT ²²	12-18	18-30	12	10-18	18-30	10-18	10-18	18-30	18-30	18-30	18-30	12	18-30	18-30	12	NR	18-30	18-30	18-30	10-18 ⁹	12-18 ⁹	18-30	18	4	4	
Varisto	3	9	18	9	18	8.5 ²⁹	9	NR	9	9	9	NR	9	9	NR	NR	9	8.5	9	9	9	9 ⁹⁹	9	9	3 ²⁹	
Verdict	7	7	7	6	7	NR	NR	7	7	7	7	4	7	7	7	NR	4	7	4	7	7	7	7	4	4	
Vida	1	1 day	1	NR	1 day	NR	1 day	1 day	1 day	1 day	1	1 day	1 day	1 day	1 day	NR	1 day	1	1	1	1 day	1 day	NR	1 day	1 day	NR
Warrant	9	NI	9	NR	NI	NR	NR ¹⁰	NY	NI	NI	NR	SY	SY	SY	NY	NR	NY	NI	NY	NY	NI	NI	NY	NY	NY	4
Warrant Ultra	18	NI	18	1	NI	10	18	NY	NI	NI	10	10	NI	NI	NY	NR	NY	NI	12	NI	NI	NI	NI	NY	NY	4
Xtendimax ¹	4	4	4	1 ¹	4	NR	0.5 ¹	4	4	4	4	4	4	4	4	1	1	4	4	4	4	4	4	1	1	
Yukon	9	15	9	4	9	1 ⁵	2	NI	9	18	6	9	10	9	2	9 ¹	2	9	3	NI	2 ⁹	9	9	2	2	
Zalo	6	4	6	NR	6	4	6	6	6	4	6	6	6	6	6	NR	4	6	4	6	6	6	4	4	4	
Zeus XC	12	NR ⁹	12B	18	12B	10	10 ¹	NR	12B	12B	4	NR	12B	12B	12B	NR	12	12B	18	NR	12B ⁹	12B	12B	4	4	
Zidua/Zidua SC (3 oz or 5 fl oz) ¹	10	18	18	4	18	NR	10	11	18	18	4	11 ¹	18	18	11	NR	11	18	NR	18	18	18	4	11 ¹	4 ¹	
Zone Defense	12	4 ³⁴	4 ³⁴	18	12	10	10	4 ³⁴	4 ³⁴	12	NR	4 ³⁴	12	12	12	NR	12	12	18	1	4 ³⁴	4 ³⁴	4 ³⁴	4	4	

Abbreviations: **AH** = after harvest; **B** = Bioassay of soil recommended before planting; **NS** = next season; **NY** = next year; **SY** = second year following application; **NR** = no restrictions.

¹ Read the label for additional restrictions due to application rate, timing, geographical region, rainfall, soil, pH, tillage, variety, or supplemental labeling.

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- ² 18 months with a soil pH > 6.5. At rates greater than 2.1 oz/A, a rotational interval of 30 months and a successful field bioassay are required.
- ³ Rotation interval for lima bean is 18 months if Armezon PRO is applied at greater than 20 fl oz/A. Rotation interval for pea and snap bean is extended to 18 months if Armezon PRO is applied at greater than 25 fl oz/A.
- ⁴ Cotton may be planted after 12 months where Authority Elite/Broadaxe was applied at rates less than 36 oz/A, Authority MTZ DF at rates less than 17 oz/A, or Authority First/Sonic at rates less than 5 oz/A and the following conditions are met: Medium and fine soils, pH < 7.2, and rainfall or irrigation must exceed 15" after herbicide application and prior to planting cotton.
- ⁵ Following application of Clarity and a minimum of 1" of rainfall or overhead irrigation, a waiting interval of 21 days is required per 8 fluid ounces per acre applied prior to planting cotton, 30 days per pint restriction for soybean, and 20 day per pint restriction for small grains. If less than 1" or rainfall or irrigation is received after application and Status is applied at greater than 5 oz/A the rotational interval is 4 months.
- ⁶ If Basis rate is 0.33 to 0.5 oz/A or Basis Blend rate is 1.25 oz/A, alfalfa, sorghum, pea = 18 months; soybean, snap bean = 10 months; STS soybean = 1 month; spring oat = 9 months; if Basis rate is greater than 0.5 oz/A or Basis Blend rate is 2.5 oz/A, cotton = 10 months and 18 months if greater than and less than 15 inches of rainfall or irrigation occur after application and prior to planting, respectively; STS soybean = 4 months; if Basis rate is 0.33 oz/A or Basis Blend rate is 0.825, soybean = 0.5 month.
- ⁷ 8 months if 0.38 oz/A Beacon is applied.
- ⁸ NR for IMI (IR/IT) or Clearfield (CL) varieties.
- ⁹ Transplanted.
- ¹⁰ Use safener with seed.
- ¹¹ Cotton may be planted no-till or strip-till after 14 or 21 days when applied at 1 oz/A or 1.5 to 2 oz/A, respectively. For winter wheat, at rates up to 2 oz/A, the rotation interval is 7 days for no-till or minimum-till wheat and 30 days for conventional-till wheat. At least 1 inch of rainfall/irrigation must occur between application and cotton, field corn, grain sorghum, tobacco, or wheat planting, or crop injury may occur. For alfalfa, clover, potato, and spring oats the rotation interval is 5 months if the soil is tilled prior to planting or 10 months if no tillage is preformed prior to planting. At lower rates of Valor/Rowel/Chateau, rotation interval for many crops are reduced. Chateau may be applied to potato following hilling at a rate of 1.5 oz/A. Consult labels for more specific information.
- ¹² Command may be applied preemergence to cotton only if Di-Syston or Thimet insecticides are applied in furrow with the seed at planting.
- ¹³ Corn hybrids that are classified as IMI-corn or as tolerant (IT) or resistant (IR) may be planted in the spring of the year following regardless of rainfall or time interval from chemical treatment to corn planting.
- ¹⁴ Rotational interval is shorter for STS soybean.
- ¹⁵ Transplanted tobacco = 10 months if ≤ 0.3 oz/A.
- ¹⁶ If Hornet WDG rate is < 4 oz/A, snap beans, peas, and some varieties of sweet corn = 10.5 months.
- ¹⁷ If no more than 2 lb ai applied the previous year.
- ¹⁸ Regardless of tillage, be sure to plant corn at least 1.5 inches deep and completely cover with soil.
- ¹⁹ Cotton may be planted 9.5 months following Pursuit if all of the following criteria are met: Pursuit is applied to peanuts only; soil texture is sandy loam or loamy sand only; and greater than 16 inches of rainfall/irrigation is received following application of Pursuit through October of the application year.
- ²⁰ The rotational interval for the sweet corn varieties 'Merit', 'Carnival', and 'Sweet Success' is 15 months.
- ²¹ Transplanted tobacco may be planted 10 months after application of 2.1 oz/A of Surveil. Tobacco in seeded nurseries may be planted 18 months after application of 2.1 oz/A of Surveil and following a successful field bioassay. At rates greater than 2.1 oz/A, a rotational interval of 30 months and a successful field bioassay are required.
- ²² Rotational intervals based on soil pH less than 7.0. In Pennsylvania, rotational interval for clover, lima bean, muskmelon, onion, pepper, spring oat, squash, and white potato is 18, 30, 30, 30, 30, 30, 30, 30, and 30 months, respectively. Consult seed corn agronomist regarding inbred sensitivity to Valor XLT/Rowel FX prior to planting inbred seed corn lines.
- ²³ If applied after June 1, rotating to crops other than corn (all types) may result in crop injury.
- ²⁴ For Bolt or Non-Bolt soybean and minimum- or no-till field corn, if Afforia is used on coarse textured soils, such as sands and loamy sands, or on high pH soils (>7.9), extend time to planting by 7 additional days. For minimum- or no-till wheat in the states of DE, MD, NJ, or VA, Afforia may be applied at a minimum 7 days before planting. Do not use on Durum wheat and do not irrigate between emergence and spike. Wheat must be planted at least 1 inch deep. Do not graze until wheat has reached 5 inches in height. For conventional-till field corn, grain sorghum, cotton, and wheat, at least one inch of rainfall/irrigation must occur between application and planting or crop injury may occur. For alfalfa, cabbage, clover, cucumber, lima bean, muskmelon, onion, pepper, pumpkin, spring oat, squash, sweet corn, tobacco, tomato, watermelon, and white potato, the rotational interval is 4 months if the soil is tilled prior to planting. If no tillage is performed prior to planting these crops the rotational interval is extended to 8 months.
- ²⁵ Rotation interval for spring oat or winter barley at 5.7 oz/A or greater rates, the rotation interval is extended to 18 months. For winter wheat, at 5.7 oz/A or greater rates, the rotation interval is extended to 6 months.
- ²⁶ Seed corn inbred lines vary in sensitivity to herbicides, therefore, users should seek advice from seed corn agronomist regarding inbred sensitivity to Canopy Blend prior to planting inbred seed corn.
- ²⁷ For onion, the rotational interval for irrigated and non-irrigated is 8 and 18 months, respectively.

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²⁸ For corn, if the original corn crop is lost do not make a second application. Injury may occur to soybean planted the year following application on soils having a calcareous subsurface layer, if products containing atrazine were used at rates greater than 0.75 lb/ai atrazine per acre in tank mixtures and/or sequentially with Resicore. If Resicore is applied after June 1, rotating to crops other than corn or grain sorghum the next spring may result in crop injury.

²⁹ NR for Clearfield corn (field and seed). For wheat, planting non-Clearfield cultivars in areas receiving less than 10 inches of precipitation from time of application up until wheat planting may result in wheat injury. Injury potential increases if less than normal precipitation occurs in the 2 months just after Varisto application. For barley, the rotation interval at pH > 6.2 and > 18 inches of rainfall/irrigation, pH < 6.2 and < 18 inches of rainfall/irrigation and with moldboard plowing, and pH < 6.2 and < 18 inches rainfall/irrigation and without moldboard plowing is 9, 9, and 18 months, respectively. For potato, the rotation interval at pH > 6.2 and > 18 inches of rainfall/irrigation and pH < 6.2 and < 18 inches of rainfall/irrigation is 9 and 18 months, respectively.

³⁰ Rotation information is unknown for this product. Please contact manufacturer for recommendations.

³¹ In Delaware and Virginia, a Special Local Needs Label 24(c), has approved a 3 month plant back restriction for soybeans after an application to winter wheat.

³² NR for Enlist varieties.

³³ In areas receiving 20 inches of rainfall or irrigation; 12 months after a spring application or 14 months after a fall application of Treflan 4L or 4EC. Labelled for these crops or after crop plants have emerged.

³⁴ Rotation is 8 months in no-till.

Surtain (Sharpen)

Beyond extra/ Raptor/ Imiflex

Banded Herbicide Application

Herbicide use can be reduced by fifty to seventy-five percent by applying the herbicide in a narrow strip or band over the row. Preemergence and postemergence herbicides can be applied as banded sprays to reduce cost and the amount of herbicide used in conventional and certain minimum tillage systems. Band spraying consists of applying an herbicide in an 8- to 15-inch band over the crop row, leaving the row middles unsprayed. Weeds that emerge between the rows must be controlled by mechanical cultivation which may be done more economically than treating them with herbicides. Banding is not practical with herbicides that must be preplant incorporated, in no-till planting systems, or when rows are planted at a close spacing.

Off-Target Movement

Off-target movement, sometimes called drift, is the movement of any pesticide to areas not intended for treatment. There are three primary forms of off-target movement: spray drift (also known as physical drift), volatility (also known as vapor drift), and sprayer contamination. Spray drift is when, during application, droplet or particle drift occurs as spray droplets or dust particles are carried by air movement from the application area to other places. Vapor drift takes place after application as herbicides evaporate (volatilize) and yield fumes (gases) that are carried on wind currents and deposited on soils or plants outside of the treated areas.

Herbicide off-target movement may injure sensitive crops, ornamentals, gardens, livestock, wildlife, or people, and may contaminate streams, lakes, or buildings. It may contaminate crops and cause illegal or intolerable residues. Excessive drift may mean poor performance in the desired spray area because the application rate is lower than expected.

Drift control should be considered with each pesticide application. Here are some ways to prevent severe drift problems:

- Use sprayer nozzles especially designed for drift reduction
- Use low-volatile or nonvolatile formulations
- Use low spray-delivery pressures (15–30 psi) and nozzles with a larger orifice
- Use drift-inhibiting adjuvants in the spray mixture when spraying under less-than-ideal conditions
- Use nozzles that allow for lowered boom height
- Avoid application of volatile chemicals at high (85 F) temperatures
- Spray when wind speed is low (less than 10 mph) or when the wind is blowing away from areas that should not be contaminated
- Use higher spray volumes during applications (e.g., 20 to 30 gallons per acre versus 5 to 10 gallons per acre)

- Spray during the early morning or evening hours when there is usually less wind. (However, applications should not be made if wind speed is less than 3 mph.)
- Leave border areas unsprayed if they are near sensitive crops

General Herbicide Mixing Procedures

Specific mixing or tank-mixing procedures may vary among product labels. When using a product alone, adhere to the mixing instructions on the product label. When tank-mixing two or more products, adhere to the most restrictive label's instructions. If it is difficult to determine which instructions to follow or when the instructions on the labels contradict each other, use the general instructions outlined below.

1. Make sure the spray equipment is properly cleaned according to the labels of the products that were last applied with the sprayer.
2. Make sure the sprayer is properly calibrated, has good agitation, and is equipped with the appropriate screens (no finer than 50 mesh; 100 mesh is finer than 50 mesh) and spray tips.
3. If tank-mixing two or more products, make sure there are no label restrictions prohibiting those products from being tank-mixed.
4. If tank-mixing two or more herbicides that are not specifically allowed on the labels, or if the labels require it, perform a compatibility test (such as a jar test) to assure that the products mix properly.
5. If a suspension or liquid fertilizer is being used as the carrier, perform a compatibility test (such as a jar test) to assure that the products dissolve properly and remain stable.
6. Fill the spray tank $\frac{1}{2}$ to $\frac{3}{4}$ full with clean water or suspension or liquid fertilizer (if being used as the carrier) and begin agitation. If possible, maintain agitation until all applications are completed.
7. If ammonium sulfate (AMS) is being added as a water conditioner, add the AMS first. This is particularly important if glyphosate (Roundup, etc.) or paraquat (Gramoxone) products are being used. Make sure the AMS is completely dissolved before continuing.
8. If compatibility agents are required, follow the herbicide label first, followed by the directions with the compatibility agent. Compatibility agents are generally either mixed or slurried with the products and/or added to the carrier solution prior to adding any products.
9. Add water soluble packets and thoroughly mix. Make sure the packets are completely dissolved.
10. Add wettable powders (WP) and thoroughly mix.
11. Add dispersible granules (DG) and dry flowables (DF) that are not in water soluble packets and thoroughly mix.
12. Add liquid flowable (FL) formulations and thoroughly mix.
13. The products in steps 9-12 can be slurried in water to assure that the products are completely dissolved before adding them to the spray tank. Some labels require that the product be slurried, particularly when using a suspension or liquid fertilizer as the carrier. Make sure to use enough water to allow the products to be completely dissolved.
14. Add water soluble concentrates (SC) and other aqueous solution products and thoroughly mix.
15. Add emulsifiable concentrate (EC) formulations and thoroughly mix.
16. Add spray adjuvants (nonionic surfactants, crop oil concentrates, methylated seed oil, etc.).
17. Add nitrogen fertilizer solutions such as urea ammonium nitrate (UAN) or ammonium sulfate (AMS) that is not being added as a water conditioner.
18. Add other tank products such as defoamers, drift control agents, dyes, etc., unless labels require their addition earlier in the mixing process.
19. Finish filling the spray tank.

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General Jar Test Procedures

A “jar test” is a type of compatibility test used to determine if two or more herbicides will mix properly, or if an herbicide(s) will mix properly with a carrier solution such as a suspension or liquid fertilizer. Incompatibility of tank mixtures is more common with suspensions of liquid fertilizers and pesticides. The idea of the jar test is to create a miniature of the actual spray tank mixture with all of the components in the proper ratios. Many herbicide labels have specific jar test procedures. If possible, follow the procedures outlined on the product label(s). If it is difficult to determine which label instructions to follow or when the instructions on the labels contradict each other, use the general instructions outlined below.

1. Use only water or carrier solution from the intended source and at the source temperature.
2. One jar will usually be adequate if only herbicide compatibility in water is being tested. Two or three jars may be needed if compatibility agents and/or adjuvants will be compared to the tank mixture alone. Use quart-size jars with re-sealable lids.
3. Add the appropriate amount of water or carrier solution to each quart jar using this formula: **[spray volume (gal/A) x 0.04 = carrier to add in pint/jar]**. For example, for a spray volume of 20 gal/A, add $20 \times 0.04 = 0.8$ pint (378 ml) of carrier to each jar.
4. If a compatibility agent will be used, add the appropriate amount of the compatibility agent to one labeled jar based on this formula: **[compatibility agent rate (pint/100 gal) x spray volume (gal/A) x 0.005 = compatibility agent to add in teaspoons/jar]**. For example, if the label rate for the compatibility agent is 3 pints/100 gal and the spray volume is 20 gal/A, then $3 \times 20 \times 0.005 = 0.3$ teaspoon (1.5 ml) of compatibility agent to one jar.
5. Add the appropriate amount of pesticides in the proper order (wetable powders, dispersible granules, dry flowables, liquid flowables, soluble concentrates and other aqueous solutions, and emulsifiable concentrates) to all jars according to one of the methods below. After each addition shake, invert several times, or stir gently to thoroughly mix.
 - a. Use the formula **[product rate/A x 0.005]**, and convert to an appropriate measurement using the conversion factors below. Or,
 - b. For dry products add 1 teaspoon per pound of product per acre, and for liquid products add ½ teaspoon per pint of product per acre.
 - i. **Dry product conversion factors:**
 1. 1 pound = 16 ounces = 454 grams
 2. 1 ounce = 28.3 grams
 - ii. **Liquid product conversion factors:**
 1. 1 gallon = 4 quarts = 8 pints = 128 fluid ounces
 2. 1 pint = 2 cups = 16 fluid ounces = 473 milliliters
 3. 1 fluid ounce = 29.57 milliliters = 2 tablespoons = 6 teaspoons
 4. 1 teaspoon = 4.93 milliliters = 60 drops
6. If adjuvants are being tested for compatibility, these should be added last to one labeled jar. Use one of these formulas based on how the adjuvant rate is expressed: **[adjuvant rate (pint/100 gal) x spray volume (gal/A) x 0.005 = adjuvant to add in teaspoons/jar]**, or **[adjuvant rate (pint/A) x 0.48 = adjuvant to add in teaspoons/jar]**.
7. When all components have been added to the jar(s), invert each jar ten times to mix and let stand for 15 to 30 minutes. If the spray solution balls up or forms flakes, sludges, jels, oily films or layers, or other precipitates it is not compatible. If a compatibility agent has not already been tested, repeat the test with a suitable compatibility agent. The tank mixture should not be used if any signs of incompatibility are evident. If the mixture separates but can be remixed readily, the mixture can be sprayed as long as good agitation is used.

8. Compatibility may be improved by using the following methods when testing and mixing.

a. Slurry the dry pesticides in water before addition to the mixture.

Oily films are usually caused by incompatibility of emulsifiable concentrates (EC). Add ½ of the compatibility agent to the carrier and ½ to emulsifiable concentrates and/or flowable pesticides before adding them to the mixture.

Sprayer Cleanout (*Modified from article Iowa State University of Science and Technology, Ames, Iowa. File code: Pest Management; PAT-30, Nov. 1997.*)

Crop injury due to contaminated sprayers is a continuing problem for both vegetables and field crops. Herbicide residues can be dissolved with time and some herbicide formulations are very effective at removing residues. This problem can be avoided by ensuring that sprayers are properly cleaned between tank loads. Sprayer cleaning is particularly important before you begin spraying a different crop or the same crop but with a different herbicide resistance trait. When determining the correct clean-out procedure, it is important to consider the product's site of action, carrier, and additives. They all have an impact on what cleaning solutions to use and potential damage to sensitive crops.

Rinsate disposal. Clean the sprayer in an area that will not contaminate water supplies, streams, or crops and in an area inaccessible to children, pets, and livestock. Pay particular attention to sensitive vegetation that is in the runoff area. The best method for rinsate disposal is in the field in a manner consistent with the product's label. The easiest way to do this is to have rinse water available in the field, either on the sprayer or support vehicle.

Tank-cleaning agents. A tank-cleaning agent's function is to penetrate, loosen, and dissolve herbicide residues and then to remove them through dilution. In some cases, the agent will provide deactivation or decomposition of the herbicide.

- Commercial tank cleaners are recommended on many product labels and help remove water and oil-soluble herbicides.
- Household ammonia, a commonly recommended cleaning agent, is effective at penetrating and loosening deposits and residues in the spraying system. Although ammonia does not decompose herbicides, it increases the solubility of some herbicides by raising the pH.
- Chlorine bleach can decompose residues of most sulfonyleurea and other herbicides into inactive compounds. However, some tank-mix partners may inhibit the decomposition. Care must be used with chlorine bleach. Chlorine bleach can combine with fertilizers containing ammonia to produce dangerous chlorine gas, which is irritating to the eyes, nose, throat, and lungs. Also, rinsate containing chlorine bleach is not labeled for application to cropland.
- Kerosene or fuel oil should be used to remove oil-based herbicide formulations such as 2,4-D esters. Following the oil rinse, the system should be cleaned with detergent or ammo

Removing precipitated pesticides. Tank-mixing more than one pesticide can sometimes result in the chemicals forming a "gunky mess" in the bottom of the tank. The result is that the pesticides are not compatible with one another and the pesticides will settle out (form gunk). If your tank does end up with incompatible pesticides gunking up the bottom use a compatibility agent (usually at a pint/100 gallons, follow directions).

Surfactants and fertilizer additives. When switching from a growth regulator (group 4) herbicide (2,4-D, dicamba, Stinger, and others) to a postemergence application in soybeans, special care should be taken if the application involves surfactants or fertilizer additives. Such materials are particularly adept at removing these herbicides from poly tanks, hoses, and strainers. It is recommended that a small amount of fertilizer or crop oil be flushed through the system before the application.

General cleaning guidelines. To avoid drying and hardening of pesticide residues, and potential corrosion and damage to equipment, clean the sprayer immediately following an application. If you are continuing with the same pesticide the next day, flushing with water is sufficient. However, if you are switching products or crops, a more thorough cleaning is required.

Be sure to clean the entire sprayer system, not just the tank. Operate the pump and flush the cleaning solution through all hoses, strainers, screens, nozzles, and the boom. Small amounts of residue left in these areas can be sufficient to cause serious damage to a sensitive crop.

Most injury occurs when switching between crops or the same crop but with a different herbicide resistance trait. The following procedure is recommended when there are no specific cleaning requirements given on the label.

1. Drain the sprayer tank and lines and rinse tank, boom, and lines with water for a minimum of 5 minutes.

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2. Fill the tank with clean water and one of the following cleaning solutions per 100 gallons of water:

- 1 gallon household ammonia, **or**
- 8 lbs trisodium phosphate cleaner detergent, **or**
- commercial tank cleaner (follow instructions).

Flush the solutions through the entire sprayer system. For growth regulator herbicides (2,4-D, Clarity, Distinct, Stinger, etc.), let the solution stand overnight. Add more water to fill tank and agitate solution for at least 15 minutes and flush through the nozzles. Drain the tank.

3. Remove the nozzles, screens, and strainers and clean them separately in a bucket of cleaning agent and water.

4. Rinse the entire system with clean water.

Sprayer Calibration

Proper sprayer calibration is one of the most important steps in any integrated pest management program. There are many reasons why you should calibrate your sprayers at least once a year. One of the most important reasons is to ensure you are not over-applying or under-applying a pesticide. Applying too much pesticide hurts your bottom line, may harm non-target plants or insects and is illegal. Too little can lead to poor pest control. Sprayer calibration is a step many producers skip because they think it is too complicated or time consuming.

A simple method for sprayer calibration has been developed which requires very few calculations. This method is based on spraying 1/128th of an acre per nozzle and simply collecting the spray released during the time it takes to travel over that area. Since there are 128 fluid ounces in 1 gallon, the number of ounces collected equals the application rate in gallons per acre. This method works well for broadcast applications, banded applications and directed applications.

To calibrate your sprayer, you will need a measuring tape, a stopwatch and a graduated liquid measuring cup. Follow these steps to determine the sprayer output:

Step 1. Determine the nozzle spacing, band width or row spacing based on type of application. Example: 18 inch band application (see Table 1).

Step 2. Determine the calibration distance for the appropriate spacing using the information in Table 1. Example: 18 inch band = 226.9 feet calibration distance.

Step 3. Mark off the appropriate calibration distance you determined in step 2. To obtain the most accurate results, conduct this step in the actual field or under similar conditions to where you will be spraying.

Step 4. Drive the calibration distance at a safe operating speed several times to determine the average time to travel the course. **Note:** It is important that ALL attachments such as harrows or planters are in operation to ensure proper calibration. Write down the engine RPM, gear, speed and time required to travel the calibration distance. To ensure accuracy, drive the course at least twice and calculate the average time to travel the distance.

Step 5. With the sprayer parked and operating at the same engine speed used to drive the calibration distance (Step 4), adjust spray pressure to the desired setting. The recommended spray pressure setting can be found on the pesticide label or based on the nozzles selected.

Step 6. With the sprayer running, collect the spray from **all** nozzles that contribute to the desired spacing for the number of seconds that were required to travel the calibration distance in step 4. The number of nozzles that contribute to the spray area will depend on your application method:

- a. Broadcast Application:** All outlets are evenly spaced; however, because pressure differences can occur along the length of the boom, collect spray from all nozzles for the number of seconds required to travel the calibration distance.
- b. Band Application:** Spray from one or more nozzles contribute to cover a specific area. Collect spray from the total number of nozzles that contribute to the selected band width for the number of seconds required to travel the calibration distance

- c. Directed Application/Row Application:** Spray from one or more nozzles contributes to cover a specific area. Collect spray from the total number of nozzles that contribute to the selected width for the number of seconds required to travel the calibration distance.

The total number of fluid ounces collected is equal to the gallons per acre rate. The rate can be adjusted by adjusting the pressure, changing nozzles or by changing the applicator speed. If speed is adjusted, begin at step 4 and recalibrate.

Determining Tank Mix

To determine the amount of chemical to mix into the spray tank, divide the number of gallons in the tank by the broadcast application rate in gallons per acre (Step 6) and multiply by the labeled per acre application rate for the pesticide. Example: A sprayer has a 200-gallon tank, and it is calibrated to apply 20 gallons per acre. The labeled rate is one pint of pesticide per acre.

- a) 200-gallon tank/ 20 gallons per acre = 10 acres covered per tank
- b) 10 acres X 1 pint per acre = 10 pints of chemical per tank

Determine the Total Number of Acres Covered by a Banded Application

Use the broadcast pesticide rates to mix into the tank for a banded application. Since a banded application sprays less area than a broadcast application, the total treated acres can be determined by dividing the treated band width by the total treated band width plus the untreated band area. Example: The above sprayer set to spray a 12-inch band over a 36-inch row spacing.

- a) 12” band/36” row spacing = 0.33.
- b) 0.33 X 10 acres per tank (broadcast) = 3.3 acres sprayed for every 10 acres covered.
- c) 10 acres/tank (broadcast)/0.33 acres sprayed in the band = 30.3 acres sprayed per tank.

Table 5.5 Calibration Distance Based on Sprayed Width (inches by nozzle)

Row spacing, nozzle spacing (broadcast) or band width (banded application) (inches)	Calibration distance (feet)
48	85.1
40	102.1
36	113.4
32	127.6
30	136.1
28	145.8
24	170.2
20	204.2
18	226.9
12	340.3
8	510.5

To determine a nozzle spacing not listed above, divide the band width in feet into 340.3.

Example: 7-inch band = 340.3 ÷ 7”/12” = 583.4

Taken with permission from Rutgers Cooperative Extension, Fact Sheet FS1085 by Stephen Komar, Bill Bamka, and Robert Mickel.

Corn Weed Management

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Integrated Weed Management

An integrated approach to managing weeds in corn includes using cultural weed control, mechanical controls where applicable, and the judicious use of herbicides. Corn fields that are weed free for the first four to six weeks after planting will often yield the same as fields that are weed free for the entire growing season. This approach relies on starting with a clean seedbed and using residual soil-applied herbicides or mechanical control. Weeds that germinate with the crop but are controlled in a timely fashion (four to five weeks after planting) will also not impact final yields. This POST herbicide approach relies on effective and timely postemergence weed control. Also, it is not necessary to control all weeds in a field to achieve maximum yield. However, certain weeds can still be problematic at harvest even at low levels (e.g., burcucumber). Weed populations of one to two weeds per 10 square feet are sufficient to cause severe yield loss depending on the species. However, weed populations at one plant per 100 square feet will have no impact on final yield. The impact of weed populations between one and 10 per 100 square feet is difficult to predict. The decision to treat the field depends on the weed species present, crop vigor, weather conditions, and herbicide cost. For more comprehensive discussion of integrated weed management see the *Integrated Weed Management Guide for Mid-Atlantic Grain Crops*.

Chemical Weed Control

Herbicides are useful tools in most weed management programs. This chapter will focus on herbicides available for use in corn. They should be used to supplement, not replace, other methods or tools available. The following are definitions of terms you will find in this and similar publications on herbicides:

Early preplant (EPP) - The herbicide is applied at least 14 days before planting. EPP applications are generally used in no-till systems to control existing vegetation and provide residual control of early-emerging weed species.

Preplant - The herbicide is applied from 0 to 14 days before planting. Preplant applications are generally used in no-till systems to control emerged weed species.

Preplant Incorporated (PPI) - The herbicide is applied to the soil after primary tillage, but before planting, and mechanically mixed with the top 1 to 3 inches of soil with one of a variety of secondary tillage implements.

Preemergence (PRE) - The herbicide is applied to the soil after the crop is planted but before emergence. Rainfall or irrigation is needed to move the herbicide into the zone of weed seed germination before weed emergence for maximum effectiveness. If adequate rainfall for herbicide activation does not occur, a shallow cultivation or rotary hoeing should be done to control weeds that have germinated.

Postemergence (POST) - The herbicide is applied to the foliage of the crop and weeds after they have emerged.

Post-directed (or directed) - Refers to use of special spray equipment to direct the spray at the weeds but avoid the spray coming in contact with as much of the crop as possible.

Residual activity - Herbicides that can be taken up by plants' roots and shoots and injure or kill the plant. All soil-applied herbicides have residual activity as well as many postemergence herbicides. Length of residual activity ranges from a few weeks to a few months.

Translocated herbicide - These herbicides move throughout the plant and can cause injury to parts of the plants that do not come in direct contact with the herbicide spray.

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Contact herbicide - These herbicides do not move throughout the plant. They cause injury only to those parts of the plant that comes in contact with the spray. Spray coverage is more critical for contact than translocated herbicides.

Non-selective herbicide - This refers to herbicides that control a broad-spectrum of plant species, including most crops and weeds. These herbicides are generally used with no-tillage production and are sprayed prior to planting when control of all plants is required.

Herbicide-Resistant Varieties

Some corn hybrids have been genetically enhanced to withstand herbicide applications that previously would have injured or killed corn. Genetically enhanced varieties allow herbicides to be used that provide a broader spectrum of control than would otherwise be available. Herbicide programs for genetically enhanced varieties also reduce the risk of crop injury associated with herbicide programs for conventional varieties.

LibertyLink corn is a GMO corn trait that allows over-the-top applications of Liberty (glufosinate) herbicide. This program should provide broad-spectrum control of annual broadleaves and grasses when in the seedling stage. Sequential applications or tank mixtures may be required for new weed flushes and perennials. This herbicide is becoming more important for the management of glyphosate resistant weeds such as horseweed, waterhemp, and Palmer amaranth.

Roundup Ready corn was developed using genetic engineering techniques (GMO). It has an altered target site that is not sensitive to glyphosate and allows postemergence applications of glyphosate directly to corn. Glyphosate resistant weeds are becoming an increasing issue in Roundup Ready crops.

Enlist corn is a GMO trait that is tolerant to glyphosate and improves 2,4-D tolerance. It also provides tolerance to FOP herbicides such as Assure II, but is sensitive to DIM herbicides such as clethodim. More varieties are becoming available that contain multiple or “stacked” traits such as both Roundup Ready and LibertyLink as well as various insect-resistant traits.

Herbicide Resistant Weeds in Corn

Herbicide-resistant weeds are common in corn in the Mid-Atlantic region. Weed species with a very high amount of seed production and a variable genetic variation are more likely to develop resistant populations—for example, common lambsquarters and pigweed species. Resistance management requires using herbicides with multiple effective modes of action and integrating mechanical (tillage and cultivation) or cultural weed control (cover crops, narrow row spacing, proper crop fertility, etc.) with chemical weed control.

Triazine-resistance. Weeds resistant to the Group 5 herbicides (triazines) in the Mid-Atlantic region include common lambsquarters, Palmer amaranth, redroot and smooth pigweed, horseweed, scattered populations of barnyardgrass, giant foxtail, goosegrass, and suspected populations of common ragweed and velvetleaf. Atrazine and simazine are the primary Group 5 herbicides used in corn. A number of POST products can provide good control of triazine-resistant (TR) weeds on corn.

For TR pigweed control, include a Group 15 herbicide for residual control (acetochlor, dimethenamid, *S*-metolachlor, or pyroxasulfone) at planting. The Group 15 herbicides will suppress initial TR pigweed, but in most years a postemergence application of a non-triazine herbicide will be needed for full-season control.

For TR lambsquarters, some of the Group 15 herbicides will help suppress emergence (acetochlor and pyroxasulfone), but they are not as active on lambsquarters as they are on pigweed. The Group 3 herbicide pendimethalin can provide good control of TR lambsquarters when applied prior to emergence. In addition, residual control can be obtained with products such as mesotrione or isoxaflutole.

ALS-resistance. Weeds resistant to the Group 2 herbicides (ALS) in the Mid-Atlantic region include several pigweed species, common and giant ragweed, common chickweed, horseweed, Italian ryegrass, giant foxtail, Johnsongrass, and shattercane. The principal issue with most ALS-resistant weeds in corn is lack of efficacy with POST ALS inhibitor products. For example, do not rely on nicosulfuron or rimsulfuron for POST control of resistant foxtail, Johnsongrass, or shattercane. ALS-resistant Johnsongrass and shattercane are a particular concern as only glyphosate and glufosinate are available for POST control in corn. Also, ALS-resistant broadleaves will not be controlled with halosulfuron or other Group 2 herbicides.

Glyphosate-resistance. Weeds resistant to the Group 9 herbicide glyphosate in the Mid-Atlantic region include Palmer ama-

ranth and waterhemp, common and giant ragweed, and horseweed. In corn, all of these can be managed with alternative herbicides, including the Group 4 growth regulators, the triazines if they are not Group 5 resistant, and several others, including the Group 27 herbicides such as mesotrione and isoxaflutole.

Control of Roundup Ready Corn: Volunteers or Replanting. There are times when corn has to be removed from a field with the intention of replanting a corn crop. Tillage is one effective method, but it is not appropriate in no-tillage situations. Use of glyphosate is highly effective for non-Roundup Ready corn. However, the challenge is in removing Roundup Ready hybrids. There are limited herbicides to consistently kill small corn plants. Gramoxone SL, Liberty, and Select are three products that have shown the most activity. Research conducted in this region with Gramoxone and Select demonstrated that Select was the most effective for corn 2 to 3 inches tall. For taller corn (4 to 6 inches tall), Gramoxone in combination with a photosystem II-inhibiting herbicide (metribuzin, Lorox, or atrazine) was the most effective. Liberty is a third option, but it will not control LibertyLink hybrids.

Select Max. up to 6 oz of Select Max with a nonionic surfactant at 0.25% v/v plus AMS at 2.5 to 4 lbs/A. Do not use a COC or MSO. Wait a minimum of 6 days from time of application until planting corn due to risk of crop injury. (Select Max will also control corn hybrids containing Roundup Ready and LibertyLink stacked traits.)

Gramoxone SL 2.0. 3 to 4.5 pt/A (2 to 2.7 pints of 3.0 SL formulation) in combination with metribuzin (4 to 6 oz/A), Lorox (1 pt/A) or atrazine (1 lb/A). These photosystem II inhibitors are not added to control the corn but are used to slow down the Gramoxone activity, which helps provide more consistent control.

Liberty 280. 22 to 29 oz Liberty has not been as consistent for controlling corn as Gramoxone and will not control varieties that contain the LibertyLink trait.

Table 5.6 - Corn Herbicides and Their Restrictions

Herbicide Trade Name	Herbicide Common Name	Herbicide group # (site of action)	Manufacturer	Restricted-Use Pesticide ¹	Water Quality Advisory ²	Worker Reentry (Hours) ³
2,4-D amine 4S	2,4-D amine	4	several	—	—	48
2,4-D LVE 4E	2,4-D LVE	4	several	—	—	12
Aatrex, Atrazine 4L/90DF	atrazine	5	Syngenta, others	yes	yes	12
Accent Q 54.5WG	nicosulfuron + safener	2	Corteva	—	—	4
Acuron 3.44SC	S-metolachlor + atrazine + mesotrione + bicyclopyrone	15/5/27/27	Syngenta	yes	yes	24
Acuron Flexi 3.26SC	S-metolachlor + mesotrione + bicyclopyrone	15/27/27	Syngenta	—	yes	24
Acuron GT 4.295SC	S-metolachlor + mesotrione + bicyclopyrone + glyphosate ⁴	15/27/27/9	Syngenta	—	yes	24
Aim 2EC	carfentrazone-ethyl	14	FMC	—	—	12
Anthem ATZ 4.5SE	atrazine + pyroxasulfone + fluthiacet	5/15/14	FMC	yes	yes	12
Anthem Maxx 4.3SC	pyroxasulfone + fluthiacet	15/14	FMC	—	yes	12
Anthem Flex 4SE	pyroxasulfone + carfentrazone	15/14	FMC	—	yes	12
Armezon 2.8SC	topramezone	27	BASF	—	—	12
Armezon PRO 5.35EC	topramezone + dimethenamid	27/15	BASF	—	yes	12
Assure II 0.88E/Targa	quizalofop	1	AMVAC/ Gowan	—	—	12

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Table 5.6 - Corn Herbicides and Their Restrictions (cont.)

Trade Name	Common Name	Herbicide group # (site of action)	Manufacturer	Restricted-Use Pesticide ¹	Water Quality Advisory ²	Worker Reentry (Hours) ³
Autumn Super 51WDG	iodosulfuron + thien carbazon	2/2	Bayer CropScience	—	—	12
Axiom 68DF	flufenacet + metribuzin	15/5	Bayer CropScience	—	yes	12
Balance Flexx 2SC	isoxaflutole + safener	27	Bayer CropScience	yes	yes	12
Basagran 4S	bentazon	6	several	—	yes	12
Basis Blend 30DF	rimsulfuron + thifensulfuron	2/2	Corteva	—	—	4
Bicep II Magnum 5.5SC/ Cinch ATZ	S-metolachlor + atrazine + safener	15/5	Syngenta/ Corteva	yes	yes	24
Bicep Lite II Magnum 6SC/ Cinch ATZ Lite	S-metolachlor + atrazine + safener	15/5	Syngenta/ Corteva	yes	yes	24
Cadet 0.91EC	fluthiacet	14	FMC	—	yes	12
Calibra 3.1ZC	S-metolachlor + mesotrione	15/27	Syngenta	—	yes	24
Callisto 4SC	mesotrione	27	Syngenta	—	—	12
Callisto Xtra 3.7SC	mesotrione + atrazine	27/5	Syngenta	yes	yes	12
Capreno 3.45SC	tembotrione + thien carbazon + safener	27/2	Bayer CropScience	—	yes	12
Clarity 4S	dicamba	4	BASF	—	yes	24
Corvus 2.63SC	isoxaflutole + thien carbazon + safener	27/2	Bayer CropScience	yes	yes	12
Coyote 3.67EC	S-metolachlor + mesotrione	15/27	UPL	—	yes	24
Curtail 2.38L	clopyralid + 2,4-D	4/4	Corteva	—	—	48
Defol 5L	sodium chlorate	not classified	Drexel	—	—	12
Degree Xtra 4.04ME	acetochlor + atrazine	15/5	Monsanto	yes	yes	12
DiFlexx 4SC	dicamba + safener	4	Bayer CropScience	—	yes	24
DiFlexx DUO 1.53SC	dicamba + tembotrione + safener	4/27	Bayer CropScience	—	yes	24
Distinct 70DF	dicamba + diflufenzopyr	4/19	BASF	—	yes	12
Dual Magnum 7.62E	S-metolachlor	15	Syngenta	—	yes	24
Dual II Magnum 7.64E	S-metolachlor + safener	15	Syngenta	—	yes	24
Durango DMA/DuraMax 4S	glyphosate	9	Corteva	—	—	4
Elevore 0.57L	halauxifen	4	Corteva	—	yes	12
Engenia 5SL	dicamba (BAPMA salt)	4	BASF	yes	yes	24
Enlist Duo 3.3SL	2,4-D choline + glyphosate	4/9	Corteva	—	—	48
Enlist One 3.8SL	2,4-D choline	4	Corteva	—	—	48
Empyros 3.82EC	S-metolachlor + tolpyralate	15/27	Helena	—	yes	12
Enversa 3CS	acetochlor	15	Corteva	—	yes	12
EverpreX 7.62E	S-metolachlor	15	Corteva	—	yes	24

Table 5.6 - Corn Herbicides and Their Restrictions (cont.)

Trade Name	Common Name	Herbicide group # (site of action)	Manufacturer	Restricted-Use Pesticide ¹	Water Quality Advisory ²	Worker Reentry (Hours) ³
Evik 80W	ametryn	5	Syngenta	—	—	12
Expert 4.88L	atrazine + S-metolachlor + glyphosate	5/15/9	Syngenta	yes	yes	12
Fierce 76WDG/Fierce EZ 3.04SC	pyroxasulfone + flumioxazin	15/14	Valent	—	yes	12
FirstShot 50WDG	thifensulfuron + tribenuron	2/2	FMC	—	—	12
FulTime NXT 4.04EC	acetochlor + atrazine	15/5	Corteva	yes	yes	12
Gramoxone SL 2S/3S	paraquat	22	Syngenta	yes	—	12–24
Halex GT 4.39EC	S-metolachlor + mesotrione + glyphosate ⁴	15/27/9	Syngenta	—	yes	24
Harmony Extra SG 50WDG/Audit 1:1	thifensulfuron + tribenuron	2/2	FMC/UPL	—	—	12
Harmony SG 50WDG	thifensulfuron	2	FMC	—	—	4
Harness 7E	acetochlor + safener	15	Bayer CropScience	—	yes	12
Harness MAX 3.85L	acetochlor + mesotrione	15/27	Bayer CropScience	—	yes	12
Harness Xtra 5.6/6L	acetochlor + atrazine	15/5	Bayer CropScience	—	yes	12
Hornet 78.5WDG	flumetsulam + clopyralid	2/4	AMVAC	—	yes	48
Impact 2.8SC/Armezon	topramezone	27	AMVAC/BASF	—	—	12
Impact Core 7.15SC	topramezone + acetochlor	27/15	AMVAC	—	yes	12
ImpactZ 4.26SC	topramezone + atrazine	27/5	AMVAC	yes	yes	12
Katagon 2OD	tolpyralate + nicosulfuron	27/2	Helm	—	yes	12
Keystone LA NXT 6SE	acetochlor + atrazine	15/5	Corteva	yes	yes	12
Keystone NXT 5.6SE	acetochlor + atrazine	15/5	Corteva	yes	yes	12
Kyro 3.1CS	acetochlor + topramezone + clopyralid	15/27/4	Corteva	—	yes	48
Laudis 3.5SC	tembotrione	27	Bayer CropScience	—	yes	12
Liberty 280 2.34L ⁵ /Rely 280	glufosinate	10	BASF	—	—	12
Lightning 70DG ⁶	imazethapyr + imazapyr	2/2	BASF	—	yes	12
Lorox 50DF/Linex 4L	linuron	5	Nova Source	—	—	24
Lumax EZ 3.67SC/Lexar EZ 3.7SC	S-metolachlor + mesotrione + atrazine	15/27/5	Syngenta	yes	yes	24
Maestro 2E/Moxy (Buctril)	bromoxynil	6	Nufarm/WinField	—	—	24
Maverick 2.04SC	pyroxasulfone + mesotrione + clopyralid	15/27/4	Valent	—	yes	12
Metribuzin 75DF/4L	metribuzin	5	various	—	yes	12
Outlook 6EC	dimethenamid	15	BASF	—	yes	12

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Table 5.6 - Corn Herbicides and Their Restrictions (cont.)

Trade Name	Common Name	Herbicide group # (site of action)	Manufacturer	Restricted-Use Pesticide ¹	Water Quality Advisory ²	Worker Reentry (Hours) ³
Panoflex 50WDG	thifensulfuron + tribenuron	2/2	FMC	—	—	12
Peak 57WG	prosulfuron	2	Gowan	—	yes	12
Permit 75WG	halosulfuron	2	Gowan	—	—	12
Permit Plus 74WDG	halosulfuron + thifensulfuron	2/2	Gowan	—	—	12
Perpetuo 2.3SC	pyroxasulfone + flumiclorac	15/14	Valent	—	yes	12
Princep, Simazine, 4L/90DF	simazine	5	Syngenta, others	—	yes	12
Prowl 3.3E	pendimethalin	3	BASF	—	—	24
Prowl H ₂ O 3.8CS	pendimethalin	3	BASF	—	—	24
Python 80WDG	flumetsulam	2	AMVAC	—	yes	12
Realm Q 39WDG	rimsulfuron + mesotrione + safener	2/27	Corteva	—	yes	12
Resicore 3.29SE/Resicore REV 3.26SE	acetochlor + mesotrione + clopyralid + safener	15/27/4	Corteva	—	yes	12
Resolve 25DF	rimsulfuron	2	Corteva	—	—	4
Resolve Q 22.4WDG	rimsulfuron + thifensulfuron + safener	2/2	Corteva	—	—	4
Resource 0.86E	flumiclorac	14	Valent	—	—	12
Restraint 6.5EC	acetochlor + tolpyralate	15/27	Summit Agro	—	yes	12
Reviton 2.83SC	tiafenacil	14	Helm	—	yes	12
Revolin Q 51.2WDG	nicosulfuron + mesotrione	2/27	Corteva	—	—	12
Roundup WeatherMax 4.5S/PowerMax 4.5S/PowerMAX3 4.8S	glyphosate	9	Monsanto	—	—	4
Sequence 5.25EW	glyphosate + S-metolachlor	9/15	Syngenta	—	yes	24
Sharpen 2.85SC	saflufenacil	14	BASF	—	yes	12
Shieldex 400SC (3.33SC)	tolpyralate	27	Summit Agro	—	yes	12
Sinate 2.57L	topramezone + glufosinate	27/10	AMVAC	—	yes	12
Starane Ultra 2.8L	fluroxypyr	4	Corteva	—	—	12
Status 56WG	dicamba + diflufenzopyr + isoxadifen	4/19	BASF	—	yes	12
Steadfast Q 37.7WG	nicosulfuron + rimsulfuron + safener	2/2	Corteva	—	—	4
Stinger 3S	clopyralid	4	Corteva	—	yes	12
Storen 3.2ZC	S-metolachlor + mesotrione + pyroxasulfone + bicyclopyrone	15/27/15/27	Syngenta	—	yes	24
Stout 72.5WDG	nicosulfuron + thifensulfuron	2/2	Corteva	—	—	4
SureStart II 4.25SE/ TripleFLEX II	acetochlor + flumetsulam + clopyralid	15/2/4	Corteva/ Monsanto	—	yes	12

Table 5.6 - Corn Herbicides and Their Restrictions (cont.)

Trade Name	Common Name	Herbicide group # (site of action)	Manufacturer	Restricted-Use Pesticide ¹	Water Quality Advisory ²	Worker Reentry (Hours) ³
Surpass NXT 7E	acetochlor + safener	15	Corteva	—	yes	12
Sustain 1.63CS	saflufenacil + pyroxasulfone	14/15	BASF	—	yes	12
TopNotch 3.2ME	acetochlor + safener	15	Corteva	—	yes	12
Tough 5EC	pyridate	6	Belchim	—	—	12
TriVolt 3.65SC	isoxaflutole + flufenacet + thien carbazon	27/15/2	Bayer CropScience	yes	yes	12
Tripzin 4ZC	pendimethalin + metribuzin	3/5	UPL	—	yes	24
ValorSX 51WDG/Valor EZ 4SC	flumioxazin	14	Valent	—	—	12
Verdict 5.57EC	saflufenacil + dimethenamid	14/15	BASF	—	yes	12
Warrant 3CS	acetochlor	15	Monsanto	—	yes	12
Xtendimax 2.9SL	dicamba	4	Monsanto	yes	yes	24
Yukon 67.5WDG	halosulfuron + dicamba	2/4	Gowan	—	—	12
Zidua SC 4.17L	pyroxasulfone	15	BASF	—	yes	12

¹ Only licensed applicators may purchase and apply restricted-use pesticides. To become licensed, contact the Pennsylvania Department of Agriculture.

² These herbicides have properties that may result in ground or surface water contamination. Do not apply them in areas where soils are permeable or coarse and groundwater is near the surface. Practices should be followed to minimize the potential for dissolved runoff and/or runoff erosion. See the herbicide label for specific restrictions.

³ If soil-applied products are incorporated at application time, under certain circumstances the Worker Protection Standard allows workers to enter the treated area if they will have no contact with anything that has been treated. Personal protective equipment is required for early entry to treated areas if contact with treated soil, plants, or water is involved.

⁴ For use on glyphosate-resistant corn hybrids only (Roundup Ready).

⁵ For use on glufosinate-resistant corn hybrids only (Liberty Link).

⁶ For use only on IMI (IR/IT) or Clearfield (CL) corn hybrids.

Table 5.7 - Corn Herbicide Prepackaged Mixes or Co-Packs, and Equivalents

Herbicide Trade Name	Components (ai or ae/gal or lb)	If you apply (per acre)...	You have applied (ai or ae)	Site of Action Number	An equivalent tank-mix of
Acuron 3.44SC	2.14 lb S-metolachlor	2.5 qt	1.34 lb S-metolachlor	15	1.4 pt Dual II Magnum 7.64E
	0.24 lb mesotrione		0.15 lb mesotrione	27	4.8 fl oz Callisto 4SC
	0.06 lb bicyclopyrone		0.038 lb bicyclopyrone	27	0.038 lb bicyclopyrone
	1 lb atrazine		0.625 lb atrazine	5	0.625 qt atrazine 4L
Acuron Flexi 3.26SC	2.86 lb S-metolachlor	2 qt	1.43 lb S-metolachlor	15	1.5 pt Dual II Magnum 7.64E
	0.32 lb mesotrione		0.16 lb mesotrione	27	5.12 fl oz Callisto 4SC
	0.08 lb bicyclopyrone		0.04 lb bicyclopyrone	27	0.04 lb bicyclopyrone

Table 5.7 - Corn Herbicide Prepackaged Mixes or Co-Packs, and Equivalents (cont.)

Product	Components (ai or ae/gal or lb)	If you apply (per acre)...	You have applied (ai or ae)	Site of Action Number	An equivalent tank- mix of
Acuron GT 4.29SC	2 lb S-metolachlor	3.75 pt	0.94 lb S-metolachlor	15	1 pt Dual Magnum 7.62E
	0.2 lb mesotrione		0.09 lb mesotrione	27	3 fl oz Callisto 4SC
	0.095 lb bicyclopyrone		0.044 lb bicyclopyrone	27	0.044 lb bicyclopyrone
	2 lb glyphosate		0.94 lb glyphosate (ae)	9	27 fl oz glyphosate 4.5S
Anthem Flex 4SE	3.733 lb pyroxasulfone	3.5 fl oz	0.102 lb pyroxasulfone	15	3.1 fl oz Zidua 4.17SC
	0.267 lb carfentrazone		0.007 lb carfentrazone	14	0.47 fl oz Aim 2EC
Anthem Maxx 4.3SC	4.174 lb pyroxasulfone	4 fl oz	0.133 lb pyroxasulfone	15	4.1 oz Zidua 4.17SC
	0.126 lb fluthiacet		0.004 lb fluthiacet	14	0.56 oz Cadet 0.91EC
Armezon PRO 5.35EC	0.1 lb topramezon	24 fl oz	0.017 lb topramezon	27	0.76 fl oz Armezon 2.8SC
	5.25 lb dimethenamid		0.84 lb dimethenamid	15	18 fl oz Outlook 6EC
Autumn Super 51WDG	0.06 lb iodosulfuron	0.4 oz	0.002 lb iodosulfuron	2	0.024 oz ai iodosulfuron
	0.45 lb thiencazabone		0.011 lb thiencazabone	2	0.18 oz ai thiencazabone
Axiom 68DF	0.544 lb flufenacet	16 oz	0.544 lb flufenacet	15	17 oz Define 4SC
	0.136 lb metribuzin		0.136 lb metribuzin	5	2.9 oz Metribuzin 75DF
Basis Blend 30DF	0.20 lb rimsulfuron	0.825 oz	0.01 lb rimsulfuron	2	0.64 oz Resolve 25DF
	0.10 lb thifensulfuron		0.005 lb thifensulfuron	2	0.16 oz Harmony SG 50DF
Bicep II Magnum 5.5SC/ Cinch ATZ	2.4 lb S-metolachlor	2.1 qt	1.26 lb S-metolachlor	15	1.33 pt Dual II Magnum 7.64E
	3.1 lb atrazine		1.63 lb atrazine	5	1.63 qt atrazine 4L
Bicep Lite II Magnum 6L/Cinch ATZ Lite	3.33 lb S-metolachlor	1.3 qt	1.08 lb S-metolachlor	15	1.13 pt Dual II Magnum 7.64E
	2.67 lb atrazine		0.87 lb atrazine	5	0.87 qt atrazine 4L
Callisto GT	0.38 lb mesotrione	2 pt	0.095 lb mesotrione	27	3.04 fl oz Callisto 4SC
	3.8 lb glyphosate		0.95 lb glyphosate	9	27 fl oz glyphosate 4.5S
Callisto Xtra 3.7SC	0.5 lb mesotrione	24 fl oz	0.09 lb mesotrione	27	3 fl oz Callisto 4SC
	3.2 lb atrazine		0.6 lb atrazine	5	1.2 pt atrazine 4L
Capreno 3.45SC	2.88 lb tembotrione	3 fl oz	0.068 lb tembotrione	27	2.5 fl oz Laudis 3.5SC
	0.57 lb thiencazabone		0.013 lb ai thiencazabone	2	0.21 oz ai thiencazabone
Corvus 2.63SC	1.88 lb isoxaflutole	5.6 fl oz	0.083 lb isoxaflutole	27	5.3 fl oz Balance Flexx 2SC
	0.75 lb thiencazabone		0.033 lb thiencazabone	2	0.52 oz ai thiencazabone
Coyote 3.67SC	0.33 mesotrione	2 qts	0.168 lb mesotrione	27	5.36 fl oz Callisto 4SC
	3.34 S-metolachlor		1.67 lb S-metolachlor	15	1.75 pt Dual II Magnum 7.64 EC

Table 5.7 - Corn Herbicide Prepackaged Mixes or Co-Packs, and Equivalents (cont.)

Product	Components (ai or ae/gal or lb)	If you apply (per acre)...	You have applied (ai or ae)	Site of Action Number	An equivalent tank-mix of
Curtail 2.38L	0.38 lb clopyralid	2 pt	0.095 lb clopyralid	4	0.25 pt Stinger 3S
	2.0 lb 2,4-D		0.5 lb 2,4D	4	1.0 pt 2,4-D 4S
Degree Xtra 4.04ME	2.7 lb acetochlor	3 qt	2.03 lb acetochlor	15	2.3 pt Harness 7E
	1.34 lb atrazine		1.0 lb atrazine	5	1.0 qt atrazine 4L
DiFlexx Duo 1.53SC	1.26 lb dicamba	32 fl oz	0.32 lb dicamba	4	10.25 oz DiFlexx 4SC
	0.27 lb tembotrione		0.068 lb tembotrione	27	2.5 fl oz Laudis 3.5SC
Enlist Duo 3.3SL	1.6 lb 2,4-D choline salt	4.75 pt	0.95 lb ae 2,4-D	4	30 fl oz Enlist One 3.8SL
	1.7 lb glyphosate		1.0 lb ae glyphosate	9	32 fl oz Durango DMA
Expert 4.88L	1.74 lb S-metolachlor	3 qt	1.3 lb S-metolachlor	15	1.4 pt Dual II Magnum 7.64E
	2.14 lb atrazine		1.6 lb atrazine	5	1.6 qt atrazine 4L
	0.75 lb ae glyphosate		0.75 lb glyphosate	9	1.5 pt glyphosate 4S
Fierce 76WDG	0.335 lb flumioxazin	3 oz	1.0 oz flumioxazin	14	2.0 oz Valor SX 51WG
	0.425 lb pyroxasulfone		1.28 oz pyroxasulfone	15	1.5 oz Zidua 85WG
Fierce EZ 3.04SC	1.34 lb flumioxazin	6 fl oz	0.063 lb flumioxazin	14	2 oz Valor SX 51WDG
	1.70 lb pyroxasulfone		0.08 lb pyroxasulfone	15	2.46 fl oz Zidua 4.17SC
FulTime NXT 4.04CS	2.7 lb acetochlor	3 qt	2 lb acetochlor	15	2.5 qt TopNotch 3.2ME
	1.34 lb atrazine		1 lb atrazine	5	1 qt atrazine 4L
Halex GT 4.39EC	2.09 lb S-metolachlor	3.6 pt	0.94 lb S-metolachlor	15	1.0 pt Dual Magnum 7.62E
	0.209 lb mesotrione		0.09 lb mesotrione	27	3.0 fl oz Callisto 4SC
	2.09 lb glyphosate		0.94 lb glyphosate (ae)	9	27 fl oz glyphosate 4.5S
Harness MAX 3.85L	3.52 lb acetochlor	2 qt	1.76 lb acetochlor	15	2 pt Harness 7E
	0.33 lb mesotrione		0.165 lb mesotrione	27	5.3 fl oz Callisto 4SC
Harness Xtra 6.0L	4.3 lb acetochlor	2 qt	2.15 lb acetochlor	15	2.46 pt Harness 7E
	1.7 lb atrazine		0.85 lb atrazine	5	0.85 qt atrazine 4L
Harness Xtra 5.6L	3.1 lb acetochlor	2.5 qt	1.94 lb acetochlor	15	2.21 pt Harness 7E
	2.5 lb atrazine		1.56 lb atrazine	5	1.56 qt atrazine 4L
Hornet 78.5 WDG	0.185 lb flumetsulam	5 oz	0.058 lb flumetsulam	2	1.15 oz Python 80WDG
	0.5 lb clopyralid		0.195 lb clopyralid	4	6.7 fl oz Stinger 3S
Impact Core 7.15SC	7.08 lb acetochlor	30 fl oz	1.66 lb acetochlor	15	1.9 pt Harness 7E
	0.071 lb topramezone		0.017 lb topramezone	27	0.77 fl oz Impact 2.8SC
ImpactZ 4.26SC	4 lb atrazine	10.7 fl oz	0.33 lb atrazine	5	10.6 fl oz atrazine 4L
	0.26 lb topramezone		0.02 lb topramezone	27	1 fl oz Impact 2.8SC
Keystone LA NXT 6SE	4.3 lb acetochlor	2.3 qt	2.47 lb acetochlor	15	2.7 pt Surpass NXT 7EC
	1.5 lb atrazine		1.43 lb atrazine	5	1.95 pt atrazine 4L

Table 5.7 - Corn Herbicide Prepackaged Mixes or Co-Packs, and Equivalents (cont.)

Product	Components (ai or ae/gal or lb)	If you apply (per acre)...	You have applied (ai or ae)	Site of Action Number	An equivalent tank- mix of
Keystone NXT 5.6SE	3.1 lb acetochlor	2.5 qt	1.94 lb acetochlor	15	2.22 pt Surpass/ Breakfree NXT
	2.5 lb atrazine		1.57 lb atrazine	5	3.15 pt atrazine 4L
Kryo 3.1CS	2.78 lb acetochlor	45 fl oz	0.977 lb acetochlor	15	1.1 pt Harness 7E
	0.046 lb topramezone		0.016 lb topramezone	27	0.73 fl oz Armezon 2.8SC
	0.247 lb clopyralid		0.087 lb clopyralid	4	0.23 pt Stinger 3S
Lexar EZ 3.7SC	1.74 lb S-metolachlor	3 qt	1.3 lb S-metolachlor	15	1.36 pt Dual II Magnum 7.64E
	0.224 lb mesotrione		0.168 lb mesotrione	27	5.36 oz Callisto 4SC
	1.74 lb atrazine		1.3 lb atrazine	5	1.3 qt atrazine 4L
Lumax EZ 3.67SC	2.49 lb S-metolachlor	2.7 qt	1.67 lb S-metolachlor	15	1.75 pt Dual II Magnum 7.64E
	0.249 lb mesotrione		0.168 lb mesotrione	27	5.36 oz Callisto 4SC
	0.935 lb atrazine		0.625 lb atrazine	5	0.625 qt atrazine 4L
Maverick 2.04SC	0.693 lb pyroxasulfone	32 fl oz	0.173 lb pyroxasulfone	15	5.3 fl oz Zidua 4.17SC
	0.829 lb mesotrione		0.207 lb mesotrione	27	6.6 fl oz Callisto 4SC
	0.525 lb clopyralid		0.131 lb clopyralid	4	5.6 fl oz Stinger 3S
Permit Plus 74WDG	0.662 lb halosulfuron	0.75 oz	0.031 lb halosulfuron	2	0.67 oz Permit 75WG
	0.078 lb thifensulfuron		0.004 lb thifensulfuron	2	0.12 oz Harmony 50SG
Perpetuo 2.3SC	0.59 lb flumiclorac	8 fl oz	0.037 lb flumiclorac	14	5.5 fl oz Resource 0.86EC
	1.71 lb pyroxasulfone		0.107 lb pyroxasulfone	15	3.28 fl oz Zidua 4.17SC
Realm Q 38.75WDG	0.075 lb rimsulfuron	4 oz	0.019 lb rimsulfuron	2	1.2 oz Resolve 25WG
	0.313 lb mesotrione		0.078 lb mesotrione	27	2.5 fl oz Callisto 4SC
Resicore 3.29SE	2.8 lb acetochlor	2.5 qt	1.75 lb acetochlor	15	2 pt Surpass NXT 7E
	0.3 lb mesotrione		0.18 lb mesotrione	27	5.76 fl oz Callisto 4SC
	0.19 lb clopyralid		0.119 lb clopyralid	4	0.3 pt Stinger 3S
Resolve Q 22.4WDG	0.184 lb rimsulfuron	1.25 oz	0.014 lb rimsulfuron	2	0.9 oz Resolve 25DF
	0.04 lb thifensulfuron		0.003 lb thifensulfuron	2	0.1 oz Harmony 50SG
Revulin Q 51.2WDG	0.144 lb nicosulfuron	4 oz	0.58 oz nicosulfuron	2	1.1 oz Accent Q 54.5WG
	0.368 lb mesotrione		1.5 oz mesotrione	27	3 fl oz Callisto 4SC
Sinate 2.57L	0.1 lb topramezone	28 fl oz	0.022 lb topramezone	27	1 fl oz Impact 2.8SC
	2.47 lb glufosinate		0.54 lb glufosinate	10	29.5 fl oz Liberty 2.34L
Status 56WG	0.4 lb dicamba	5 oz	0.125 lb dicamba	4	4 fl oz Clarity 4S
	0.16 lb diflufenzopyr		0.05 lb diflufenzopyr	19	0.05 lb diflufenzopyr

Table 5.7 - Corn Herbicide Prepackaged Mixes or Co-Packs, and Equivalents (cont.)

Product	Components (ai or ae/gal or lb)	If you apply (per acre)...	You have applied (ai or ae)	Site of Action Number	An equivalent tank- mix of
Steadfast Q 37.7WG	0.125 lb rimsulfuron	1.5 oz	0.012 lb rimsulfuron	2	0.76 oz Resolve 25WG
	0.252 lb nicosulfuron		0.02 lb nicosulfuron	2	0.7 oz Accent Q 54.5WG
Storen 3.24ZC	2.69 lb S-metolachlor	2.1 qt	1.41 lb S-metolachlor	15	1.48 pt Dual II Magnum 7.64E
	0.31 lb mesotrione		0.163 lb mesotrione	27	5.2 fl oz Callisto 4SC
	0.15 lb pyroxasulfone		0.079 lb pyroxasulfone	15	2.4 fl oz Zidua 4.17SC
	0.075 lb bicyclopyrone		0.039 lb bicyclopyrone	27	0.039 lb bicyclopyrone
Stout 72.5WDG	0.675 lb nicosulfuron	0.75 oz	0.031 lb nicosulfuron	2	0.67 oz Accent 75DF
	0.05 lb thifensulfuron		0.002 lb thifensulfuron	2	0.05 oz Harmony 75DF
SureStart II 4.25SE or TripleFLEX II	3.75 lb acetochlor	2 pt	0.94 lb acetochlor	15	1.1 pt Surpass NXT 7E
	0.29 lb clopyralid		0.075 lb clopyralid	4	3.2 fl oz Stinger 3S
	0.12 lb flumetsulam		0.03 lb flumetsulam	2	0.6 oz Python 80WDG
Surtain 1.63ZC	0.63 lb saflufenacil	14 oz	0.068 lb saflufenacil	14	3 fl oz Sharpen 2.85SC
	1.00 lb pyroxasulfone		0.109 lb pyroxasulfone	15	3.8 fl oz Zidua 4.17SC
TriVolt 3.65SC	0.57 lb isoxaflutole	20 fl oz	0.09 lb isoxaflutole	27	5.76 fl oz Balance Flexx 2SC
	2.85 lb flufenacet		0.45 lb flufenacet	15	0.45 lb flufenacet
	0.23 lb thien carbazon		0.04 lb thien carbazon	2	0.04 lb thien carbazon
Verdict 5.57EC	5.0 lb dimethenamide	13 fl oz	0.5 lb dimethenamide	15	11 fl oz Outlook 6EC
	0.57 lb saflufenacil		0.058 lb saflufenacil	14	2.6 fl oz Sharpen 2.85L
Yukon 67.5WDG	0.125 lb halosulfuron	4 oz	0.03 lb halosulfuron	2	0.67 oz Permit 75WG
	0.55 lb dicamba		0.125 lb dicamba	4	4.0 fl oz Clarity 4S

Table 5.8 - Relative Effectiveness of “Burndown” Treatments for Control of Weeds in No-Till Corn

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rates and weed size or growth stage. Treatments are rated only for control of vegetation existing at the time of application.

Weed control rating: 10 = 95–100% 9 = 85–95% 8 = 75–85% 7 = 65–75% 6 = 55–65%
 N = less than 55% or no control + = upper end of rating scale — = not applicable or no local data available

Herbicide ¹	Site of Action Number	Burdock, common	Chickweed ⁴	Dandelion	Dock, Curly	Downy Brome	Evening Primrose,	Cutleaf	Field Violet/Pansy	Annual Flea-banes	Foxtail	Garlic, Wild	Geranium, Carolina	Groundsel, common ²	Hemp Dogbane, Dewberry, Milkweed, etc.	Henbit/Dead-nettle	Horseweed/Marestail ^{3,4}	Lambs-quarters	Mustards spp.	Quack-grass Sod	Ragweed, common	Smart-weed	Thistle, Canada
2,4-D (1 qt) (spring-applied)	4	7	6	8	7	N	9	6	6	6	N	7	—	6	N	N	8+	9	9	N	9	7	8
2,4-D + dicamba (spring-applied)	4/4	8	8	8	7+	N	9	7	7	8	N	7	7+	7	6	6	9	9	N	9	9	8+	
Atrazine	5	6	8	N	6	7	7	8	8	7+	7	N	9	9	N	8	8	N	8	8	9	9	6
Atrazine + 2,4-D	5/4	7+	8	9	7	7	9	8	8	7+	7	7	9	9	N	8	9	9	9	7	9	9	8+
Autumn Super + 2,4-D (fall-applied)	2/4	9	9 ⁴	9	7	N	9	6	6	8	N	—	—	8	N	9	9	—	9	N	—	—	6
Balance/Corvus	27/(2)	7	8	6	N	N	—	6	6	7	6	—	—	8	N	7+	7	7	8	N	7	6	6
Glyphosate (fall-applied) ⁵	9	8+	9	9	7	9	7	7	7	8	—	9	8	9	8+	8	N	—	9	9	—	—	9
Glyphosate (spring-applied) ⁵	9	7	9	6	6	9	6	6	6	7+	9+	8	7	9	7	6	N	9	9	8	9	7	8
Gramoxone	22	N	8+	N	N	7	7	8	8	6	9	6	8	8+	6	7	7	8	8	6	8	7	6
Liberty	10	6	8	6	—	6	6	N	8	8	8	—	—	7	N	6	8	8	8	6	8	8	6
Reviton (2 fl oz)	14	—	8	6	—	6	8	8	8	7+	6	—	—	—	—	8	7	8	8	—	8	—	—
Sharpen ⁷ (2 fl oz)	14	N	6	7	—	N	N	N	N	7+	N	—	—	8	N	6	8	8	8	N	8	8	6
Valor SX/Fierce	4/(15)	N	9	7	N	8 ⁷	6	N	N	N	N	—	—	7	N	7	6	9	8	N	7	7	N
Mixtures																							
Glyphosate + 2,4-D or dicamba (fall-applied)	9/4	9+	9	9	7	9	9+	7	7	9 ⁶	—	9	8	9	9	8+ ⁶	9 ⁶	—	9 ⁶	9	—	—	9+
Glyphosate + 2,4-D or dicamba (spring-applied)	9/4	7+	9	8	7	9	9	8	8	8	9+	8	7	9	7+	8+	9	9	9	9	9	8+	8+
Glyphosate + Atrazine	9/5	7+	9	7	6	9	6	8	8	7+	9	8	7	9	N	9	—	9	9	9	9	9	8

Table 5.8 - Relative Effectiveness of “Burndown” Treatments for Control of Weeds in No-Till Corn (cont.)

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rates and weed size or growth stage. Treatments are rated only for control of vegetation existing at the time of application.

Weed control rating: 10 = 95–100% 9 = 85–95% 8 = 75–85% 7 = 65–75% 6 = 55–65%
 N = less than 55% or no control + = upper end of rating scale — = not applicable

Herbicide ¹	Site of Action Number	Burdock, common	Chickweed ⁴	Dandelion	Dock, Curly	Downy Brome	Evening Primrose,	Field Violet/Pansy	Annual Fleabanes	Foxtail	Garlic, Wild	Geranium, Carolina	Groundsel, common ²	Hemp Dogbane, Dewberry, Milkweed, etc.	Henbit	Deadnettle	Horseweed/ ³ Marestail ⁴	Lambs-quarters, TR	Mustards spp.	Quackgrass Sod	Ragweed, common	Smartweed	Thistle, Canada
Glyphosate + Metribuzin	9/5	7	9	6	6	9	6	8	8	9	8	7	9	7	8+	N	9	9	9	9	9	9	8
Glyphosate + Sharpen	14/9	7	9	6	6	9	6	6	8	9+	—	—	9	7	6	9	9	9	9	8	9	9	8
Gramoxone + 2,4-D or dicamba ⁵	22/4	7	9	7	7	7	9	8+	7	9	7	8	8+	6	8	8+	9	9	9	6	9	8+	8
Gramoxone + Atrazine	22/5	6	9	N	6	8	7	8	7	9	6	8	8+	6	9	8+	8	8	8+	8	9	9	7
Gramoxone + Metribuzin	22/5	6	9	N	N	7	7	8	6	9	6	8	8+	6	8	8	8	8	8+	6	9	9	6
Harmony Extra/FirstShot/Audit	2/2	6	9	6	8	N	—	N	N	N	8+	—	9	6	8	8	7+ ⁴	9	9	N	6	9	8
Harmony Extra/FirstShot/Audit + 2,4-D	2/4	7	9	9	9	N	9	7	6	N	8+	—	9	6+	9	8+	9	9	9	N	9	9	8+
Lumax	15/5/ 27	8	9	8	8	N	—	7	8	6	N	8+	9	N	8	8	8	9	8	N	8+	9	7

¹ See Table 5.2 for additional formulations or trade names containing some of these same active ingredients.

² Certain populations of common groundsel in the northeastern U.S. are resistant to triazine herbicides. Herbicide programs that contain bromoxynil (Maestro, Moxy) or clopyralid (Stinger) provide good control of groundsel in-crop.

³ Roundup and other glyphosate products are not effective on glyphosate-resistant horseweed biotypes.

⁴ Group 2 herbicides will not control ALS-resistant biotypes.

⁵ Activity is reduced if applied in certain tank-mixes; glyphosate with photosynthesis inhibitors such as triazine herbicides; 2,4-D and dicamba with Gramoxone. May still be tank-mixed for convenience, but burndown is improved if applied separately.

⁶ Based on control in early spring. Emergence of seedlings in the spring will reduce effectiveness.

⁷ Use rate of 1.5 fl oz/A has been more consistent for horseweed/marestail control than 1.0 fl oz/A.

⁸ Valor provides control of germinating dandelion seedling; however, it is weak on dandelion when applied post.

Table 5.9 - Effectiveness of Herbicides for Control of Common Cash or Cover Crops in Spring Before Corn Establishment

Control ratings: 10 = 95-100%; 9 = 85-95%; 8 = 75-85%; 7 = 65-75%; 6 = 55-65%; and N = less than 55%; L= listed as controlled on herbicide label, but local data are limited, + = upper end of rating scale, - = not applicable or no local data available.

Herbicide	Rate ¹ (lb/acre)	Site of Action Number	Broadleaf species							Grass species					
			Alfalfa ²	Austrian Winter Pea	Clover, crimson	Clover, red ²	Clover, white ²	Mustards/Radish/Rapeseed	Vetch, hairy	Bluegrass/timothy ²	Bromegrass/orchardgrass/fescue ²	Ryegrass, annual ⁴	Rye, cereal	Triticale	Wheat, winter
2,4-D ester	0.5	4	7+	N	7	8	6	8	9	N	N	N	N	N	N
	1	4	8	N	8	9	7	9	9+	N	N	N	N	N	N
atrazine	1.0	5	N	-	6	6	6	6	7	6	6	6	6	6	6
clopyralid	0.25	4	8+	8	8	9	9	N	9	N	N	N	N	N	N
dicamba	0.5	4	9	7	8	9	9	6	9	N	N	N	N	N	N
Elevore	0.004	4	-	7	N	-	-	N	8	N	N	N	N	N	N
glyphosate	0.75	9	6	8	8+	7	6	7+	7	9	8	8	9	9	9
	1.5	9	7	8+	9	7+	7	8+	8	9+	8+	9	9	9	9
paraquat	0.5	22	N	7	8	7	7	8	7	7	6	6	7	7	8
	0.75	22	N	8	9	8	7	8+	8	7+	7	6	8	7+	8+
Liberty, others ³	0.59	10	N	8+	9	L	-	6	9	-	N	6	6	7	7
Reviton (2 fl oz)	0.04	14	N	6+	8	-	-	-	N	N	N	N	N	N	N
Sharpen (1 fl oz)	0.02	14	N	6	N	-	-	N	N	N	N	N	N	N	N
Mixtures															
2,4-D ester + dicamba	0.5 + 0.5	4 + 4	9+	7	8+	9	9	8	9+	N	N	N	N	N	N
2,4-D ester + Liberty, others ³	0.5 + 0.59	4 + 10	N	9	9	-	-	8	9+	-	N	6	6	6	7
glyphosate + 2,4-D ester	0.75 + 0.5	9 + 4	8+	9	9	8	8	9	9+	9	8	8	9	9	9
glyphosate + dicamba	0.75 + 0.5	9 + 4	9	9	9	9	9	8	9+	9	8	8	9	9	9
glyphosate + Liberty, others ³	0.75 + 0.59	9 + 10	-	9	9	-	-	6	9	-	-	8	9	9	9
glyphosate + Reviton	0.75 + 0.04	9 + 14	6	8	9	-	-	9	7	9	8	8	9	9	9
glyphosate + Sharpen	0.75 + 0.02	9 + 14	-	9	8	-	-	7	8	-	8	8+	9	9	9

Table 5.9 - Effectiveness of Herbicides for Control of Common Cash or Cover Crops in Spring Before Corn Establishment (cont.)

Control ratings: 10 = 95-100%; 9 = 85-95%; 8 = 75-85%; 7 = 65-75%; 6 = 55-65%; and N = less than 55%; L= listed as controlled on herbicide label, but local data are limited, + = upper end of rating scale, – = not applicable or no local data available.

Herbicide	Rate ¹ (lb/acre)	Site of Action Number	Broadleaf species							Grass species					
			Alfalfa ²	Austrian Winter Pea	Clover, crimson	Clover, red ²	Clover, white ²	Mustards/Radish/Rapeseed	Vetch, hairy	Bluegrass/timothy ²	Bromegrass/orchardgrass/fescue ²	Ryegrass, annual	Rye, cereal	Triticale	Wheat, winter
paraquat + 2,4-D or dicamba	0.75 + 0.5	22 + 4	7+	8	9	8+	8	9	9+	7	6	6	8	7	8+
paraquat + atrazine	0.5 + 1	22 + 5	7	8+	9+	8+	7	9	9	9	8	7	8+	8	8+
paraquat + metribuzin	0.5 + 0.25	22 + 5	7	8+	9+	8+	7	8+	9	9	8	7	8+	7+	8+

¹0.75 lb Glyphosate = 32 fl. oz of a 41% glyphosate; 0.5 lb paraquat = 2 pt Gramoxone SL2.0 or 1.33 pt Gramoxone SL 3.0. Clopyralid is a component of Stinger, and Surestart/Tripleflex.

²Application in the fall can improve control with some herbicides.

³Warm temperatures, high humidity, and bright sunlight improve the performance of Liberty. Weed control may be reduced when applications are made to weeds under stress from drought or cool temperatures.

⁴Tank mixing clethodim (Select, etc.) or rimsulfuron (Resolve, Basis Blend) with glyphosate has shown improved burndown activity on annual ryegrass cover crop control in university field trials. Consult herbicide label for use guidelines.

See Table 5.8 for relative effectiveness of these treatments. May need to combine with residual treatment or postemergence program (Tables 5.6 and 5.11) for complete no-till weed-control program.

Table 5.10 - Characteristics of “Burndown” Herbicides for No-Till Corn

Herbicide Trade name	Herbicide Common name	Herbicide group # (site of action)	product/A	lb ai/A
2,4-D LVE 4E	2,4-D ester	4	1 – 2 qt	1–2
Atrazine 90DF	atrazine	5	1.8–2.2 lb	1.6–2

- Apply 7–14 days before planting or 3–5 days after planting for greater crop safety.
- Plant corn at least 1.5 inches deep.
- This product is poor on chickweed, henbit, and deadnettle, and ineffective on all grasses.
- Add Clarity (dicamba) to increase efficacy on legume sods. A combination of 2,4-D + Clarity/Banvel controls most annual broadleaf weeds and alfalfa. Emerged perennial broadleaves are partially controlled. This combination is fair on chickweed, henbit, and deadnettle, and ineffective on all grasses.
- Spray droplet size plays an important role in minimizing off-target movement. Nozzles that produce extremely coarse or ultra coarse droplets while limiting the amount of driftable fine droplets are necessary to limit spray drift. Comply with guidelines for drift management (see label for details).

- Apply 1.6–2 qt atrazine 4L prior to planting.
- Controls small emerged annual broadleaves and some grasses.
- Can be applied in liquid nitrogen as the carrier to improve burndown characteristics.

ATRAZINE USE RESTRICTIONS**Preplant or Preemergence**

- On highly erodible soils (as defined by the U.S. Natural Resources Conservation Service):
- Fields where more than 30 percent of the soil surface is covered with plant residue at planting, apply a maximum of 2.0 lb of active ingredient per acre as a broadcast spray.
- Fields where less than 30 percent of the soil surface is covered with plant residue at planting, apply a maximum of 1.6 lb of active ingredient per acre as a broadcast spray.
- Apply a maximum of 2.0 lb of active ingredient per acre as a broadcast spray.

Postemergence

- If no atrazine was applied prior to crop emergence, use a maximum rate of 2.0 lb of active ingredient per acre.
- If a soil-applied application was made in the same calendar year, the combined preplant or preemergence and postemergence applications may not exceed 2.5 lb of active ingredient per acre.

Safety Precautions for Using Atrazine

- Do not mix, load, or apply within 50 feet of drinking water wells, livestock wells, agricultural drainage wells, irrigation wells, abandoned wells, or sinkholes.
- Do not mix or load within 50 feet of intermittent streams, perennial streams, rivers, lakes, or reservoirs.
- Do not apply within 200 feet of lakes or reservoirs.
- Do not apply within 66 feet of the points where surface water runoff enters intermittent streams, perennial streams, or rivers. The 66-foot buffers should be planted to a crop or seeded with grass on highly erodible land.
- *Restricted-use pesticide and water quality advisory.*

Table 5.10 - Characteristics of “Burndown” Herbicides for No-Till Corn (cont.)

Herbicide Trade name	Herbicide Common name	Herbicide group # (site of action)	product/A	lb ai/A
Autumn Super 51WDG	iodosulfuron	2	0.3–0.5 oz	0.001–0.002
	thiencarbazone	2		0.01–0.014
<ul style="list-style-type: none"> • Autumn Super may be applied after fall harvest and up to 30 days prior to corn planting. • Do not apply to frozen ground. Apply to actively growing weeds. • Autumn Super will provide short-term residual control of small seeded broadleaves but will not provide season-long pre control of annual grasses and broadleaf weeds. • Apply Autumn Super at 0.3–0.5 oz/A plus necessary adjuvants. • For enhanced burndown activity, tank-mix with 2,4-D, glyphosate, paraquat, simazine, or metribuzin. • Be cautious of crop rotation restrictions. 				
dicamba-containing products	dicamba	4	varies	0.25–0.5 lb ae
<ul style="list-style-type: none"> • Apply 7–14 days before planting or 3–5 days after planting for greater crop safety. • Plant corn at least 1.5 inches deep. • A combination of 2,4-D + dicamba controls most annual broadleaf weeds and alfalfa. Emerged perennial broadleaves are partially controlled. This combination is fair on chickweed, henbit, and red deadnettle, and ineffective on all grasses. Applications should be made while annual weeds are small (4 inches) and actively growing. • Spray droplet size plays an important role in minimizing off-target movement. Nozzles that produce extremely coarse or ultra coarse droplets while limiting the amount of driftable fine droplets are necessary to limit spray drift. Comply with guidelines for drift management (see label for details). • Dicamba can be difficult to completely remove from spray equipment and residue is capable of injuring sensitive plants. Follow label instructions concerning sprayer cleanout. 				
Engenia 5SL XtendiMax 2.9SL	dicamba (BAPMA salt) dicamba (DGA salt with VaporGrip Technology)	4	6.4–12.8 fl oz 11–22 fl oz	0.25–0.5 lb ae
<ul style="list-style-type: none"> • Carefully read and follow product labels. • See comments under Clarity for more details. • <i>Engenia/XtendiMax are restricted-use products; all dicamba formulations have a water quality advisory.</i> 				
Enlist Duo 3.3SL	2,4-D choline +	4	3.5–4.75 pt	0.7–0.95 ae
	glyphosate	9		0.74–1.0 ae
<ul style="list-style-type: none"> • Can be used as a burndown application to corn with or without the Enlist trait to control broadleaves and grasses. • Apply 7–14 days before planting for greater crop safety. • Do not apply less than 10 gpa total spray solution and do not use nitrogen solutions as a carrier. • Comply with guidelines for drift management (see label for details). • For best results do not apply to light sandy soils as a pre application. • Can be tank-mixed with residual herbicides. 				
Enlist One 3.8SL	2,4-D choline	4	1.5–2 pt	0.71–0.95
<ul style="list-style-type: none"> • See comments under 2,4-D LVE and Enlist Duo for more details. 				

Table 5.10 - Characteristics of “Burndown” Herbicides for No-Till Corn (cont.)

Herbicide Trade name	Herbicide Common name	Herbicide group # (site of action)	product/A	lb ai/A
Expert 4.88L	S-metolachlor +	15		1.09–1.63
	atrazine +	5	2.5–3.75 qt	1.33–2.0
	glyphosate	9		0.63–0.94 ae

- Expert is a premix of metolachlor (Dual II Magnum), atrazine, and glyphosate.
- The 3 qt. rate contains 1.3 lb S-metolachlor, 1.6 lb atrazine and 0.75 lb ae glyphosate.
- Expert can be used as a burndown/preprogram in corn or as an early post application in Roundup Ready hybrids.
- See Expert label for additional information.
- *Restricted-use pesticide and water quality advisory.*

Glyphosate¹	glyphosate	9	See Table 5.2	
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Fall applications of glyphosate are better than spring applications for control of orchardgrass sods and quackgrass.

- If controlling orchardgrass sod in spring it is best to spray when sod is 6 to 10 inches tall.
- Use at least 1.13 lbs ae glyphosate or higher, especially if tank-mixing with preresidual herbicide and nitrogen carriers.
- Spring applications may be used for control of annual weeds.
- Using low-volume sprays may allow for a reduced rate.
- For control of small annual weeds or volunteer small grains, glyphosate may be used at reduced rates.
- Can be tank-mixed with residual herbicides such as atrazine. When tank-mixing glyphosate with residual herbicides, apply in 10–20 gal water/A or 10–60 gal liquid fertilizer nitrogen/A.
- Adding 2,4-D or dicamba improves control of large annual broadleaf weeds, dandelion, and alfalfa.
- Glyphosate may be applied in clear liquid nitrogen fertilizers and clear liquid complete-analysis fertilizers, but may be less effective on certain annual grasses and perennials.
- Do not use glyphosate with suspension-type liquid fertilizers.

Gramoxone SL 2.0			2–4 pt	
Gramoxone SL 3.0	paraquat	22	1.3–2.7 pt	0.5–1

- Apply in 20–60 gal/A for control of emerged annual weeds.
- Add 16–32 oz non-ionic surfactant/100 gal of spray.
- Adding 2,4-D or dicamba improves control of large annual broadleaf weeds and alfalfa. Alfalfa control is improved by applying 2,4-D or dicamba separately at least 1 day ahead of paraquat.
- Can be tank-mixed with residual herbicides; adding atrazine to paraquat can improve control of fescue and certain other perennial sods.
- Phosphate-containing liquid fertilizer solutions diminish paraquat activity if used as a carrier.
- Use appropriate precautions when handling paraquat to minimize exposure to the herbicide.
- Do not use flood jet tips larger than size 20 or spacing greater than 40 inches.
- Other labeled formulations of paraquat are available; see Table 5.3 for options.

Paraquat Use Restrictions

- Only certified applicators, who successfully complete the paraquat-specific training, can mix, load or apply paraquat.
- Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed; registered technicians cannot apply.
- Required training link (<http://usparaquattraining.com>); certified applicators must repeat training every three years.
- *Gramoxone is a restricted-use pesticide.*

Table 5.10 - Characteristics of “Burndown” Herbicides for No-Till Corn (cont.)

Herbicide Trade name	Herbicide Common name	Herbicide group # (site of action)	product/A	lb ai/A
Harmony Extra SG 50DF	thifensulfuron +	2	0.45–0.9 oz	0.009–0.018
	tribenuron	2		0.005–0.009
<ul style="list-style-type: none"> • Adding Harmony Extra to glyphosate or 2,4-D can improve control of certain winter annual broadleaves and perennials. • Must be applied in fall or early spring at least 14 days ahead of planting. • Other products that contain thifensulfuron and tribenuron include Audit 1:1, FirstShot and Panoflex. 				
Liberty 2.34SL	glufosinate	10	32–43 fl oz	0.59–0.79
<ul style="list-style-type: none"> • Liberty may be applied as a burndown treatment prior to the planting or emergence of any corn variety. • However, early season burndown activity may be reduced since warm temperatures, high humidity, and bright sunlight are necessary to maximize the performance of Liberty. Weed control may be reduced when applications are made to weeds under stress from drought or cool temperatures. • Liberty performs better as a POST herbicide as compared to burndown applications in April. • Apply a minimum of 32 fl oz/A to young, actively growing weeds; burndown and in-crop applications may not exceed 87 fl oz/A per season. • Applications should be made from dawn until 2 hours prior to sunset to avoid the possibility of reduced weed control. • Liberty must be applied with ammonium sulfate and the recommended use rate is 3 lb/A. • Uniform, thorough spray coverage (20 gal/A is recommended) is necessary to achieve consistent weed control; do not use nozzles that produce large droplets; use at least 15 gal/A (20 gal/A if dense vegetation is present). 				
Metribuzin 75DF/4L	metribuzin	5	2–4 oz DF	0.094–0.19
<ul style="list-style-type: none"> • Include metribuzin as part of an herbicide program for burndown of existing vegetation prior to crop emergence. • Metribuzin may be tank-mixed with 2,4-D LVE, Gramoxone, or glyphosate. • Use a maximum of 4 oz DF if applying less than 10 days before planting or on soils with less than 2% organic matter. • Do not use on coarse soils with less than 1.5% organic matter or on soils having pH 7.0 or greater. • Plant corn at least 1.5 inches deep to avoid injury. • <i>Water quality advisory.</i> 				
Reviton 2.83SC	tiafenacil	14	1–3 fl oz	0.022–0.066
<ul style="list-style-type: none"> • Reviton may be applied as an early preplant/burndown treatment through preemergence timings; it will injure emerged corn. There are no plant back restrictions between application and corn planting. • It is best to apply before weeds are taller than 5 inches and complete spray coverage is important for adequate weed control. • Reviton can be applied with glyphosate (or other herbicides) to enhance the speed of burndown and increase weed spectrum. • Include necessary additives MSO plus nitrogen solution or AMS to the spray mixture. • Burndown activity may be decreased or slowed under cloudy, foggy, or cooler weather or when weeds are drought stressed. • Reviton is similar to Sharpen but is less active on marestail, however it has better grass, field pansy/violet, and primrose activity. 				

Table 5.10 - Characteristics of “Burndown” Herbicides for No-Till Corn (cont.)

Herbicide Trade name	Herbicide Common name	Herbicide group # (site of action)	product/A	lb ai/A
Sharpen 2.85SC	saflufenacil	14	1–3 fl oz	0.022–0.067
<ul style="list-style-type: none"> Sharpen may be applied as a preplant/burndown treatment from 14 days early preplant through preemergence timings; do not apply to emerged corn. Apply Sharpen in a typical glyphosate burndown herbicide program to enhance the speed of burndown and increase weed spectrum including glyphosate-resistant horseweed. Depending on the rate, Sharpen can provide some short-term residual control of certain annual broadleaf weeds. Include necessary additives MSO plus nitrogen solution or AMS to the spray mixture. Do not apply more than 1 fl oz/A where an at planting OP or carbamate insecticides are being used. Sharpen is a Group 14 herbicide, and due to concerns for long-term viability of this herbicide mode of action, extension specialists in the Mid-Atlantic region recommend not using it every year. This mode of action has greater utility in soybeans than corn, especially for control of glyphosate-resistant horseweed (marestail). As such, we suggest that Sharpen and other saflufenacil-containing products (e.g., Verdict, Optill) be used in soybean first and only in alternate years. The use of Sharpen in continuous corn should also be limited to every other year (alternating years with HPPD-containing herbicide [Group 27]) and avoided if Sharpen is used in soybean in a corn-soybean rotation. 				
Valor SX 51WDG	flumioxazin	14	1–2 oz	0.51–1.02 oz
<ul style="list-style-type: none"> Valor may be included in a typical no-till burndown herbicide program to enhance the speed of burndown and increase weed spectrum. Corn can be planted 7 days after application if there is at least 25% soil residue cover and ¼ inch rainfall. Fierce 76WDG contains the active ingredients in Valor and Zidua and can be used in burndown programs; see Table 5.15 for additional details. Valor is a Group 14 herbicide, and due to concerns for long-term viability of this herbicide mode of action, extension specialists in the Mid-Atlantic region recommend not using it every year. This mode of action has greater utility in soybeans than corn, especially for control of glyphosate-resistant horseweed (marestail). As such, we suggest that Valor and other flumioxazin-containing products (e.g., Fierce, Valor XLT, Envive) be used in soybean first and only in alternate years. The use of Valor in continuous corn should also be limited to every other year (alternating years with HPPD-containing herbicide [Group 27]) and avoided if Valor is used in soybean in a corn-soybean rotation. 				
<p>¹ Refer to current product label for active ingredient concentration and application rate (e.g., 1 qt/A glyphosate 4S = 22 fl oz/A Roundup WeatherMax).</p>				

Water Solubility and Residual Length Of Soil-Applied Herbicides

Solubility (parts per million; ppm): How many microliters of the herbicide will dissolve in 1 liter of water. The less soluble the herbicide, the more moisture (rain or irrigation) is needed to activate the herbicide and move it into the root zone. Solubility is used as a guideline for rainfall or irrigation required within a short time after application. Moisture needed also depends on the soil moisture at time of application.

Relative moisture levels to move herbicide into the soil to achieve optimum level of control:

Relative Moisture to Activate	ppm	Estimate Water to Activate*
Low	>500 ppm (very soluble)	0.33 inch
Medium	250-500 ppm	0.33-0.5 inch
High	100-250 ppm	0.5-0.75 inch
Very High	<100 ppm	>0.75 inch

*More water (additional irrigation) maybe necessary if soil is dry at time of application, soils with higher clay content, or high plant residues are present.

Relative duration of residual control is for comparison only based on herbicide half-life (length of time it takes for half the herbicide to break down). Herbicide breakdown results from chemical and/or microbial activity. Since the speed of breakdown is affected by a number of factors including soil pH, soil temperature, and soil moisture, duration can vary for herbicides based on the specific conditions. Residual activity is not the same as herbicide carryover.

Duration of residual control assumes 1) good activation; 2) no excessive rain or irrigation; and 3) weed species are sensitive to the herbicide(s) applied.

Table 5.11 - Water Solubility and Longevity Of Soil-Applied Herbicides

Herbicide Trade Name	Solubility (ppm)	Relative moisture amount required to activate	Duration of residual weed control
Atrazine	33	Very High	4-5 weeks
Balance Flexx	7	Very High	2-4 weeks
Callisto	1500	Low	2-4 weeks
Dual II Magnum Cinch	488	Medium	4-5 weeks
Flufenacet	56	Very High	2-4 weeks
Harmony SG	pH5-223	High	1-2 weeks
	pH7-2240	Low	
Harness / Breakfree / Surpass	223	High	2-4 weeks
Intrro	242	High	2-4 weeks
Metribuzin	1,200	Low	2-4 weeks
Outlook	1,174	Low	2-4 weeks
Princep	5	Very High	4-5 weeks
Prowl / other Pendimethalin Formulations	1	Very High	4-5 weeks
Python	5,600	Low	4-6 weeks
Resolve SG	pH7-7300	Low	1-2 weeks
Sharpen	pH 5: 30	Very High	1-3 weeks
	pH 7: 2,100	Low	
Stinger	1000	Low	1-3 weeks
Thiencarbazone-methyl	436	Medium	2-4 weeks
Topnotch	223	High	2-4 weeks
Valor SX	2	Very High	4-5 weeks
Zidua	3.49	Very High	4-5 weeks
Premixes	Constituents		
Acuron	Dual II Magnum, Callisto, atrazine, bicyclopyrone		
Acuron Flexi	Dual II Magnum, Callisto, bicyclopyrone		
Anthem ATZ	Zidua, Cadet, atrazine		
Anthem Flex	Zidua, Aim		
Anthem Maxx	Zidua, Cadet		
Bicep II Magnum /Cinch ATZ	Dual II Magnum (or Cinch), atrazine		
Bicep Lite II Magnum	Dual II Magnum, atrazine		
Corvus	Balance Flexx, thiencarbazone		
Coyote	Dual Magnum, Callisto		
Fierce	Valor SX, Zidua		

5-50 Weed Control in Field Crops: *Corn*

Table 5.11 - Water Solubility and Longevity Of Soil-Applied Herbicides (cont.)

Premixes	Constituents
FulTime / Keystone / Breakfree ATZ	Topnotch (or Surpass), atrazine
Harness MAX	Harness, Callisto
Harness Xtra / Degree Xtra	Harness (or Degree), atrazine
Lumax EZ / Lexar EZ	Dual II Magnum, Callisto, atrazine
Maverick	Zidua, Callisto, Stinger
Resicore	Surpass, Callisto, Stinger
Resolve Q/Basis Blend	Resolve SG, Harmony SG
Storen	Dual II Magnum, Callisto, Zidua, bicyclorpyrone
SureStart II / TripleFLEX II	Harness, Python, Stinger
Surtain	Sharpen, Zidua
TriVolt	Balance Flexx, thiencazone, flufenacet

Table 5.12 - Relative Effectiveness of Soil-Applied (Preemergence) Corn Herbicides¹

Weed control rating:	Crop tolerance:
10 = 95–100%	E = excellent; almost never any crop injury observed
9 = 85–95%	VG = very good; on rare occasion is crop injury observed
8 = 75–85%	G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., seedling depth, seed slit closure, herbicide rate and application timing, adjuvants)
7 = 65–75%	FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions
6 = 55–65%	F = fair; some crop injury is commonly observed
N = less than 55% or no control	
+ = upper end of rating scale	
— = not applicable or no local data available	

Grasses	Site of Action Number	Barnyardgrass	Bermudagrass	Broadleaf signalgrass	Crabgrass	Fall Panicum	Foxtail spp.	Goosegrass	Johnsongrass (Seedling)	Johnsongrass (Rhizome)	Quackgrass	Shattercane	Texas panicum	Wirestem Muhly	Yellow Nutsedge
Trade Name ¹															
Atrazine	5	7	N	N	7	6	6+	7	N	N	7+	6	N	6	6
Balance Flexx ²	27	8	N	N	7	8	8 ³	N	7+	6	N	7+	N	N	N
Dual products	15	9	N	8	9	8	9	9+	6	N	N	6	N	N	8
Harness, Surpass NXT, or TopNotch	15	9	N	8	8+	8	9	9+	7	N	N	6	N	N	7+
Outlook	15	9	N	7	8	8	9	9	6	N	N	6	N	N	7+
Princep	5	8+	N	N	8	8+	8	8	6	N	7	6	N	8	6
Prowl	3	8+	N	8	8+	8+	8	8	7	N	N	7	7	N	6
Zidua	15	8+	N	8	9	8	8+	9+	6	N	N	6	N	N	6
Mixtures															
Acuron	5/15/27	9	N	8	9	8	9	9+	6	N	6	6	N	6	8+
Acuron Flexi	15/27/27	9	N	8	9	8	9	9+	6	N	N	6	N	N	8+
Anthem Maxx or Flex	14/15	8+	N	8	9	8	8+	9+	6	N	N	6	N	N	6
Atrazine + Princep	5/5	8+	N	N	8+	8+	8+	8	6	N	8+	6	N	8	8+
Axiom	5/15	9	N	N	9	8	9	8	6	N	N	6	N	N	6

Table 5.12 - Relative Effectiveness of Soil-Applied (Preemergence) Corn Herbicides¹ (cont.)

<u>Grasses</u>	Site of Action Number	Barnyardgrass	Bermudagrass	Broadleaf signalgrass	Crabgrass	Fall Panicum	Foxtail spp.	Goosegrass	Johnsongrass (Seedling)	Johnsongrass (Rhizome)	Quackgrass	Shattercane	Texas panicum	Wirestem Muhly	Yellow Nutsedge
Tradename ¹															
Bicep, Cinch ATZ	5/15	9	N	8	9	8	9	9+	6	N	6	6	N	6	8+
Corvus	2/27	8	N	N	8	8	8+	N	7+	7	N	7+	N	N	7
Fierce	14/15	8+	N	–	9	8	9	9+	6	N	N	6	N	N	6
Harness MAX, Coyote	15/27	9	N	8	8+	8	9	9+	7	N	N	6	N	N	7+
Harness Xtra, Degree Xtra, FulTime NXT or Keystone NXT	5/15	9	N	8	9	8	9	9+	7	N	6	6	N	6	8+
Lumax/Lexar	5/15/27	9	N	8	9	8	9	9+	6	N	6	6	N	6	8+
Maverick	15/27/4	8+	N	8	9	8	8+	9+	6	N	N	6	N	N	6
Resicore/Resicore XL	15/27/4	9	N	8	8+	8	9	9+	7	N	N	6	N	N	7+
Storen	15/27/15/27	9	N	8	9	8	9	9+	6	N	N	6	N	N	8+
SureStart II/ TripleFLEX II	2/4/15	8	N	8	8	8	8	9+	6	N	N	6	N	N	6
TriVolt	27/15/2	9	N	8	9	8	9	9	7+	7	N	7+	N	N	7
Verdict	14/15	8	N	N	8	8	8	9	N	N	N	N	N	N	7+

¹ See Table 5.4 and 5.6 for additional products that contain these active ingredients.

² Performance ratings based on full labeled rates.

³ Herbicide is less effective on yellow foxtail: Balance-6, and Liberty-7.

Table 5.12 - Relative Effectiveness of Soil-Applied (Preemergence) Corn Herbicides¹ (cont.)

<u>Broadleaves</u>	Site of Action Number	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters ²	Marestail / Horseweed ⁵	Annual Morningglory	Eastern Black Nightshade	Palmer Amaranth / Waterhemp ⁷	Pigweed ²	Common Ragweed ⁸	Giant Ragweed ⁸	Prickly Sida	Smartweed	Spurred Anoda	Velvetleaf	Corn Tolerance, medium soils	Corn Tolerance, coarse soils
Tradename ¹																		
Atrazine	5	6	8+	9	N	9	8+	9	9+	N	9	8	9	9+	8	8	F	F
Balance Flexx	27	7	N	8	9	8+	N	9	8	8	8	7	7	7+	–	9	F–G ³	G
Dual Products	15	N	N	N	6	N	N	7+	8+	8	6	N	N	N	N	N	G	G
Harness, Surpass NTX, or TopNotch	15	N	N	N	7	N	N	8+	8	9	7+	N	N	7	N	6	G	G
Lorox	7	N	7+	7	8+	7	N	6	7	8	7	N	N	9	–	7	F–G	F

5-52 Weed Control in Field Crops: Corn

Table 5.12 - Relative Effectiveness of Soil-Applied (Preemergence) Corn Herbicides on Grasses, Grasslike Species, and Broadleaf Weeds¹ (cont.)

Broadleaves																		
Tradename¹	Site of Action Number	Burcucumber	Cocklebur	Jimsonweed	Lambs-quarters²	Marestail / Horseweed⁵	Annual Morning Glory	Eastern Black Nightshade	Palmer Amaranth / Waterhemp⁷	Pigweed²	Common Ragweed⁸	Giant Ragweed⁸	Prickly Sida	Smartweed	Spurred Anoda	Velvetleaf	Corn Safety medium soils	Corn Safety coarse soils
Outlook	15	N	N	N	6	N	N	7+	8	8	6	N	N	6	N	N	G	G
Princep	5	6	8	9	N	9	9	9	9+	N	9+	7	9	9	8	8	F	F
Prowl	3	N	N	6	9	N	N	N	8	8	N	N	N	8	N	8	G ³	FG
Python	2	6	8	8	8+	N	N	7	N	9	7+	6	8	8+	7	8	F-G ³	F
Zidua	15	N	N	7	8	N	N	8	9+	9	7+	N	7	6	N	7	G	G
Mixtures																		
Acuron	5/15/27	7	9	9	9	9	9	9	9+	9	9	8+	9	9	9	9	G	G
Acuron Flexi	15/27/27	N	6	8	9	8+	6	8+	8+	8+	7	7	N	8+	-	9	G	G
Anthem ATZ	5/14/15	6	9	9	8	9	8+	9	9+	9	8+	8	9	9	8	8	G	G
Anthem Maxx or Flex	14/15	N	N	7	8	N	N	8	9	9	7+	6	6	7	N	7	G	G
Atrazine + Princep	5/5	7	9	9+	N	9	9	9	9+	N	9	8+	9	9	8	8+	F	F
Axiom	5/15	N	N	6	N	6	N	N	7	N	N	N	6+	6	-	N	G	FG
Basis Blend/ Resolve ⁶	2/2	N	6	6	8+	N	N	N	N	9	N	N	N	6	-	6	F-G	F ⁶
Bicep, Cinch ATZ	5/15	6	8+	9	7	9	8+	9	9+	8+	8+	8	9	9	9	8+	G	G
Corvus	2/27	7	8	8	9	8+	7	9	8	9	7+	7+	7	8+	-	9	G	F
Fierce	14/15	N	6	8	9	8+	7+	9	9	9	7+	6	8	7	8	8	G	F
Harness MAX, Coyote	15/27	6	8+	8	9	8	6	8+	8+	8+	7	7	N	8+	-	9	G	G
Harness Xtra, Degree Xtra ⁴ , Fultime NXT, Keystone NXT	5/15	6	8+	9	7+	9	8+	9	9+	9	8+	8	9	9	9	8+	G	G
Lexar	5/15/27	7	9	9	9	9	9	9	9	8+	8+	8+	9	9	9	9	G	G
Lumax	5/15/27	6	8+	9	9	9	8+	9	9	8+	9	8	7+	9	9	9	G	G
Maverick	15/27/4	N	6	8	9	9	6	8+	9	8+	7	7	N	8+	-	9	G	G
Prowl + Atrazine	3/5	6	8+	9	9	9	8+	9	9+	9	8+	8	9	9+	8	9+	G ³	FG
Resicore/ Resicore XL	15/27/4	N	6	8	9	9	6	8+	8+	8+	7	7	N	8+	-	9	G	G
Storen	15/27/15/27	N	6	8	9	8+	6	8+	9	8+	7	7	6	8+	-	9	G	G
SureStart II/ TripleFLEX II	2/4/15	N	7	7	8	9	6	8	8+	8+	8	7+	7	8	-	8	G	F
TriVolt	27/15/2	7	8	8	9	8+	7	9	8	9	7+	7+	7	8+	-	9	G	F
Verdict	14/15	6	8	8	9	7+	8	9	9	9	8	8	7	9	-	8	G	G

Table 5.12 - Relative Effectiveness of Soil-Applied (Preemergence) Corn Herbicides on Grasses, Grasslike Species, and Broadleaf Weeds¹ (cont.)

- ¹ See Table 5.4 and 5.6 for additional products that contain these active ingredients.
- ² Triazine-resistant (TR) biotypes of common lambsquarters and redroot/smooth pigweed are widespread in the region and thus triazine (Group 5) herbicides are not effective against these populations.
- ³ See remarks in Table 5.14 and the herbicide label for specific management guidelines to maximize crop tolerance.
- ⁴ Degree Xtra may be less consistent on lambsquarters control compared to other acetochlor products.
- ⁵ ALS-resistant biotypes of marestail/horseweed are found in the region and thus Group 2 herbicides will not be effective against these populations.
- ⁶ Corn stunting is likely with products that contain rimsulfuron if: 1) used on coarse-textured soils; 2) applied with 7 days of planting; and 3) growing conditions are less than ideal.
- ⁷ Biotypes resistant to Groups 2 and 9 herbicides are common in the region; do not rely on Groups 2 or 9 herbicides to provide effective control.
- ⁸ Biotypes resistant to Groups 2 and 9 herbicides are found in the region; Groups 2 or 9 herbicides may not provide effective control.

Table 5.13 - Comments on Preplant or Preemergence Herbicides for Conventional, Min-, or No-Till Corn

See specific product label to determine correct rate for soil type and weed species found in each field.

- These treatments may be used in conventional, reduced-till, and no-till systems.
- Treatments may be applied preplant-incorporated or preemergence, unless stated otherwise.
- Incorporation reduces the need for timely rainfall after application and may improve control of certain weeds.
- The higher rates for a given soil may be required for no-till.
- In no-till situations, “burndown” herbicides may be required to control weeds or cover crops present at time of application. Tables 5.12, 5.13, and 5.14 list characteristics of “burndown” herbicides.
- EPP = early preplant means application prior to plant (in most cases it’s 7-14 days before planting); PPI = applied to conventionally tilled soil than mechanically incorporated; PRE = preemergence (applied before the crop has emerged); EPOST = early postemergence (during the early stages of crop and weed growth)

Trade Name ¹	Common name	Site of Action Number	Application	Product/A	lb ai/A
Anthem Flex	pyroxasulfone +	15	EPP, PRE, or EPOST	3.5–6 fl oz	0.102–0.175
	carfentrazone	14			0.007–0.012
Anthem Maxx 4.3SE	pyroxasulfone +	15	EPP, PRE, or EPOST	3–6 fl oz	0.1–0.2
	fluthiacet	14			0.003–0.006

- Fluthiacet (Cadet) or carfentrazone (Aim) does not provide any residual weed control.
- See Zidua (pyroxasulfone) entry for more details.

Table 5.13 - Comments on Preplant or Preemergence Herbicides for Conventional, Min-, or No-Till Corn (cont.)

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Atrazine 4L	atrazine	5	EPP or PRE	1–2 qt	1–2

- Atrazine may be used at 1–2 qt/A. Most commonly used in combination with other herbicides at 1–1.5 qt.
- On highly erodible ground with less than 30% surface residue, no more than 1.6 qt may be applied prior to crop emergence.

ATRAZINE USE RESTRICTIONS**Preplant or Preemergence**

- On highly erodible soils (as defined by the U.S. Natural Resources Conservation Service):
- Fields where more than 30 percent of the soil surface is covered with plant residue at planting, apply a maximum of 2.0 lb of active ingredient per acre as a broadcast spray.
- Fields where less than 30 percent of the soil surface is covered with plant residue at planting, apply a maximum of 1.6 lb of active ingredient per acre as a broadcast spray.
- Apply a maximum of 2.0 lb of active ingredient per acre as a broadcast spray.

Postemergence

- If no atrazine was applied prior to crop emergence, use a maximum rate of 2.0 lb of active ingredient per acre.
- If a soil-applied application was made in the same calendar year, the combined preplant or preemergence and postemergence applications may not exceed 2.5 lb of active ingredient per acre.

Safety Precautions for Using Atrazine

- Do not mix, load, or apply within 50 feet of drinking water wells, livestock wells, agricultural drainage wells, irrigation wells, abandoned wells, or sinkholes.
- Do not mix or load within 50 feet of intermittent streams, perennial streams, rivers, lakes, or reservoirs.
- Do not apply within 200 feet of lakes or reservoirs.
- Do not apply within 66 feet of the points where surface water runoff enters intermittent streams, perennial streams, or rivers. The 66-foot buffers should be planted to a crop or seeded with grass on highly erodible land.
- *Restricted-use pesticide and water quality advisory.*

	isoxaflutole + corn safener				
Balance Flexx 2SC		27	EPP, PRE, or EPOST	3–6 fl oz	0.047–0.094

- Balance Flexx contains isoxaflutole plus a corn safener (cyprosulfamide) and can be applied from preplant through early postemergence (up to V2 corn).
- The medium soil texture rate is 5 fl oz/A.
- Tank-mix with pregrass products (Define, Dual, Harness, TopNotch, Outlook, etc.) to improve residual grass control. Balance Flexx can be mixed with atrazine, 2,4-D, Gramoxone, or glyphosate plus COC or MSO to improve burndown activity on emerged weeds in a no-till setting.
- Early postemergence applications of Balance Flexx will likely not control weeds that are larger than one-leaf stage, but the addition of atrazine can improve control.
- Balance Flexx also can be used as a foundation herbicide in a planned pre herbicide followed by POST herbicide system.
- Do not apply with adjuvants, tank-mixtures with other herbicides or OP or carbamate insecticides, or use fluid fertilizer carriers after corn has emerged.
- To improve crop safety, it is best to plant corn at least 1.5 inches deep and make sure seed is completely covered and seed slit is firmed.
- Do not apply more than 6 fl oz/A/year Balance Flexx (0.094 lb ai isoxaflutole).
- When HPPD-containing (Group 27) herbicides are used in both pre and post sequential applications, the post HPPD product must be tank-mixed with another herbicide that has a different and effective site of action on the target weeds.
- *Restricted-use pesticide and water quality advisory.*

Table 5.13 - Comments on Preplant or Preemergence Herbicides for Conventional, Min-, or No-Till Corn (cont.)

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Basis Blend 30WDG	rimsulfuron +	2	PRE	0.825–1.25 oz	0.01–0.015
	thifensulfuron	2			0.005–0.008
<ul style="list-style-type: none"> • Basis Blend is a mixture of rimsulfuron (Resolve) and thifensulfuron (Harmony SG). • Soil application of Basis Blend is permitted in the Mid-Atlantic region, including Pennsylvania. • Soil-applied Basis Blend is effective on triazine-resistant lambsquarters and pigweed. • Corn stunting is commonly observed when Basis Blend is used on coarse-textured soils. • Tank-mix with other products to broaden the spectrum of control. • For additional remarks, see Basis Blend remarks in the postemergence herbicide for corn section. 					
Bicep II Magnum 5.5SC/Cinch ATZ or	S-metolachlor + atrazine			1.3–2.6 qt	See Table 5-10 for ai rates
Bicep Lite II Magnum 6SC/Cinch ATZ Lite or				0.9–2.2 qt	
Degree Xtra 4.04 ME or	acetochlor + atrazine			2.9–3.7 qt	
FulTime NXT 4.04CS or				2.9–4.4 qt	
Harness Xtra 6L or	acetochlor + atrazine	15, 5	EPP, PRE, or EPOST	1.8–2.3 qt	
Harness Xtra 5.6L				1.4–3 qt	
Keystone LA NXT 6SE/Breakfree NXT Lite or				1.8–2.7 qt	
Keystone NXT 5.6SE/Breakfree NXT ATZ				1.4–3 qt	
<ul style="list-style-type: none"> • These mixtures contain one of the chloroacetamide herbicides plus atrazine. • Bicep Lite II Magnum, Cinch ATZ Lite, Harness Xtra 6L, and Keystone LA NXT are premixes of reduced-atrazine-rate ratios. • The application rates based on soil texture for each of these products are listed in Table 5-17. • These products may be applied to emerged corn in a water carrier; refer to Table 5-19 for maximum corn and weed size restrictions. • Degree Xtra can be applied early POST in a UAN carrier if the temperature is below 85°F. Some corn leaf burn should be expected. Refer to label for more details. Do not include surfactants, crop oils, or other additives. • See individual component sections in this table and atrazine use restrictions under that entry for additional information. • <i>Restricted-use pesticides and water quality advisory.</i> 					

5-56 Weed Control in Field Crops: *Corn*

Table 5.13 - Comments on Preplant or Preemergence Herbicides for Conventional, Min-, or No-Till Corn (cont.)

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
	isoxaflutole +	27			0.049–0.083
Corvus 2.63SC	thiencarbazone + corn safener	2	EPP, PRE, or EPOST	3.33–5.6 fl oz	0.02–0.033

- Corvus is a premix of isoxaflutole, cyprosulfamide (Balance Flexx), and thiencarbazone (ALS-inhibitor herbicide that improves control of annual weeds) and can be applied from preplant through early postemergence (up to V2 corn) to provide residual control of annual broadleaves and grasses, especially when tank-mixed with atrazine.
- The typical use rate is 5.6 fl oz/A.
- Corvus can provide some control of small, emerged annual weeds (<6 inches) in no-till.
- To improve burndown activity on emerged weeds in a no-till setting, mix with atrazine, 2,4-D, Gramoxone, or glyphosate plus COC or MSO.
- Early postemergence applications of Corvus will control small, emerged weeds, but the addition of atrazine can improve control.
- Corvus also can be used as a foundation herbicide in a planned preherbicide followed by postherbicide system.
- Do not apply with adjuvants (COC or MSO), tank mixtures with other herbicides or OP or carbamate insecticides, or use fluid fertilizer carriers after corn has emerged.
- To improve crop safety, it is best to plant corn at least 1.5 inches deep and make sure seed is completely covered and seed slit is firmed.
- Do not apply more than 0.094 lb ai isoxaflutole/A/year.
- When HPPD-containing (Group 27) herbicides are used in both pre and post sequential applications, the post HPPD product must be tank-mixed with another herbicide that has a different and effective site of action on the target weeds.
- *Restricted-use pesticide and water quality advisory.*

Dicamba-containing products	dicamba	4	PRE or EPOST	varies	0.5 lb ae
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- Dicamba may be applied after planting on medium- to fine-textured soils.
- Do not apply preemergence to soil containing less than 2% organic matter or to coarse-textured soils.
- Preemergence applications have a greater potential to injure corn under conditions of excessive moisture and cool temperatures.
- Crop tolerance is greatest to dicamba, and weeds are generally most susceptible when corn is from the spike to five-leaf stage of growth.

Dual II Magnum 7.64E	S-metolachlor	15	EPP or PRE	1–2 pt	0.96–1.9
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- Dual II Magnum are similar in activity to Harness, Outlook, Surpass, and Zidua.
- Dual II Magnum contains a crop-safening agent, benoxacor.
- These may be applied broadcast on up to 40-inch- tall corn prior to weed emergence.
- The medium soil texture rate is 1.67 pt for Dual II Magnum.
- For early preplant applications or fields with heavy surface plant residue, the Dual II Magnum rate may need to be increased by up to 20%.
- Incorporation improves control of yellow nutsedge.
- *Water quality advisory.*

Table 5.13 - Comments on Preplant or Preemergence Herbicides for Conventional, Min-, or No-Till Corn (cont.)

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Fierce 76WDG	pyroxasulfone +	15	EPP or PRE	3 oz	0.08
	flumioxazin	14			0.063
<ul style="list-style-type: none"> • Fierce contains pyroxasulfone (Zidua) and flumioxazin (Valor) and can be used only in no-till or minimum-tilled fields where crop residue has not been incorporated into the soil and corn will be planted directly into a stale seedbed, cover crop, or previous crop residue. • Apply Fierce at 3 oz/A to field corn early preplant. • Corn must be planted between 7 and 30 days after application. • When applied as part of a burndown program, Fierce must be tank-mixed with appropriate herbicides and adjuvants to control emerged weeds. • In addition, Fierce provides residual control of several annual grass and broadleaf weeds, but other herbicides can be tank-mixed to improve control spectrum. • Do not use on soils with less than 1% organic matter unless an activation rainfall (½ inch or more) has occurred between application and planting. • Fierce also can be used as part of a fall burndown program. • <i>Water quality advisory.</i> 					
Harness 7E				1.25–3.0 pt	1–2.6.0
Surpass NXT 7E	acetochlor	15	EPP or PRE	1.25–3.0 pt	1.09–2.6
TopNotch 3.2CS				2–3.75 qt	1.6–3.0
<ul style="list-style-type: none"> • Harness, Surpass NXT, and TopNotch contain acetochlor. • Acetochlor is similar in activity to Dual, Outlook, and Zidua, but is more active on certain broadleaf weeds. • Acetochlor may be applied on up to 11-inch-tall corn depending on the tank-mix partner. • The medium soil texture rate is about 2 pt/A for Harness, 2.25 pt for Surpass NXT, and 2.25 qt for TopNotch. • For early preplant applications or fields with heavy surface plant residue, the rate of acetochlor may need to be increased by up to 20%. • Incorporation improves control of yellow nutsedge. • <i>Restricted-use pesticide and water quality advisory.</i> 					
Harness MAX 3.85L	acetochlor +	15	EPP or PRE	1.7–2.75 qt	1.5–2.42
	mesotrione	27			0.14–0.227
<ul style="list-style-type: none"> • Controls many annual broadleaf and grass weeds but will not provide consistent control if grasses have already emerged. • Can be applied PRE thru POST; when applied in a planned PRE followed by POST programs better weed control usually can be expected and more modes of action can be incorporated for better resistance management. • Typical medium soil rate is 64 fl oz/A Harness MAX. • It does not contain atrazine, so it provides a non-atrazine alternative for triazine-sensitive areas. However, other herbicides can be tank-mixed to broaden the weed control spectrum. • Harness MAX can be applied to corn that is no more than 11 inches tall; use rates might need to be reduced for POST applications and include necessary adjuvants. • Do not apply more than 0.24 lb ai mesotrione/A/year from any product or combination of products containing mesotrione. • When HPPD-containing (Group 27) herbicides are used in both pre and post sequential applications, the post HPPD product must be tank-mixed with another herbicide that has a different and effective site of action on the target weeds. • See label for additional application guidelines. • Coyote is a similar premix but contains S-metolachlor and mesotrione. May be applied EPP, PRE, or EPOST. 					

Table 5.13 - Comments on Preplant or Preemergence Herbicides for Conventional, Min-, or No-Till Corn (cont.)

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Lexar EZ 3.7SC or	S-metolachlor + mesotrione + atrazine	15, 27, 5		3–3.5 qt	See Table 5-8 for ai rates
Lumax EZ 3.67SC		15, 27, 5		2.7–3.25 qt	
Acuron 3.44SC	S-metolachlor + mesotrione + atrazine + bicyclopyrone	15, 27, 5	EPP, PRE, or EPOST	2.5–3 qt	
Acuron Flexi 3.26SC	S-metolachlor + mesotrione + bicyclopyrone	15, 27		2–2.25 qt	

- Lexar EZ and Lumax EZ are mixtures of S-metolachlor (Dual II Magnum), mesotrione (Callisto), and atrazine.
- Acuron contains the same active ingredients as Lumax/Lexar with the addition of another Group 27 herbicide, bicyclopyrone. In general, it controls a broader weed spectrum and is better on ragweed, cocklebur, and annual morningglory, and effective on many annual broadleaves and some grasses compared to Lumax/Lexar.
- The typical use rates in all tillage systems are 3 qt/A Lexar EZ, 2.7 qt/A Lumax EZ, and 2.5 qt/A Acuron.
- These products may be applied broadcast on up to 12-inch-tall corn, but prior to annual grass emergence.
- Do not apply more than 3.5 qt/A Lexar EZ, 3.25 qt/A Lumax EZ, or 3 qt/A Acuron per growing season.
- Do not apply more than 0.24 lb ai mesotrione/A/year from any product or combination of products containing mesotrione.
- When HPPD-containing (Group 27) herbicides are used in both pre and post sequential applications, the post HPPD product must be tank-mixed with another herbicide that has a different and effective site of action on the target weeds.
- Do not apply Lexar, Lumax, or Acuron early POST if the corn was treated with Counter insecticide. Do not tank-mix Lexar, Lumax, or Acuron with organophosphate (OP) or carbamate insecticides and apply as a foliar POST application. Do not make a foliar POST application of any OP or carbamate insecticide within 7 days before or 7 days after a Lexar EZ, Lumax EZ, or Acuron application, or severe corn injury may occur.
- Corn, soybeans, small grains, and sorghum may be planted the spring following Lexar EZ, Lumax EZ, or Acuron application.
- *Restricted-use pesticide and water quality advisory.*

Lorox 50DF	linuron	7	PRE	0.7–1.0 lb	0.3–0.5
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- Lorox applied at 0.7 to 1.0 lb/A will help control lambsquarters.
- Do not incorporate.
- Plant corn at least 1.5 inches deep to minimize risk of crop injury.
- *May cause crop injury under adverse conditions*

Outlook 6.0E	dimethenamid	15	EPP or PRE	10–21 fl oz	0.47–0.98
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- Outlook is similar in activity to Dual, Harness, and Zidua.
- Outlook (dimethenamid) may be applied preemergence on up to 12-inch-tall corn prior to weed emergence.
- The medium soil texture rate is 16 fl oz/A for Outlook.
- For early preplant applications or fields with heavy surface plant residue, increase the Outlook rate by 1–2 fl oz/A.
- Lower use rates, 6–16 fl oz/A, may be used in situations where partial control or reduced length of residue control is required, such as early postemergence applications or preemergence applications followed by postemergence herbicides.
- Incorporation improves control of yellow nutsedge.
- *Water quality advisory.*

Table 5.13 - Comments on Preplant or Preemergence Herbicides for Conventional, Min-, or No-Till Corn (cont.)

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Princep 90DF	simazine	5	EPP or PRE	1.1–3.3 lb	1–3
<ul style="list-style-type: none"> • Princep is similar to atrazine but has better grass activity and less broadleaf control. • Like atrazine, Princep can persist in soil and leave carryover residues. • Use in combination with other herbicides to lower the necessary rate and broaden the weed spectrum. • If using Princep in combination with atrazine, follow recrop restrictions. • <i>Water quality advisory.</i> 					
Princep 90DF +	simazine +	5	EPP or PRE	1.1–1.7 lb	1–1.5
Atrazine 90DF	atrazine	5		1.1–1.7 lb	1–1.5
<ul style="list-style-type: none"> • Both simazine and atrazine have long soil residuals. • Plant corn, sorghum, or sudangrass the following year. • Simazine improves annual grass control; use 2:1 ratio of simazine to atrazine in fields with heavy grass pressure. • See comments under atrazine. • When tank-mixing or sequentially applying simazine and/or atrazine or products containing either active ingredient to corn, the total pounds of simazine and/or atrazine applied must not exceed 2.5 lb ai/acre per calendar year. • <i>Atrazine is a restricted-use pesticide, and both atrazine and simazine have a water quality advisory.</i> 					
Prowl 3.3E	pendimethalin	3	PRE or EPOST	1.8–4.0 pt	0.75–1.65
Prowl H₂O 3.8CS	pendimethalin	3	PRE or EPOST	2.0–4.0 pt	0.95–1.9
<ul style="list-style-type: none"> • Plant corn at least 1.5 inches deep to avoid Prowl injury. • Do not incorporate. • Must be applied after planting up until corn reaches 30 inches tall or V8 growth stage (whichever is most restrictive). • Preemergence applications can injure corn. • Delaying application until spike stage helps maximize crop safety. • Prowl H₂O is a water-based capsule suspension formulation that provides similar weed control as the older 3.3E product but causes less staining and odor. 					
Prowl 3.3E or	pendimethalin	3		1.8–3.6 pt	0.75–1.5
H₂O 3.8CS +	pendimethalin	3	PRE or EPOST	2.0–4.0 pt	0.95–1.9
Atrazine 90DF	atrazine	5		1.1–2.2 lb	1.0–2.0
<ul style="list-style-type: none"> • Plant corn at least 1.5 inches deep to avoid Prowl injury. • Do not incorporate. • Must be applied after planting up until corn reaches 12 inches tall. • Preemergence applications can injure corn. • Delaying application until spike stage helps maximize crop safety. • See remarks under atrazine. • <i>Atrazine is a restricted-use pesticide and has a water quality advisory.</i> 					

5-60 Weed Control in Field Crops: *Corn*

Table 5.13 - Comments on Preplant or Preemergence Herbicides for Conventional, Min-, or No-Till Corn (cont.)

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Python 80WDG	flumetsulam	2	EPP or PRE	0.8–1.14 oz	0.04–0.057
<ul style="list-style-type: none"> • Apply before crop or weed emergence. • Plant corn at least 1.5 inches deep. • Do not use where soil pH is greater than 7.8, where organic matter is less than 1.5% or when extended cool, wet conditions exist. • Apply all insecticides in a T band or a band to avoid serious crop injury. • Do not use if Counter insecticide was applied. • See Table 5.4 for recrop restrictions. • To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (group 2) herbicides. • <i>Water quality advisory.</i> 					
Resicore 3.29SE Resicore XL 3.26SE	acetochlor +	15			1.58–2.1
	mesotrione +	27	EPP, PRE, or POST	2.25–3 qt	0.162–0.216
	clopyralid + corn safener	4			0.107–0.143
<ul style="list-style-type: none"> • It controls many annual broadleaf and grass weeds but will not provide consistent control if grasses have already emerged. • It can be applied PRE thru POST; when applied in a planned PRE followed by POST programs better weed control usually can be expected and more modes of action can be incorporated for better resistance management. • The typical medium soil rate is 2.5 qt/ A Resicore. • Resicore does not contain atrazine, so it provides a non-atrazine alternative for triazine-sensitive areas. However, atrazine, glyphosate, 2,4-D, and other herbicides can be tank-mixed with Resicore to broaden the weed control spectrum. • It contains acetachlor, so be sure to follow acetachlor use restrictions for soil type, organic matter, and depth to water table. • Do not apply more than 0.24 lb ai mesotrione/A/year from any product or combination of products containing mesotrione. • When HPPD-containing (Group 27) herbicides are used in both pre and post sequential applications, the post HPPD product must be tank-mixed with another herbicide that has a different and effective site of action on the target weeds. • Adequate soil moisture is required for optimum herbicidal activity. If adequate soil moisture is not received within 7–10 days after a surface-applied treatment, a shallow cultivation is recommended. • Observe the rotational restrictions on the label. • If corn has received an at-plant phorate or terbufos insecticide application, POST applications of Resicore may cause severe injury. Refer to label for additional restrictions with insecticides. • Do not make POST applications of Resicore using liquid fertilizer carriers or tank-mixed with OP insecticides otherwise severe crop injury will occur. • Resicore can be applied to corn that is no more than 11 inches tall. Resicore XL can be applied to corn up to 24 inches tall. 					
Resolve 25DF	rimsulfuron	2	PRE	0.5–2.0 oz	0.0078–0.03
<ul style="list-style-type: none"> • Resolve can be applied pre and may be tank-mixed with full or reduced rates of other soil-applied corn herbicides. • Crop injury may occur following an application of Resolve if there is a prolonged period of cold weather and/or in conjunction with wet soil. • Corn stunting is commonly observed when Resolve is used on coarse-textured soils. • See additional comments about Resolve in Table 5.19 in the postemergence herbicides for corn section. 					

Table 5.13 - Comments on Preplant or Preemergence Herbicides for Conventional, Min-, or No-Till Corn (cont.)

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
SureStart II 4.25SE or TripleFLEX II	acetochlor +	15			0.71–1.41
	flumetsulam +	2	EPP, PRE, or EPOST	1.5–3 pt	0.056–0.113
	clopyralid	4			0.022–0.045

- SureStart II or TripleFLEX II is intended to be used with Roundup Ready or LibertyLink field or silage corn hybrids.
- When applied PRE, it is designed to provide early season control of common annual grasses and broadleaf weeds to allow better timing of the in-crop application of glyphosate or glufosinate.
- The typical medium soil rate is 1.75 pt/ A SureStart II/TripleFLEX II. For longer residual control, use up to 3 pt/A.
- SureStart II/TripleFLEX II does not contain atrazine, so it provides a non-atrazine alternative for triazine-sensitive areas. However, atrazine, glyphosate, 2,4-D, and other herbicides can be tank-mixed with SureStart II/TripleFLEX II to broaden the weed control spectrum.
- It contains acetachlor, so be sure to follow acetachlor use restrictions for soil type, organic matter, and depth to water table.
- Adequate soil moisture is required for optimum herbicidal activity. If adequate soil moisture is not received within 7–10 days after a surface-applied treatment, a shallow cultivation is recommended.
- Observe the rotational restrictions on the label.
- Injury to corn has been observed when cool, wet soil conditions follow application.
- Apply soil insecticides in furrow, a T-band, or a band. To avoid serious crop injury if using OP insecticides, apply in a T-band or a band. Do not use if Counter or Thimet insecticide was applied. Refer to label for additional restrictions with soil insecticides.
- Corn must be planted at least 1.5 inches deep.
- Do not use as a soil treatment in fields with less than 1.5% organic matter unless the risk of crop injury is acceptable.

Verdict 5.57EC	saflufenacil +	14	EPP or PRE	10–16 fl oz	0.058–0.071
	dimethenamid	15			0.384–0.615

- Verdict can be used in a burndown program or in a planned PRE followed by POST herbicide system. In a burndown program it is best to include glyphosate and atrazine in addition to the necessary adjuvants (MSO plus AMS; substituting COC can result in reduced weed control) to improve control of emerged weeds including horseweed.
- The medium soil texture rate is 13 fl oz/A and will provide some initial residual weed control, but it will likely need to be followed by a POST application of glyphosate (RR-corn), glufosinate (LL-corn), or conventional herbicides as needed.
- The use of Verdict can follow a burndown application of Sharpen (1 fl oz/A).
- Do not apply Verdict to emerged corn or if OP or carbamate insecticides are being used.

5-62 Weed Control in Field Crops: Corn

Table 5.13 - Comments on Preplant or Preemergence Herbicides for Conventional, Min-, or No-Till Corn (cont.)

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Zidua SC 4.17L or Zidua 85WDG	pyroxasulfone	15	EPP or PRE	1.75–6.5 fl oz or 1.5–4.0 oz	0.05–0.21

- Zidua has annual grass activity similar to Dual, Harness, Outlook, Surpass, etc., but also provides good control of several annual broadleaves.
- Zidua can be applied preplant (surface or incorporated) up to 45 days before planting or preemergence.
- The typical use rate is 4 fl oz/A SC (2.5 oz WDG) on medium-texture soils. Rates can be adjusted for soil type or two-pass application programs.
- Corn must be planted at least 1 inch deep.
- Zidua does not control existing weeds and must be activated by at least 1/2 inch of rainfall prior to weed germination; otherwise, effectiveness may be reduced.
- Zidua can be tank-mixed with atrazine or other corn herbicides to broaden weed control spectrum.
- Zidua may be applied in a carrier of water (5 gal/A or more) or liquid nitrogen fertilizer solution (20 gal/A or more). Also, it may be impregnated and applied on certain dry bulk fertilizers.
- Zidua may be applied up to V8 corn stage, but tank-mix if weeds are emerged.
- Zidua may be applied in the fall.
- Other pyroxasulfone-containing products include Anthem Flex, Anthem Maxx, Fierce, Maverick, and Perpetuo. Maverick is a premix of pyroxasulfone, mesotrione (Callisto), and clopyralid (Stinger). Perpetuo is a premix of flumiclorac (Resource) plus pyroxasulfone and must be applied post. Storen is a premix of pyroxasulfone, S-metolachlor (Dual II Magnum), mesotrione (Callisto), and bicyclopyrone.
- *Water quality advisory.*

¹ See Tables 5.4 and 5.6 for additional formulations or trade names containing some of these same active ingredients.

Table 5.14 - Corn Herbicide Preplant or Preemergence Rates Per Acre Based on Soil Texture and Organic Matter¹

Trade Name	Site of Action Number	Unit	<3% Organic Matter			>3% Organic Matter			Inc. for No-till	Max rate on HEL, less than 30% residue
			Coarse	Medium ¹	Fine	Coarse	Medium	Fine		
Acuron 3.44SC	5/15/27/ 27	qt	2.5	2.5	2.5	3.0	3.0	3.0	no	N/A
Acuron Flexi 3.26SC	15/27/27	qt	2.0	2.0	2.0	2.25	2.25	2.25	no	—
Anthem Flex 4SC	14/15	fl oz	3.5	4.5	5.5	4.5	5.5	6.5	no	—
Anthem Maxx 4.3SC	14/15	fl oz	3.0	4.0	5.0	4.0	5.0	6.0	no	—
Atrazine 4L ²	5	qt	1.25	1.5	1.5	1.25	1.5	2.04	no	1.6
Atrazine 90DF ²	5	lb	1.4	1.67	1.67	1.4	1.67	2.24	no	1.8
Axiom 68DF	5/15	oz	13.0	16.0	20.0	15.0	18.0	22.0	1–2 oz	—
Balance Flexx 2SC	27	fl oz	3.0	6.0	6.0	4.0	6.0	6.0	no	—
Basis 75DF	2/2	oz	0.33	0.33	0.33	0.825	0.33	0.33	no	—
Basis Blend 30DF	2/2	oz	0.825	0.825	0.825	0.33	0.825	0.825	no	—
Bicep II Magnum 5.5SC/Cinch ATZ	5/15	qt	1.8	2.1	2.1	2.1	2.4	2.6	up to 25%	2.1

Table 5.14 - Corn Herbicide Preplant or Preemergence Rates Per Acre Based on Soil Texture and Organic Matter¹ (cont.)

Herbicide	Site of Action Number	Unit	<3% Organic Matter			>3% Organic Matter			Inc. for No-till	Max rate on HEL, less than 30% residue
			Coarse	Medium ¹	Fine	Coarse	Medium	Fine		
Bicep Lite II Magnum 6SC/Cinch ATZ Lite	5/15	qt	1.5	1.5	1.5	1.3	1.9	1.9	up to 20%	N/A
Bullet 4L	5/15	qt	2.5	3.0	3.75	3.0	3.75	4.0	20%	N/A
Corvus 2.63SC	2/27	fl oz	3.3 ³	5.6	5.6	5.6	5.6	5.6	no	—
Degree Xtra 4.04 ME	5/15	qt	2.0	3.0	3.2	2.0	3.2	3.7	up to 25%	N/A
Dual II Magnum 7.64E	15	pt	1.33	1.67	1.67	1.33	2.0	2.0	up to 20%	—
Fierce 76WDG	14/15	oz	3.0	3.0	3.0	3.0	3.0	3.0	no	—
FulTime 4.04CS	5/15	qt	2.5	2.9	3.1	2.5	3.0	4.0	no	4.0
Harness 7E	15	pt	1.5	2.0	2.0	1.75	2.0	2.25	up to 25%	—
Harness MAX	15/27	fl oz	55	64	64	60	64	75	no	—
Harness Xtra 6.0L	5/15	qt	1.8	2.0	2.3	2.0	2.3	2.3	up to 25%	N/A
Harness Xtra 5.6L	5/15	qt	1.8	2.0	2.3	1.8	2.3	2.6	up to 25%	2.5
Keystone LA NXT 6SE	5/15	qt	1.8	2.0	2.1	1.8	2.1	2.4	no	N/A
Keystone NXT 5.6 SE	5/15	qt	1.4	2.0	2.5	2.0	2.5	2.5	up to 20%	2.5
Lexar EZ 3.7SC	5/15/27	qt	3.0	3.0	3.0	3.5	3.5	3.5	no	N/A
Lumax EZ 3.67SC	5/15/27	qt	2.7	2.7	2.7	3.25	3.25	3.25	no	N/A
Maverick 2.04SC	4/15/27	fl oz	18	21	25	18	21	25	no	—
Outlook 6.0E	15	fl oz	14.0	16.0	18.0	16.0	16.0	18.0	add 1–2 oz	—
Princep 4L	5	qt	1.0	2.5	2.7	1.0	2.7	3.0		
Princep 90DF	5	lb	1.1	2.6	3.0	1.1	3.0	3.3	no	—
Prowl 3.3E	3	pt	2.0	3.6	4.0	3.6	4.0	4.2	no	—
Prowl H ₂ O 3.8CS	3	pt	2.5	3.0	3.0	3.0	4.0	4.0	no	—
Python 80WDG	2	oz	0.8	0.89	1.0	0.89	1.0	1.1	no	—
Resicore 3.29SE/ Resicore XL 3.26SE	4/15/27	qt	2.25	2.5	2.75	2.5	2.75	30	up to 0.25 qt/A	—
Sharpen 2.85SC	14	fl oz	2.0	2.5	3.0	2.0	2.5	3.0	no	—
Storen	15/27/15/27	qt	—	2.1	2.1	—	2.4	2.4	no	—
SureStart II 4.25SE/ TripleFLEX II	2/4/15	pt	1.5	1.75	2.0	1.75	1.75	2.0	no	—
Surpass NXT 7E	15	pt	1.5	2.0	2.25	2.0	2.5	2.5	up to 25%	—
Top Notch 3.2ME	15	qt	2.0	2.25	2.5	2.0	2.5	3.0	no	—
TriVolt 3.65SC	2/15/27	fl oz	10.75	20	20	10.75	20	20	no	—
Verdict 5.57EC	14/15	fl oz	10	13	16	11.0	13	16	no	—
Zidua 85WDG	15	oz	2.0	2.5	2.5	2.5	2.5	3.0	no	—
Zidua SC 4.17L	15	fl oz	3.5	4.0	4.0	4.0	4.0	5.0	no	—

¹ Average soil type in most Mid-Atlantic areas.

² On highly erodible ground with less than 30% residue, apply no more than 1.6 qt/A or 1.8 lb/A of 90 DF (i.e., 1.6 lb ai).

³ Reduce Corvus rate to 3.33 fl oz/A if soils are coarse and have < 2% organic matter.

Table 5.15 - Maximum Corn, Weed Sizes, and recommended adjuvants for Delayed Preemergence/Early Postemergence Herbicide Applications

See specific herbicide label(s) for additional information on application.

- This type of application generally is used when weather conditions preclude use of standard preemergence program.
- For most products, do not apply in liquid fertilizer if corn has emerged.
- Poor control from residual herbicides may result if annual grasses such as foxtail and panicum have emerged at time of application; tank-mix with product that controls emerged grasses.
- Delayed preemergence/early postemergence programs can work well with herbicide-resistant corn hybrids now available (e.g., Roundup Ready, LibertyLink).
- When tank-mixing with other pesticides, follow the most restrictive product label.

Trade Name	Maximum Corn Size	Maximum Weed Size
Acuron	12 inches	3-inch broadleaves; inconsistent on emerged grasses
Acuron Flexi	30 inches	3-inch broadleaves
Anthem Maxx	4 collars (V4)	2-inch broadleaves, before grass emergence
Atrazine	12 inches	1.5 inches
Axiom	before emergence	before emergence
Balance Flexx	2-leaf (V2)	1 true leaf stage
Bicep II Magnum	12 inches	1- to 2-leaf
Bicep Lite II Magnum, Cinch ATZ Lite	5 inches	2-leaf
Corvus	2-leaf (V2)	<2 inches (in general)
Dual, Dual II Magnum	40 inches	before emergence
Fierce	before emergence	2-inch broadleaves; by tank-mix partner for grasses
Halex GT/Acuron GT	30 inches (V8)	4 inches
Harness, Harness MAX, Harness Xtra ¹ , or Degree Xtra	11 inches or by tank-mix partner	before broadleaf emergence, 2-leaf grasses or by tank-mix partner
Lexar EZ	12 inches	3-inch broadleaves; before grass emergence
Lumax EZ	12 inches	3-inch broadleaves; inconsistent on emerged grasses
Maverick	18 inches (V6)	3-inch broadleaves; before grass emergence
Outlook	12 inches	before emergence or by tank-mix partner
Princep	before emergence	before emergence
Prowl H ₂ O	30 inches (V8)	before weed emergence
Python WDG	20 inches (V6)	before weed emergence
Resicore/Resicore XL	11 inches/24 inches	3-inch broadleaves
Resolve Q	20 inches	2-inch grasses; 3-inch broadleaves (in general)
Storen	V8 3-inch broadleaves	2-inch grasses
SureStart II/TripleFLEX II	11 inches	limited activity on 1-inch broadleaves; before grass emergence
Surpass NXT, FulTime NXT, TopNotch, or Keystone NXT ²	11 inches or by tank-mix partner	before emergence or by tank-mix partner
Surtain	3-leaf (V3)	before emergence
TriVolt	2-leaf (V2)	<2 inches (in general)
Verdict	before emergence	before emergence
Zidua SC	Postemergence up to V8	before emergence or by tank-mix partner

Table 5.15 - Maximum Corn, Weed Sizes, and recommended adjuvants for Delayed Preemergence/Early Postemergence Herbicide Applications (cont.)

¹ May be tank-mixed with Accent Q, Atrazine (Harness), Clarity, Permit, or Roundup (Roundup Ready corn).

² May be tank-mixed with a number of different products including Accent Q, Clarity, Prowl, etc. See an herbicide label for specific information.

Table 5.16 - Recommended Adjuvants when Preemergence Herbicides are Used Early Postemergence

Trade Name	Recommended if corn has emerged and weeds are present	Optional
Acuron ^{1,2}	NIS (0.25% v/v) or COC ⁴ (1% v/v)	AMS 8.5 lb/100 gal
Acuron Flexi	NIS (0.25% v/v) or COC ⁴ (1% v/v)	
Anthem ATZ / Anthem Flex / Anthem Maxx	NIS (0.25% v/v) or COC (1-2 pts/A) or MSO (1-2 pts/A)	
Atrazine	label only mentions COC	
Balance Flexx	label states "Do not use COC or MSO or fully loaded glyphosate formulation"	
Bicep II Magnum	label mentions only NIS when tankmixed with specific herbicides	
Corvus	label states "Do not use COC or MSO"	
FulTime NXT, TopNotch ¹ , or Keystone NXT ¹	not addressed on label	
Halex GT/Acuron GT	NIS (1-2 qt/100 gal)	
Harness MAX ^{1,3}	NIS (1 qt/100 gal) or COC (1 gal/100 gal)	
Harness Xtra or Degree Xtra	not addressed on label	
Lexar EZ ^{1,2}	NIS (0.25% v/v) or COC (1% v/v)	
Lumax EZ ^{1,2}	NIS (0.25% v/v) or COC (1% v/v)	
Maverick	NIS (1 qt/100 gal) or COC ³ (1 gal/100 gal)	AMS only allowed with glyphosate or glufosinate herbicides
Python WDG	NIS (1 qt/100 gal) or COC (1 gal/100 gal)	
Resicore/Resicore XL	NIS (1 qt/100 gal) or COC ⁴ (1 gal/100 gal)	
Storen		
TriVolt	Label states: "Do not use COC or MSO"	

¹ Do not use either NIS or COC if tank-mixed with Liberty (AMS is allowed).

² Do not use either NIS or COC if tank-mixed with a fully loaded glyphosate (AMS is allowed); if glyphosate label recommends an adjuvant, add NIS and AMS.

³ Label cautions about crop injury.

⁴ Do not use either NIS or COC if tank-mixed with glyphosate (AMS is allowed).

5-66 Weed Control in Field Crops: Corn

Table 5.17 - Relative Effectiveness of Postemergence Corn Herbicides¹

Weed control rating:	Crop tolerance:
10 = 95–100%	E = excellent; almost never any crop injury observed
9 = 85–95%	VG = very good; on rare occasion is crop injury observed
8 = 75–85%	G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., seedling depth, seed slit closure, herbicide rate and application timing, adjuvants)
7 = 65–75%	FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions
6 = 55–65%	F = fair; some crop injury is commonly observed
N = less than 55% or no control	
+ = upper end of rating scale	
— = not applicable or no local data available	

Grasses	Trade Name ¹ (rate/A)	Site of Action	Barnyardgrass	Bermudagrass	Broadleaf Signalgrass	Crabgrass	Fall Panicum	Foxtail spp.	Goosegrass	Johnsongrass (Seedling)	Johnsongrass (Rhizome)	Quackgrass	Shattercane	Texas panicum	Wirestem Muhly	Yellow Nutsedge
	Accent Q (0.9 oz)	2	8+	N	9+	7	9	9	N	9	8+	8+	9	9	7	6
	Atrazine (1 qt)	5	8	N	7	6	6	7+	9	N	N	7	6	N	6	7
	Basagran (1.5 pt)	6	N	N	N	N	N	N	N	N	N	N	N	N	N	8
	Callisto (3 fl oz)	27	N	N	N	8 ¹⁰	N	N	N	N	N	N	N	N	N	8
	Glyphosate ^{3,4} (0.75 lb ae)	9	9+	9	10	9+	9+	9+	10	9+	9	9	9	9	9	7
	Impact/Armezon (0.75 fl oz)/ Impact Core	27/15	7	N	N	8	8	8+	7	N	N	N	7	8	6	7
	Laudis (3 fl oz)/DiFlexx Duo (32 fl oz)	27/4	8	N	8	8	N	8+	7	6	N	N	7+	8	6	7
	Liberty ⁵ (32 fl oz)	10	8	N	7	8	7+	9 ⁴	N	8	6	6	8	8	7	6
	Permit/Sandea (1 oz)	2	N	N	N	N	N	N	N	N	N	N	N	N	N	9+
	Shieldex (1 fl oz)/Restraint	27/15	7	N	6	8	6	8	7	6	N	N	6	6	6	6
Mixtures																
	Basis Blend (0.83 oz)/ Resolve Q (1.25 oz)	2/2	8	N	8	6	8+	8+	N	8+	7	7+	8+	7	6	6
	Capreno (3 fl oz)	2/27	8	N	6	8	8	8+	7	8	7	6	8	9	6	7
	Halex GT (3.6 pt)/Acuron GT (3.75 pt)	9/15/ 27	9+	N	10	9+	9+	9+	10	9+	9	9	9	9	9	8
	Kyro (45 fl oz)	15/27/4	7	N	N	8	8	8+	7	N	N	N	7	8	6	7
	Realm Q (4 oz)	2/27	8	N	8	8	8+	8+	N	8+	7	7+	8+	7	6	8
	Revulin Q (4 oz)	2/27	8+	N	9	8	9	9	N	9	8+	8+	9	9	7	8
	Sinate (28 fl oz)	10/27	8	N	7	8	8	9	7	8	6	6	8	8	7	7
	Steadfast Q (1.5 oz)	2/2	8+	N	9+	7	9	9	N	9	8	9	9	9	6+	6
	Stout (0.75 oz)	2/2	8+	N	9+	7	9	9	N	9	8+	8+	9	9	7	6
	Yukon (4 oz) / Permit Plus (0.75 oz)	2	N	N	N	N	N	N	N	N	N	N	N	N	N	9+

Control of Roundup Ready Corn: Volunteers or Replanting

There are times when corn has to be removed from a field with the intention of replanting a corn crop. Tillage is one effective method, but it is not appropriate in no-tillage situations. Use of glyphosate is highly effective for non-Roundup Ready corn. But, the challenge is in removing

Weed Control in Field Crops: **Corn** 5-67

Roundup Ready hybrids. There are limited herbicides to consistently kill small corn plants. Gramoxone SL, Liberty, and Select are three products that have shown the most activity. Research conducted in this region with Gramoxone and Select demonstrated that Select was the most effective for corn 2 to 3 inches tall. For taller corn (4 to 6 inches tall), Gramoxone in combination with a photosystem II-inhibiting herbicide (metribuzin, Lorox, or atrazine) was the most effective. Liberty is a third option, but it will not control Liberty Link hybrids.

Select Max/clethodim: up to 6 fl oz of Select Max or 3 fl oz clethodim 2EC with a nonionic surfactant at 0.25% v/v plus AMS at 2.5 to 4 lbs/A. Do not use a COC or MSO. Wait a minimum of 6 days from time of application until planting corn due to risk of crop injury. (Select Max/clethodim will also control corn hybrids containing Roundup Ready and Liberty Link stacked traits.)

Gramoxone SL 2.0: 3 to 4.5 pt/A (2 to 2.7 pints of 3.0 SL formulation) in combination with metribuzin (4 to 6 oz/A), Lorox (1 pt/A) or atrazine (1 lb/A). These photosystem II inhibitors are not added to control the corn but are used to slow down the Gramoxone activity, which helps provide more consistent control.

Liberty 280: 22 to 29 oz Liberty has not been as consistent for control corn as Gramoxone and will not control varieties with LibertyLink traits.

¹ See Table 5.4 and 5.6 for additional products that contain these active ingredients.

² Large crabgrass only.

³ For use on Roundup Ready corn varieties only.

⁴ Glyphosate-containing products include Roundup, Durango, and many others; see Table 5.1.

⁵ For use on LibertyLink or glufosinate-resistant corn varieties only.

⁶ Herbicide is less effective on yellow foxtail: Balance-6, and Liberty-7.

Table 5.17 - Relative Effectiveness of Postemergence Corn Herbicides¹ (cont.)

Broadleaves	Site of Action Number	Burdock	Cocklebur	Jimsonweed	Lambs-quarters ²	Marestail/Horseweed ³	Annual Morning Glory	Eastern Black Nightshade	Palmer Amaranth / Waterhemp ^{8,9}	Pigweed ²	Common Ragweed ^{8,9}	Giant Ragweed	Prickly Sida	Smartweed	Spurred Anoda	Velvetleaf	Corn Tolerance
Trade Name (rate/A) ¹	Site of Action Number	Burdock	Cocklebur	Jimsonweed	Lambs-quarters ²	Marestail/Horseweed ³	Annual Morning Glory	Eastern Black Nightshade	Palmer Amaranth / Waterhemp ^{8,9}	Pigweed ²	Common Ragweed ^{8,9}	Giant Ragweed	Prickly Sida	Smartweed	Spurred Anoda	Velvetleaf	Corn Tolerance
2,4-D (1 pt)	4	6	9	8	9	7+	8	7	8	9	8+	7+	9	7	-	8	F ⁴
Accent Q (0.9 oz)	2	7	7	7	6	N	7	N	N	9	6	N	N	8	-	7	F-G
Aim (0.8) /Cadet (0.9)	14	N	N	N	9	N	8+	9	N	9	N	N	7	N	-	9+	G
Atrazine (1 qt)	5	8	9	9	N	N	9	9	9+	N	9	8	8+	10	-	8	VG
Basagran (1.5 pt)	6	N	9	9	8	6	N	N	N	6+	8	7	8	9	7	8+	G
Callisto (3 fl oz)	27	7+	8+	9	9	6	7+	9	8+	8+	8	8	6	9	8	9	G
Dicamba (0.25 lb ae)	4	7	9	9	9	8+	8	8	8+	9	8+	7+	8	9	-	8	F-G ⁴
DiFlexx (8 fl oz)/DiFlexx Duo (32 fl oz)	4	7	9	9	9	8+	9	8	8+	9	9	9	8	9	-	8	G
Glyphosate ^{5,6} (0.75 lb ae)	9	8+	9	9	8+	N	7	8	N	9	8+	8	7	8+	8	8	E
Harmony SG (0.125 oz)	2	7	7+	7	9	N	N	N	N	9	6	N	N	9	N	8+	G
Impact/Armezon (0.75 fl oz)/Impact Core	27/15	7+	8+	9	9	6	7+	9	8+	8+	8	8	6	9	-	9	VG
Laudis (3 fl oz)	27	7	8+	9	9	6	7	9	8+	8+	8	8	N	9	-	9	VG
Liberty ⁷ (32 fl oz)	10	8	9	9	8+	9	8	8	9	8	9	8+	8	8+	-	8	E
Maestro/Moxy (1 pt)	6	8	9	9	9	6	8	9	N	7	7+	8	N	9	-	8+	F-G ⁴
Peak (0.5 oz)	2	8+	8+	8	8	N	7	N	N	8+	9	6	6	7	-	8	G
Permit/Sandea (1 oz)	2	6	9	N	N	N	6	6	N	9	9 ⁹	8 ⁹	7	8	-	9	G
Resource (6 fl oz)/Perpetuo	14	7	6	7	7	N	N	8	7	7+	8	6	7	6	-	9+	G

Table 5.17 - Relative Effectiveness of Postemergence Corn Herbicides¹ (cont.)

Broadleaves																	
Trade Name (rate/A)¹	Site of Action Number	Burcucumber	Cocklebur	Jimsonweed	Lambs-quarters²	Marestail/Horseweed³	Annual Morning Glory	Eastern Black Nightshade	Palmer Amaranth / Waterhemp^{8,9}	Pigweed²	Common Ragweed^{8,9}	Giant Ragweed	Prickly Sida	Smartweed	Spurred Anoda	Velvetleaf	Corn Tolerance
Stinger (0.5 pt)	4	N	9	8	6	7	N	7	N	6	9+	9	7	7	-	6	VG
Mixtures																	
Basis Blend (0.83 oz)	2/2	N	7	7	8+	N	6	N	N	9	7 ⁹	N	N	9	-	9	F-G
Capreno (3 fl oz)	2/27	7	8+	9	9	6	7	9	8+	9	8	8	6	9	-	9	G
Curtail	4/4	6	9	8	9	7+	9	7	9	9	9	9+	9	7	-	8	F
Halex GT (3.6 pt)	9/15/ 27	8+	9	9	9+	6	7+	9+	8+	9	8+	8	7	9	-	9	G
Kyro (45 fl oz)	15/27/ 4	7+	8+	9	9	6	7+	9	8+	8+	8+	8	7	9	-	9	VG
Permit Plus (0.75 oz)	2/2	7	9	7	9	N	6	6	N	9	9 ⁹	8 ⁹	7	9	-	9	G
Realm Q (4 oz)	2/27	7+	8+	9	9	6	7+	9	8+	9	8	8	6	9	8	9	G
Resolve Q (1.25 oz)	2/2	N	7	7	8+	N	6	N	N	9	7 ⁹	N	N	9	-	9	G
Revulin Q (4 oz)	2/27	7+	8+	9	9	N	7+	9	8+	9	8	8	6	9	-	9	G
Shieldex (1 fl oz)/ Restraint	27/15	-	7	-	9	8	7	7	8+	9	8+	8	-	7	-	9	VG
Sinate (28 fl oz)	10/27	8	9	9	9	9	8	9	9	9	9	8+	8	9	-	9	VG
Status (5-8 oz)	4/19	7	9	9	9	9	9	9	8+	9	9	9	8	9	-	9	G
Steadfast Q (1.5 oz)	2/2	7	7	7	6	N	7	N	N	9	6	N	N	8	-	8+	F-G
Stout (0.5 oz)	2/2	7	7	7	9	N	7	N	N	9	6	N	N	8+	-	8	F-G
Tough 5EC (24 fl oz)	6	6	8	8	9	-	N	9	8+	9	7	7	-	7	-	6	F-G
Yukon (4-8 oz)	2/4	6	9	9	9	8+	9	8	7	9	9	8	8	9+	-	9	F-G

¹ See Table 5.4 and 5.6 for additional products that contain these active ingredients.

² Triazine-resistant (TR) biotypes of common lambsquarters and redroot/smooth pigweed are widespread in the region and thus triazine (Group 5) herbicides are not effective against these populations.

³ Most marestail populations in the region are glyphosate-resistant (Group 9); some populations are also resistant to ALS (Group 2) herbicides. For best management of marestail, control in the fall or with an effective burndown program before planting. There are several herbicides that provide effective residual activity. However, marestail control in-crop can be challenging since there are only a few herbicides that are effective postemergence. Make sure to apply herbicide before marestail reaches 8 inches tall.

⁴ See remarks in Table 5.16 and the herbicide label for specific management guidelines to maximize crop tolerance.

⁵ For use on Roundup Ready corn varieties only.

⁶ Glyphosate-containing products include Roundup, Durango, and many others; see Table 5.1.

⁷ For use on LibertyLink or glufosinate-resistant corn varieties only.

⁸ Glyphosate resistance has been confirmed for this species and is widespread in the region.

⁹ Group 2 (ALS) resistance is confirmed for this species and is widespread in the region.

Glyphosate resistant biotypes are common in the region; glyphosate will not control these biotypes

Triazine-resistant (Group 5) biotypes are common in the region; atrazine nor simazine will not control these biotypes.

ALS-resistant biotypes are present in the region, Group 2 herbicides will not control these biotypes.

Table 5.18 - Herbicide Effectiveness on Perennial Broadleaf Weeds

Performance ratings are based on seasonal control from early season application in corn.

Weed control rating:

10 = 95–100%

9 = 85–95%

8 = 75–85%

7 = 65–75%

6 = 55–65%

N = Less than 55% or no control

+ = upper end of rating scale

– = not applicable or no local data available

Crop tolerance:

E = excellent; almost never any crop injury observed

VG = very good; on rare occasion is crop injury observed

G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., seedling depth, seed slit closure, herbicide rate and application timing, adjuvants)

FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions

F = fair; some crop injury is commonly observed

Trade Name	Site of Action Number	Canada Thistle	Dandelion	Dewberry Species	Dock Species	Hedge Bindweed	Hemp Dogbane	Horsenettle	Jerusalem Artichoke	Milkweed	Mugwort	Poison Ivy	Pokeweed	Corn Tolerance
2,4-D	4	7+	8	6	7+	8	7	6	7	6	6	7	7	F
Accent Q	2	6	N	8	N	7	6	6	6	6	N	–	7	F-G
Atrazine ¹	5	6	6	6	7	7+	6	6	N	N	N	6	6	VG
Callisto	27	8	7+	N	–	–	7	7+	–	7	?	–	7	G
Clarity/DiFlexx	4	8	7+	6	8	8+	7	7	8	6	7+	7+	7	F-G
Glyphosate ²	9	8+	7	8	8	7+	8	7	8	8	7	8	8	E
Liberty ³ (36 fl oz)	10	6	7	–	6	N	6	7	–	6	–	–	6	E
Starane Ultra	4	N	N	N	N	8	8+	N	N	N	N	N	N	VG
Stinger	4	9	7	N	8+	N	N	6	9	N	8	7	N	VG
Mixtures														
Curtail	4/4	9	8	6	8+	8	7	6	9	6	8	7	7	F
Spirit + Clarity or 2,4-D	2/4	8+	8	6	7	8	7	7+	8	7	7+	–	8	F-G
Status	4/19	8+	8+	6	8	8+	7	7	8	7	7+	7+	8	G
Yukon	2/4	8+	8	6	7	8	7	7+	7	8	7+	–	8	F-G

¹ Ratings based on 1.6–2 lb/A rate.

² For use on Roundup Ready corn varieties only. Glyphosate-containing products include Roundup, Durango, and many others; see Table 5.1.

³ For use on glufosinate-tolerant or LibertyLink corn varieties only.

5-70 Weed Control in Field Crops: Corn

Table 5.19 - Comments on Postemergence Herbicides for Corn

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Site of Action Number	Product/A	lb ai/A
2,4-D amine 4S	2,4-D amine	4	0.5–1 pt	0.2–0.5
<ul style="list-style-type: none"> • Use from time corn emerges until approximately 36 inches. • Risk of 2,4-D injury increases as corn increases in size. • Use 0.5 pt rate with drop nozzles after corn exceeds 8 inches in height. • Corn is most susceptible to injury when growing rapidly. • Adjust sprayer to minimize drift in order to prevent injury to non-target plants. 				
Accent Q 54.4WG	nicosulfuron + safener	2	0.9 oz	0.031
<ul style="list-style-type: none"> • Accent Q contains nicosulfuron plus isoxadifen (corn safener) and has similar utility as Accent 75DF; however, it is a different formulation and rates must be adjusted. • The typical use rate of Accent Q is 0.9 oz/A and it controls many annual grasses and some broadleaves. Accent Q is weak on crabgrass. • Apply to corn broadcast or directed up to 20 inches tall (V6) or directed up to 36 inches tall (V10). • Include appropriate adjuvant in spray tank (see Table 5.23). • Accent Q may be tank-mixed with certain herbicides. Do not tank-mix with Basagran, 2,4-D, or certain foliar applied organophosphate insecticides. Refer to label for restrictions when soil-applied organophosphate insecticides are used (i.e. terbufos). There are no precautions for non-OP insecticides. Do not use Counter 15G. Do not use Counter 20CR in furrow or over the row at cultivation; may be banded, but may cause injury, especially on soils with less than 4% organic matter. The use of Dyfonate, Lorsban, Thimet may result in temporary injury. There are no precautions for Non-OP insecticides. • Revulin Q is a premix that contains nicosulfuron + mesotrione. • To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (group 2) herbicides. 				
Acuron GT 4.29SC	S-metolachlor +	15	3.75 pt	0.94
	mesotrione +	27		0.09
	bicyclopyrone	27		0.044
	glyphosate	9		0.94 ae
<ul style="list-style-type: none"> • Acuron GT is very similar to Halex GT and has a similar utility and can only be applied to glyphosate-resistant (RR) corn hybrids from emergence to 30 inches tall (8-leaf stage). • For best results, apply to weeds before they are 4 inches tall. • Include NIS and AMS in the spray mixture. • Tank-mix with 0.25 to 1 lb ai/A of atrazine for much improved control and to broaden the spectrum of control. Local university data supports at least 0.5 lb ai/A of atrazine. Do not apply the tank mixture of Acuron GT and atrazine to corn greater than 12 inches tall. • Do not apply another HPPD-inhibitor herbicide (Callisto, Capreno, Impact/Armezon, Laudis) postemergence in the same season. • See label for additional use restrictions. 				
Aim 2EC	carfentrazone	14	0.5–1.0 fl oz	0.008–0.016
<ul style="list-style-type: none"> • Apply to corn up to 8-leaf collar stage and when weeds generally are 1–4 inches tall. • Include a nonionic surfactant (2 pt/100 gal). • Tank-mix with other herbicides to increase weed control spectrum. 				
Armezon 2.8SC	topramezone	27	0.5–1 fl oz	0.011–0.022
<ul style="list-style-type: none"> • See Impact entry for more details • Tank-mix with 0.25 to 1 lb ai/A of atrazine for much improved control and to broaden the spectrum of control. Local university data supports at least 0.5 lb ai/A of atrazine. Do not apply the tank mixture of Armezon and atrazine to corn greater than 12 inches tall. • Armezon PRO is a premix containing topamazone plus dimethenamid-P (Outlook) and can be applied over-the-top of corn for additional residual weed control. Kryo is a premix containing topamazone, acetochlor (Harness), and clopyralid (Stinger) and can be applied over the top of corn for additional weed control. 				

Table 5.19 - Comments on Postemergence Herbicides for Corn (cont.)

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Site of Action Number	Product/A	lb ai/A
Atrazine 4L	atrazine	5	1–2 qt	1–2
<ul style="list-style-type: none"> • Apply before weeds are 1.5 inches tall and before corn reaches 12 inches in height. • Add 1 qt crop oil concentrate/A to spray solution. Do not include oil if corn is under stress from prolonged cold, wet weather or other factors. • Provides good to excellent residual control of susceptible broadleaf weeds. 				
ATRAZINE USE RESTRICTIONS				
Postemergence				
<ul style="list-style-type: none"> • If no atrazine was applied prior to crop emergence, use a maximum rate of 2.0 lb of active ingredient per acre. • If a soil-applied application was made in the same calendar year, the combined preplant or preemergence and postemergence applications may not exceed 2.5 lb of active ingredient per acre. 				
Safety Precautions for Using Atrazine				
<ul style="list-style-type: none"> • Do not mix, load, or apply within 50 feet of drinking water wells, livestock wells, agricultural drainage wells, irrigation wells, abandoned wells, or sinkholes. • Do not mix or load within 50 feet of intermittent streams, perennial streams, rivers, lakes, or reservoirs. • Do not apply within 200 feet of lakes or reservoirs. • Do not apply within 66 feet of the points where surface water runoff enters intermittent streams, perennial streams, or rivers. The 66-foot buffers should be planted to a crop or seeded with grass on highly erodible land. • <i>Restricted-use pesticide and water quality advisory.</i> 				
Basagran 4S	bentazon	6	1.5–2.0 pt	0.75–1.0
<ul style="list-style-type: none"> • Apply when weeds are small and actively growing. • Split treatments may be required for yellow nutsedge and Canada thistle. • Include the appropriate adjuvant in the spray tank (see Table 5.20). • Basagran poses less threat to off-target plants from drift than 2,4-D or dicamba. • Basagran is weak on pigweed and the addition of atrazine improves control. 				
Basis Blend 30WDG	rimsulfuron +	2	0.825 oz	0.01
	thifensulfuron	2		0.005
<ul style="list-style-type: none"> • Basis Blend is a mixture of rimsulfuron (Resolve) and thifensulfuron (Harmony) (SG); however, its formulation is different from Basis 75DF; thus, the application rate has changed. • Apply 0.825 oz/A Basis Blend to corn from spike stage through 2 collars (about 6 inches tall). Do not apply to corn having 3 fully emerged collars or corn over 6 inches tall. • Basis Blend controls some small annual grasses and broadleaves. Will provide residual control of susceptible species. • Basis Blend must include an adjuvant including an ammonium nitrogen fertilizer. • Crop injury may occur following an application of Basis Blend if there is a prolonged period of cold weather and/or in conjunction with wet soil. • Do not tank-mix with Basagran. • Regardless of PRE and/or POST applications, do not apply more than a total of 1 oz/A/season active ingredient rimsulfuron. • Do not tank-mix Basis Blend with foliar-applied organophosphate insecticides such as Lorsban, malathion, etc., as severe crop injury may occur. To avoid crop injury or antagonism, apply these products at least 7 days before or 3 days after the application of Basis Blend. Do not apply Counter (terbufos) within 60 days of a preemergence or preplant application of Basis Blend since crop injury may result. Do not apply Basis Blend within 45 days of crop emergence where Counter was applied as a treatment since crop injury may occur. There are no precautions for Force and Fortress. • To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides. 				

5-72 Weed Control in Field Crops: *Corn*

Table 5.19 - Comments on Postemergence Herbicides for Corn (cont.)

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Site of Action Number	Product/A	lb ai/A
Cadet 0.91EC	fluthiacet	14	0.4–0.9 fl oz	0.0028–0.006
<ul style="list-style-type: none"> • Application timing to corn ranges from 2 visible collars (V2) until the corn is 48 inches tall (or prior to tasseling). • Apply 0.4 to 0.6 fl oz/A with glyphosate (RR-corn) or glufosinate (LL-corn) or 0.5 to 0.9 fl oz when applied alone. • Include the necessary spray additives (NIS or COC plus AMS or nitrogen solution). • Applications should be made when susceptible broadleaf weeds are small. • Cadet is very effective on velvetleaf (up to 36 inches tall), but other broadleaf weeds must be small to achieve control/suppression. • Cadet does not provide residual weed control. • Cadet can cause burning/speckling on the corn leaves. • Cadet is similar to Aim herbicide. 				
Callisto 4SC	mesotrione	27	3 fl oz	0.094
<ul style="list-style-type: none"> • Callisto can be applied postemergence at 3 fl oz/A to corn up to 30 inches tall (8-leaf stage). • Always include crop oil concentrate and UAN or AMS in the spray mixture. Do not use methylated seed oil (MSO). • Tank-mix with 0.25 to 1 lb ai/A of atrazine for much improved control and to broaden the spectrum of control. Local university data supports at least 0.5 lb ai/A of atrazine. Do not apply the tank mixture of Callisto and atrazine to corn greater than 12 inches tall. (Callisto Xtra is a premix of Callisto + atrazine.) • Do not apply more than a total of 7.7 oz/A of Callisto/A/season. (i.e., 0.24 lb ai/A mesotrione) from any product or combination of products containing mesotrione. • Callisto will provide residual control of susceptible weed species. • When HPPD-containing (Group 27) herbicides are used in both pre and post sequential applications, the post HPPD product must be tank-mixed with another herbicide that has a different and effective site of action on the target weeds. • Do not apply Callisto postemergence in a tank mix with emulsifiable concentrate grass herbicides. • Do not apply Callisto postemergence: (1) if the crop was previously treated with Counter (terbufos) or chlorpyrifos insecticide or Lorsban insecticide, (2) with any OP or carbamate insecticide, or (3) 7 days before or after an OP or carbamate insecticide was applied. • Small grains may be planted 4 months after application. Corn, soybeans, and sorghum can be planted the year after application, 10-month restriction for alfalfa and 18-month restriction for clover. See Table 5.3 for additional rotational crops. • Other postemergence premixes that contain mesotrione include: <ul style="list-style-type: none"> - Callisto GT (mesotrione + glyphosate) - Callisto Xtra (mesotrione + atrazine) - Halex GT (mesotrione + S-metolachlor + glyphosate) - Harness MAX (mesotrione + acetochlor) - Realm Q (mesotrione + rimusulfuron) - Revulin Q (mesotrione + nicosulfuron) 				

Table 5.19 - Comments on Postemergence Herbicides for Corn (cont.)

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Site of Action Number	Product/A	lb ai/A
Capreno 3.45SC	tembotrione +	27		0.068
	thiencarbazone +	2	3 fl oz	0.013
	corn safener			
<ul style="list-style-type: none"> • Capreno is a premix of tembotrione (Laudis), thiencarbazone (ALS-inhibitor herbicide that improves control of annual weeds), and cyprosulfamide (corn safener) and can be applied postemergence up to V7 corn stage to provide control of annual broadleaves and grasses, especially when tank-mixed with atrazine. • The use rate is 3 fl oz/A in addition to COC and UAN or AMS in the spray mixture. (Do not use NIS or MSO.) • For best results, apply Capreno when broadleaf weeds are less than 4 to 6 inches tall and grasses are less than 3 inches tall and not tillering. • Do not apply more than 0.164 lb ai tembotrione/A/year (6 fl oz/A total Capreno). • Temporary stunting is occasionally observed with Capreno, corn recovers in 7 to 10 days and does not affect yield. • When HPPD-containing (Group 27) herbicides are used in both pre and post sequential applications, the post HPPD product must be tank-mixed with another herbicide that has a different and effective site of action on the target weeds. • Tank-mix with 0.25 to 1 lb ai/A of atrazine for much improved control and to broaden the spectrum of control. Local university data supports at least 0.5 lb ai/A of atrazine. Do not apply the tank mixture of Capreno and atrazine to corn greater than 12 inches tall. • Capreno can be tank-mixed with glyphosate or glufosinate to broaden control spectrum. • Capreno will provide residual control of susceptible weed species. • Do not use Capreno in the same season as OP insecticides such as chlorpyrifos or terbufos. Refer to label for restrictions. 				
Clarity 4S	dicamba (DGA salt)	4	8–16 fl oz	0.25–0.5
<ul style="list-style-type: none"> • May apply dicamba up to 1 pint before corn is 8 inches tall (5-leaf stage). Use 0.25 lb ae/A on corn between 8 and 36 inches. • Take precautions to prevent drift of dicamba off the target site. • Early postemergence applications are preferable for lambsquarters control. • Applications should be made while annual weeds are small (4 inches) and actively growing. • Spray droplet size plays an important role in minimizing off-target movement. Nozzles that produce extremely coarse or ultra coarse droplets while limiting the amount of driftable fine droplets are necessary to limit spray drift. Comply with guidelines for drift management (see label for details). • Dicamba can be difficult to completely remove from spray equipment and residue is capable of injuring sensitive plants. Follow label instructions concerning sprayer cleanout. 				
Curtail 2.38L	clopyralid +	4	2 pt	0.095
	2,4-D	4		0.5 ae
<ul style="list-style-type: none"> • Curtail contains clopyralid (Stinger) and 2,4-D. • Apply to corn less than 8 inches tall (V4). • For increased control of Canada thistle, tank-mix Curtail with Stinger (2–6 fl oz). 				
DiFlexx 4SC	dicamba + safener	4	8–32 fl oz	0.25–1
<ul style="list-style-type: none"> • This safened dicamba product contains cyprosulfamide which is the same safener used in Balance Flexx and Corvus. • Can be applied to field corn from spike stage to V6 (36 inches tall) • The lower use rates (8–16 fl oz) are recommended for annual broadleaf weeds that are small and actively growing; while the mid and higher rates are recommended for larger annual weeds and established biennial and perennial species. • The addition of UAN or AMS plus NIS or COC/MSO is recommended to improve control. • See label for additional use details and restrictions. 				

5-74 Weed Control in Field Crops: Corn

Table 5.19 - Comments on Postemergence Herbicides for Corn (cont.)

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Site of Action Number	Product/A	lb ai/A
DiFlexx Duo 1.53SC	dicamba + safener +	4	24–40 fl oz	0.24–0.4
	tembotrione	27		0.051–0.085
<ul style="list-style-type: none"> • DiFlexx Duo contains the active ingredients in DiFlexx (dicamba) and Laudis (tembotrione) and has activity on both broadleaf and grassy weeds. • DiFlexx Duo can be applied from corn emergence to 36 inches tall or before V7 stage, whichever comes first. • For best results apply before annual broadleaf weeds reach 6 inches tall and grasses, 3 inches tall. • The addition of UAN or AMS plus MSO or COC is recommended to improve control. • Do not apply more than 0.164 lb ai tembotrione/A/year. • When HPPD-containing (Group 27) herbicides are used in both pre and post sequential applications, the post HPPD product must be tank-mixed with another herbicide that has a different and effective site of action on the target weeds. 				
Enlist One 3.8SL	2,4-D choline	4	1.5–2.0 pt	0.71–0.95 ae
Enlist Duo 3.3SL	2,4-D choline +	4	3.5–4.75 pt	0.7–0.95 ae
	glyphosate	9		0.74–1.0 ae
<ul style="list-style-type: none"> • Enlist Duo and Enlist One can only be applied post to corn with the Enlist trait and has activity on both broadleaf and grassy weeds. • Apply broadcast from corn emergence to 30 inches tall or before V8 stage, whichever comes first; use drop nozzles for corn heights 30 to 48" tall. • Make one or two applications with a minimum of 12 days between applications. • Apply in a broadcast spray volume from 10 to 15 gpa for best results and do not use nitrogen solutions as a carrier. • Spray droplet size plays an important role in minimizing off-target movement. Nozzles that produce extremely coarse or ultra coarse droplets while limiting the amount of driftable fine droplets are necessary to limit spray drift. Comply with guidelines for drift management (see label for details). 				
Engenia 5SL or XtendiMax 2.9SL	dicamba (BAPMA salt) dicamba (DGA salt with VaporGrip Technology)	4	6.4–12.8 fl oz 11–22 fl oz	0.25–0.5 lb ae
<ul style="list-style-type: none"> • Carefully read and follow product labels. • Refer to Clarity for comments • See label for additional use details and restrictions. • <i>Engenia/XtendiMax are restricted-use products; all dicamba formulations have a water quality advisory.</i> 				

Table 5.19 - Comments on Postemergence Herbicides for Corn (cont.)

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Site of Action Number	Product/A	lb ai/A
Halex GT 4.39EC	S-metolachlor +	15		0.94–1.04
	mesotrione +	27	3.6–4.0 pt	0.09–0.1
	glyphosate	9		0.9–1.04 ae

- Halex GT contains S-metolachlor (Dual Magnum) + mesotrione (Callisto) + glyphosate and can only be applied to glyphosate-resistant (RR) corn hybrids from emergence to 30 inches tall (8-leaf stage).
- For best results, apply to weeds before they are 4 inches tall.
- Include NIS and AMS in the spray mixture.
- Tank-mix with 0.25 to 1 lb ai/A of atrazine for much improved control and to broaden the spectrum of control. Local university data supports at least 0.5 lb ai/A of atrazine. Do not apply the tank mixture of Halex GT and atrazine to corn greater than 12 inches tall.
- Do not apply another HPPD-inhibitor herbicide (Callisto, Impact/Armezon, Laudis, Capreno) postemergence in the same season.
- Do not apply more than 4 pt/A Halex GT per season (0.0105 lb mesotrione, 1.05 lb S-metolachlor, and 1.05 lb glyphosate) or make more than 1 application per year.
- Do not apply more than 0.24 lb ai mesotrione/A/year from any product or combination of products containing mesotrione.
- When HPPD-containing (Group 27) herbicides are used in both pre and post sequential applications, the post HPPD product must be tank-mixed with another herbicide that has a different and effective site of action on the target weeds.
- Halex GT will provide effective residual control of susceptible weed species.
- Halex GT is not recommended for use as a preplant or PRE application.
- Halex GT can be used in a planned PRE followed by POST herbicide program.
- Use caution if applying OP or carbamate insecticides 7 days before or after Halex GT application.
- See label for additional use restrictions.

Harmony SG 50WDG	thifensulfuron	2	0.125 oz	0.063 oz
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- Harmony SG can be applied to 2–6 leaf corn (1–4 collars, up to 12 inches tall) at a rate of 1/8 oz/A.
- Harmony SG can be used in a tank-mix to control velvetleaf, pigweed, smartweed, wild mustard, and lambsquarters (including triazine-resistant species).
- Include the necessary adjuvants in the spray solution.
- Corn treated with an organosphosate insecticide such as chlorpyrifos or terbufos can cause injury. Refer to label for restrictions.
- Harmony SG is an ALS (group 2) inhibitor herbicide. To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (group 2) herbicides.

5-76 Weed Control in Field Crops: Corn

Table 5.19 - Comments on Postemergence Herbicides for Corn (cont.)

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Site of Action Number	Product/A	lb ai/A
Impact 2.8SC or Armezon 2.8SC	topramezone	27	0.5–2.0 fl oz	0.011–0.044

- Impact/Armezon is similar to Callisto but has more annual grass activity.
- Apply postemergence to corn up to V8 growth stage or 45 days prior to corn harvest, whichever is more restrictive (use drop nozzles when necessary).
- Always include methylated seed oil (MSO) or crop oil concentrate (COC) and UAN or AMS in the spray mixture.
- Tank-mix with 0.25 to 1 lb ai/A of atrazine for much improved control and to broaden the spectrum of control. Local university data supports at least 0.5 lb ai/A of atrazine. Do not apply the tank mixture with atrazine to corn greater than 12 inches tall.
- Impact is often used at 1 fl oz/A but the rate can be increased to 2 fl oz/A for larger or harder to control weeds such as fall panicum, yellow foxtail, or seedling Johnsongrass.
- Impact/Armezon will control/suppress crabgrass, foxtails, and other grass species but is weak on fall panicum.
- Impact/Armezon can be used in sequence after herbicides such as Balance, Lumax, Lexar, etc., but be cautious of rate restrictions. Impact/Armezon may be used after or in combination with all soil or foliar-applied insecticides registered for use in corn.
- Do not apply more than 0.022 lb ai topramezone/A/year.
- When HPPD-containing (Group 27) herbicides are used in both preemergence and postemergence (sequential applications), Impact must be tank-mixed with another herbicide that has a different and effective site of action on the target weeds.
- Corn can be planted any time after Impact/Armezon application, 3-month restriction for small grains, 9-month restriction for alfalfa, potato, soybean, and sorghum and 18 months for other crops. See Table 5.4 for other rotational crops.
- ImpactZ is a premix containing topiramazone plus atrazine.
- Impact Core is a premix of topramezone plus acetochlor (Harness) and can be applied post.
- Sinate is a premix of topramezone plus glufosinate (Liberty).
- Armezon PRO is a premix containing topiramazone plus dimethenamid (Outlook) and can be applied over-the-top of corn for additional residual weed control. Kryo is a premix containing topiramazone, acetochlor (Harness), and clopyralid (Stinger) and can be applied over the top of corn for additional weed control.

Kryo	acetochlor (Group 15) +	35	35-60 fl oz	
	topramezone (Group 27)			
	+			
	clopyralid (Group 4)			

- Can be applied emergence up to 24-inch tall corn.
- Kryo is most effective when applied to actively growing weeds that are 4 inches or less in height.
- Use rate from 35-60 fl oz/A. Max use rate is 60 fl oz/A.
- 45 fl oz/A is a typical rate when post emergent control of grasses is required.
- Consider tank mixing with atrazine at .25 to 1 lb ai/A. (do not apply a tank mix containing atrazine on corn taller than 12 inches).
- Glufosinate and glyphosate can also be tank mixed to broaden control in glyphosate and glufosinate-resistant corn.
- Use a crop oil concentrate or methylated seed oil with Kryo when applied alone. Nonionic surfactant or oil type adjuvants may be used in tank mixtures containing Kryo unless the glyphosate or glufosinate product includes an adjuvant system. Do not add an oil-type adjuvant with glufosinate or atrazine containing tank mixtures. Ammonium sulfate may be used with Kryo alone or in tank mixtures.

Table 5.19 - Comments on Postemergence Herbicides for Corn (cont.)

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name¹	Common Name	Site of Action Number	Product/A	lb ai/A
Laudis 3.5SC (tembotrione)	tembotrione	27	3 fl oz	0.082
<ul style="list-style-type: none"> • For best results apply Laudis at 3 fl oz/A when weeds are small (i.e., 1 to 3 inches tall). • Methylated seed oil (MSO) or crop oil concentrate (COC) adjuvants are recommended by manufacturer. In addition, nitrogen fertilizer is required (UAN or AMS). • Tank-mix with 0.25 to 1 lb ai/A of atrazine for much improved control and to broaden the spectrum of control. Local university data supports at least 0.5 lb ai/A of atrazine. Do not apply the tank mixture of Laudis and atrazine to corn greater than 12 inches tall. • Laudis can be tank-mixed with other herbicides to improve weed control spectrum. • Laudis will control/suppress crabgrass, foxtails, and other grass species, but it will not control fall panicum. • Do not make more than two applications of Laudis in a growing season. • Do not apply more than 0.164 lb ai tembotrione/A/year. • When HPPD-containing (Group 27) herbicides are used in both pre and post sequential applications, the post HPPD product must be tank-mixed with another herbicide that has a different and effective site of action on the target weeds. • Be cautious of crop rotation restrictions; see Table 5.3. 				
Liberty 2.34L	glufosinate	10	22–32 fl oz	0.40–0.59
<ul style="list-style-type: none"> • Liberty controls most annual grasses and broadleaves. • Apply over the top to glufosinate-resistant (e.g., LibertyLink) corn only. • Up to three Liberty applications can occur during the growing season (one at burndown and two in-crop). • Two postemergence applications of Liberty can be applied at least 7 days apart. • Broadcast applications may be made from corn emergence until corn is in the V-5 stage of growth, whichever comes first. • For best results, apply 22 to 32 fl oz of Liberty when weeds are 2 to 6 inches tall. • Do not apply more than 87 fl oz/A/year. • Liberty herbicide should generally follow a soil residual herbicide program and/or be tank-mixed with an appropriate postemergence product to broaden the spectrum of control. • Applications should be made between dawn and 2 hours before sunset to avoid the possibility of reduced lambsquarters or velvetleaf control. • Weed control can be reduced if application is made when heavy dew, fog, or mist are present or when weeds are under environmental stress. • Liberty provides no soil residual activity. • See Table 5.20 for adjuvant information. Include ammonium sulfate (AMS) at 3 lb/A (17 lbs/100 gal) but a lower rate is recommended if temperatures exceed 85 degrees (8.5 lbs/100 gal) to reduce risk of leaf burn. Do not add any surfactants or crop oils. • Sinate is a premix of topramezone plus glufosinate (Liberty). 				
Maestro / Moxy 2E	bromoxynil	6	1–1.5 pt	0.25–0.375
<ul style="list-style-type: none"> • Apply to small actively growing weeds. • Maestro or Moxy pose less threat to off-target plants from drift than 2,4-D or dicamba. • Bromoxynil is weak on pigweed. 				
Metribuzin 75DF	metribuzin	5	2 oz	0.094
<ul style="list-style-type: none"> • Metribuzin may be applied postemergence at the 2-oz rate in tank-mix combination with atrazine, Banvel, Clarity, Basagran, Buctril, Marksman, and 2,4-D for improved control of certain broadleaf weeds (e.g., velvetleaf). • Observe precautions and limitations of tank-mix partners. • <i>Water quality advisory.</i> 				

5-78 Weed Control in Field Crops: Corn

Table 5.19 - Comments on Postemergence Herbicides for Corn (cont.)

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Site of Action Number	Product/A	lb ai/A
Peak 57WG	prosulfuron	2	0.25–1.0 oz	0.009–0.036
<ul style="list-style-type: none"> • Peak is an ALS (group 2) herbicide and can be applied in field corn to control broadleaf weeds. • Include necessary adjuvants in the spray mixture. • Peak can be applied when corn is 4 to 30 inches tall; use drop nozzles when corn is >20 inches tall. • In university field trials, Peak at 0.5 oz/A provided season-long control of burcucumber, especially when applied to 25-30 inch tall corn. • Be cautious of interactions with certain OP insecticides. • Be cautious of long crop rotational intervals for many crops, see label for details. • Refer to label for additional information on use and restrictions. 				
Permit 75WG or Sandea	halosulfuron	2	0.67–1.33 oz	0.032–0.063
<ul style="list-style-type: none"> • Apply to corn from spike through layby (last cultivation). • The 0.67 oz rate is the standard rate for annual weed control. • Permit/Sandea is excellent on yellow nutsedge, but is weak on common lambsquarters. • Tank-mix with products such as dicamba or 2,4-D to increase the weed control spectrum. • Permit/Sandea will provide residual control of susceptible weed species. • Permit/Sandea has no insecticide use restrictions. • To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (group 2) herbicides. • Yukon is a prepackaged product containing halosulfuron (Permit) plus dicamba. 				
Permit Plus 74WDG	halosulfuron +	2	0.75 oz	0.031
	thifensulfuron	2		0.004
<ul style="list-style-type: none"> • The addition of thifensulfuron (Harmony SG) to halosulfuron (Permit) allows for a broader spectrum of control, especially at lambsquarter postemergence. • Apply 0.75 oz/A plus necessary adjuvants to corn with 2–6 leaves (but with no more than 5 collars). • Tank-mix to broaden control spectrum. • Permit Plus contains two ALS-type (Group 2) herbicides. To prevent herbicide resistance, avoid repeated annual applications of ALS herbicides. 				
Realm Q 38.8WDG	rimsulfuron +	2	4 oz	0.019
	mesotrione +	27		0.078
	corn safener			
<ul style="list-style-type: none"> • Realm Q contains the active ingredients in Resolve and Callisto and the postemergence corn safener isoxadifen. • For best results, apply Realm Q at 4 oz/A in a two-pass program and when weeds are small and prior to corn reaching 12 inches tall. • Realm Q requires use of nitrogen fertilizer (AMS or UAN) in addition to COC or NIS. • Make only one application per season. • The addition of atrazine will improve postemergence weed control and is strongly recommended. • Realm Q can be used alone, in combination with glyphosate on Roundup Ready corn or glufosinate on LibertyLink corn, or included in other POST herbicide programs to improve weed control spectrum. • Realm Q will provide some residual as well as foliar control. • Do not apply more than 0.063 lb ai rimsulfuron/A/year from any product or combination of products containing rimsulfuron. • Do not apply more than 0.24 lb ai mesotrione/A/year from any product or combination of products containing mesotrione. • When HPPD-containing (Group 27) herbicides are used in both pre and post sequential applications, the post HPPD product must be tank-mixed with another herbicide that has a different and effective site of action on the target weeds. • Refer to the Realm Q label for all restrictions concerning increased injury when used with corn treated with organophosphate insecticides (chlorpyrifos, terbufos etc). 				

Table 5.19 - Comments on Postemergence Herbicides for Corn (cont.)

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name¹	Common Name	Site of Action Number	Product/A	lb ai/A
Resolve 25DF	rimsulfuron	2	0.5–2.0 oz	0.0078–0.03
<ul style="list-style-type: none"> Resolve contains the single active ingredient rimsulfuron. Resolve can be applied pre or post in corn at 0.5–2.0 oz/A. Use the higher rate when applying as a tank-mix partner in a pre program. The typical use rate for post applications is 1 oz/A, plus the necessary adjuvants. Resolve alone will control small seedling weeds, grasses less than 2 inches and broadleaves less than 3 inches. Resolve will control crabgrass less than 0.5 inch tall. Resolve can be tank-mixed with glyphosate to provide residual control of broadleaf and grass weed species emerging after the application. Resolve may be tank-mixed with full or reduced rates of other corn herbicides as well. Do not apply Resolve to corn under stress due to crop injury. Refer to the Resolve label for all restrictions concerning increased injury when tank-mixed with organophosphate insecticides terbufos, chloryrifos, etc. Do not tank-mix with Basagran due to crop injury concern. Apply Resolve up to 12 inch tall corn or before the appearance of 6 or more collars, whichever is more restrictive. Resolve must be applied with a nonionic surfactant (NIS) and nitrogen fertilizer. Crop oil concentrate (COC) may be used in place of nonionic surfactant. When applying Resolve in tank-mixture with a glyphosate product that contains a “built-in” adjuvant system, the Resolve label does not recommend the use of extra adjuvants. To prevent herbicide resistance, avoid repeated annual applications of soil persistent ALS (group 2) herbicides. 				
Resolve Q	rimsulfuron +	2	1.25 oz	0.014
	thifensulfuron	2		0.003
<ul style="list-style-type: none"> Do not confuse Resolve with Resolve Q. Resolve Q contains rimsulfuron (Resolve) plus thifensulfuron (Harmony SG) and a postemergence corn safener. Apply 1.25 oz/A postemergence to corn up to 20 inches tall. Applications made after weed emergence will provide contact control of labeled weeds and limited residual control of later emergence. For control of emerged weeds, include a nonionic surfactant and an ammonium nitrogen fertilizer. If applied in combination with a glyphosate or glufosinate herbicide that contains a built-in adjuvant system, no additional surfactant needs to be added. Resolve Q may be tank mixed with glyphosate or glufosinate herbicides if applications are made to corn hybrids containing appropriate herbicide tolerance genes, and can be tank-mixed with full or reduced rates of other products registered for use in corn. Resolve Q may be tank- mixed with full or reduced rates of preemergence grass and broadleaf herbicides to provide added residual activity. Do not tank-mix Resolve Q with Basagran. Resolve Q may negatively interact with certain OP insecticides, see label for specific details. To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides. 				
Resource 0.86EC	flumiclorac	14	4–6 fl oz	0.027–0.04
<ul style="list-style-type: none"> Apply to corn from 2-leaf to 10-leaf stage. Good on velvetleaf up to 30 inches tall. Tank-mix with other products such as dicamba or atrazine to increase the weed control spectrum. Perpetuo is a premix of flumiclorac plus pyroxasulfone (Zidua) and must be applied post. 				

5-80 Weed Control in Field Crops: Corn

Table 5.19 - Comments on Postemergence Herbicides for Corn (cont.)

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Site of Action Number	Product/A	lb ai/A
Roundup PowerMax 4.5S or PowerMax3 4.8S Durango DMA Other glyphosate products	glyphosate	9	22 to 32 fl oz or 20 to 30 fl oz 24 to 36 fl oz	0.75 lb ae to 1.12 lb ae

- Apply over-the-top to Roundup Ready corn hybrids only.
- Apply from corn emergence through 48-inch tall corn in a 10–20 GPA spray solution.
- Do not apply more than 1.13 lb ae/A of glyphosate (Roundup PowerMax at 32 fl oz or PowerMax3 at 30 fl oz/A) in a single in-crop application. (Refer to current product label for other use restrictions.)
- For corn grain and silage corn, two in-crop applications of Roundup can be made; allow 10 days between applications.
- For best results, apply a pre residual herbicide followed by glyphosate when weeds are 4–6 inches tall (for best results tank mix with other post herbicides to improve weed control spectrum and to prevent glyphosate-resistant weed species.)
- Early postemergence programs that include glyphosate plus a residual herbicide also are an option, but may not be as consistent as the preemergence followed by the postemergence program.
- Be cautious of corn height restrictions for residual herbicides.
- Roundup WeatherMax does not require additional adjuvants in the spray tank under most conditions.
- Do not harvest silage for 50 days or grain for 7 days after last application.
- Refer to Table 5.1 for various glyphosate products and see specific product label for additional application information and restrictions.

Shieldex 400 3.33SC	tolpyralate	27	1–1.35 fl oz	0.026–0.035
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- For best results apply Shieldex before weeds reach 5 inches tall.
- Methylated seed oil (MSO) or crop oil concentrate (COC) adjuvants are recommended by manufacturer. In addition, nitrogen fertilizer is required (UAN or AMS).
- Tank-mix with 0.25 to 1 lb ai/A of atrazine for much improved control and to broaden the spectrum of control. Local university data supports at least 0.5 lb ai/A of atrazine. Do not apply the tank mixture of Laudis and atrazine to corn greater than 12 inches tall. Shieldex can be tank-mixed with other herbicides to improve weed control spectrum.
- Shieldex will control/suppress crabgrass, foxtails, and other grass species, but it will not control fall panicum. Also, it will provide control of several common annual broadleaf weeds found in our region.
- Do not make more than 2 applications of Shieldex in a growing season.
- Do not apply more than 0.07 lb ai (2.7 fl oz) tolpyralate per acre per year
- When HPPD-containing (Group 27) herbicides are used in both pre and post sequential applications, the post HPPD product must be tank-mixed with another herbicide that has a different and effective site of action on the target weeds.
- Be cautious of crop rotation restrictions; see Table 5.17.
- Other products that contain tolpyralate include: Empyros product line, Katagon, and Restraint.

	dicamba +	4		0.063–0.25
Status 56WDG	diflufenzopyr +	19	2.5–10 oz	0.025–0.1
	safener			

- Status contains dicamba (Clarity) plus another plant growth regulator (diflufenzopyr) and the postemergence corn safener isoxadifen.
- Apply Status at 5 oz/A to 4- to 36-inch-tall corn (V2–V8).
- Status can be tank-mixed with glyphosate at 2.5 oz/A. Use higher rates for more difficult to control weeds. Do not exceed a total of 12.5 oz/A per season.
- Include a non-ionic surfactant at 1 qt plus 5 qt of UAN (28–34% nitrogen) per 100 gallons of water (COC or MSO may be used instead of NIS).
- Status is effective on many broadleaf weeds.
- Do not tank-mix with products that contain 2,4-D, dicamba, or clopyralid.
- *Water quality advisory.*

Table 5.19 - Comments on Postemergence Herbicides for Corn (cont.)

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Site of Action Number	Product/A	lb ai/A
Steadfast Q 37.7WG	nicosulfuron +	2	1.5 oz	0.02
	rimsulfuron +	2		0.012
	corn safener			

- Steadfast Q also contains a 2:1 ratio of nicosulfuron to rimsulfuron in addition to the postemergence corn safener isoxadifen.
- Apply Steadfast Q at 1.5 oz/A to corn up to 20 inches tall (6 collars) and while weeds are young and actively growing.
- Steadfast Q is weak on crabgrass, especially if >1 inch tall. Always include the necessary adjuvants in the spring mixture.
- Steadfast Q can be tank-mixed to improve control and increase weed spectrum.
- Steadfast Q may negatively interact with certain OP insecticides (i.e. chlopyrifos, terbufos, etc), see label for specific details.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.
- See Table 5.3 for recrop restrictions.

Stinger 3S	clopyralid	4	0.25–0.66 pt	0.093–0.25
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- Apply to corn up to 24 inches tall. Use 0.25–0.5 pt/A for ragweed, cocklebur and Jerusalem artichoke and 0.33–0.66 pt/A for Canada thistle.
- Delay planting soybeans for 18 months following Stinger application.
- Other premix products containing clopyralid for postemergence use in corn include:
 - Kryo (clopyralid, topramazone, and acetochlor)
 - Curtail (clopyralid and 2,4-D)
 - Maverick (clopyralid, mesotrione, and pyroxasulfone)
 - Resicore (clopyralid, acetochlor, and mesotrione)
 - SureStart II and TripleFlex II (clopyralid, acetochlor, and flumetsulam)
- *Water quality advisory.*

Stout 72.5WDG	nicosulfuron +	2	0.5–0.75 oz	0.031
	thifensulfuron	2		0.002

- Stout contains nicosulfuron (Accent) and thifensulfuron (Harmony SG).
- The typical use rate for Stout is 0.75 oz/A and must include a crop oil concentrate (COC) or a non-ionic surfactant (NIS) in the spray mixture as well as a nitrogen fertilizer (UAN or AMS).
- Stout can be applied up to 16 inch tall corn or to corn with less than 6 collars, whichever is more restrictive.
- Stout will not control crabgrass species.
- Do not tank-mix Stout with Basagran due to crop safety concerns. Do not tank-mix with 2,4-D due to reduced grass control.
- Refer to Stout label for restrictions regarding OP insecticides such as terbufos, chlopyrifos, etc. Do not tank-mix with other ALS-inhibitor herbicides unless stated on herbicide label.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.

5-82 Weed Control in Field Crops: Corn

Table 5.19 - Comments on Postemergence Herbicides for Corn (cont.)

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Site of Action Number	Product/A	lb ai/A
SureStart II 4.25SE or TripleFLEX II	acetochlor +	15		0.71–1.41
	flumetsulam +	2	1.5–3.0 pt	0.056–0.113
	clopyralid	4		0.023–0.045
Tough 5EC	pyridate	6	24 fl oz	0.94
Warrant 3CS	acetochlor	15	1.5–3.0 qt	1.13–2.25
Yukon 67.5WDG	halosulfuron +	2	4–8 oz	0.03
	dicamba	4		0.125

- SureStart II/TripleFLEX II can be applied up to the early POST stage (11-inch-tall corn) and is intended to be used with Roundup Ready or LibertyLink field or silage corn hybrids.
- When applied PRE, it is designed to provide early season control of common annual grasses and broadleaf weeds to allow better timing of the in-crop application of glyphosate or glufosinate.
- The use rate on medium-textured soils ranges from 1.5 to 1.75 pints/A, but for longer residual control, use up to 3 pt/A.
- SureStart II/TripleFLEX II does not contain atrazine, so it provides a non-atrazine alternative for triazine-sensitive areas. However, atrazine and other herbicides can be tank-mixed with SureStart II/TripleFLEX II to broaden the weed control spectrum.
- SureStart II/TripleFLEX II can be tank-mixed with glyphosate (in Roundup Ready corn) or glufosinate (LibertyLink corn) to provide broader spectrum of POST weed control.
- Applications should be made to weeds 2 inches or less in height.
- Make sure to plant corn 1.5 inches deep and be cautious of interactions with certain OP insecticides that may cause crop injury.

- Tough is good on common lambsquarters and pigweeds but should generally be tank-mixed with atrazine or another suitable foliar-applied product to broaden the control spectrum.
- Apply when broadleaves are in the one- to four-leaf stage of growth and before corn reaches V8 growth stage.
- Include NIS, COC, or MSO plus AMS or nitrogen fertilizer to improve weed control.
- Thorough spray coverage (15 to 20 gal/A) is necessary for optimal weed control.

- Warrant can be tank-mixed with glyphosate and post applied to emerged corn to provide residual control of annual weeds.
- Warrant does not control emerged weeds.
- The typical use rate is 1.5 qt/A.
- *Water quality advisory.*

- Yukon is a premix of halosulfuron (Permit) plus dicamba.
- Yukon can be applied at 4–8 oz/A to corn from spike to 36 inches tall; use drop nozzles when necessary. (The 4 oz/A Yukon rate equals 0.67 oz/A Permit plus 4 fl oz/A Clarity.)
- Include necessary adjuvants in the spray solution (Table 5-22).
- Yukon has no insecticide use restrictions.
- To prevent herbicide resistance, avoid repeated annual applications of soil-persistent ALS (Group 2) herbicides.

¹ See Table 5.4 and 5.6 for additional formulations or trade names containing some of these same active ingredients.

Table 5.20 - Weed Sizes for Postemergence Corn Herbicides

This table lists postemergence corn herbicides, their rates, and heights of weed species that are controlled or suppressed. This table is only a “quick reference”; refer to the herbicide label for additional information on application and timing.

Grasses	Barnyardgrass	Bermudagrass	Broadleaf Signal Grass	Crabgrass	Fall Panicum	Foxtail spp.	Goosegrass	Johnsongrass (Seedling)	Johnsongrass (Rhizome)	Quackgrass	Shattercane	Texas Panicum	Wirestem Muhly	Yellow Nutsedge
Herbicide (rate/A)	Height Range (inches) at Application													
Accent Q (0.9 oz)	<4	-	≤2	-	<4	<4	-	<12	<18	<10*	<12	≤3	<8*	-
Basis Blend (0.825 oz)	1-2	-	-	-	1-2	1-2	-	-	-	-	-	-	-	-
Callisto (3 fl oz)	-	-	-	≤2	-	-	-	-	-	-	-	-	-	-
Capreno (3 fl oz)	<5	-	≤5	<3	<5	<3	-	<5	-	-	<12	≤3	-	-
Glyphosate (0.75 ae)	4-6	L*	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6
Halex GT (3.6 pt)/ Acuron GT (3.75 pt)	<4	-	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Impact/Armezon (0.75 fl oz)/Impact Core	≤4	-	≤3*	≤3	≤3*	3-4 ¹	≤3	4*	-	-	-	≤3*	-	-
Laudis (3 fl oz) / DiFlexx Duo (32 fl oz)	1-5	-	1-4	1-3	-	1-3	1-3	1-5	-	-	1-6	1-3	-	-
Liberty ² (32 fl oz)	≤3	≤3	≤3	≤3	≤3	≤3	≤3	≤3	≤3	≤3	≤3	≤3	≤3	≤3
Permit (1.0 oz)	-	-	≤2*	-	-	-	-	-	-	-	-	-	-	4-12
Realm Q (4.0 oz)	1-2	-	≤2*	≤0.5	1-2	1-2	-	1-2*	-	1-2*	1-4	-	-	1-2*
Require Q (4 oz)	1-2	-	-	0.5	1-2	1-2	-	*	-	*	1-4	-	-	*
Resolve (1 oz)	1-2	-	1-2*	≤0.5	1-2	1-2	-	1-2*	-	1-2*	1-4	-	-	1-2*
Resolve Q (1.25 oz)	1-2	-	1-2*	0.5	1-2	1-2	-	*	-	*	1-4	-	-	*
Revolin Q (4 oz)	1-4	-	≤2	≤2	<4	≤4	-	<12	<18	<10*	<12	<3	<6*	-
Roundup PowererMax (22 fl oz) ³	4-6	L*	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6
Shieldex (1 fl oz)/ Restraint	<5	-	<5	<5	-	<5	<5	-	-	-	<5	-	-	-
Sinate (28 fl oz)	≤4	-	≤4	≤4	≤4	≤4	-	≤4	-	-	≤4	≤4	*	*
Steadfast Q (1.5 oz)	<4	-	≤2	<1*	<4	<4	≤2	<12	<12	<8*	<6	≤4	<4*	-
Stout (0.75 oz)	≤4	-	≤2	-	≤3	≤4	-	≤12	≤18	≤10*	≤12	≤3	≤8*	-
Yukon (6-8 oz)	-	-	-	-	-	-	-	-	-	-	-	-	-	1-12

* Suppression only; additional control measures may be necessary.

¹ Yellow foxtail suppression only.

² For use on LibertyLink/GR corn hybrids only.

³ For use on Roundup Ready corn hybrids only.

5-84 Weed Control in Field Crops: Corn

Table 5.20 - Weed Sizes for Postemergence Corn Herbicides (cont.)

This table lists postemergence corn herbicides, their rates, and heights of weed species that are controlled or suppressed. This table is only a “quick reference”; refer to the herbicide label for additional information on application and timing.

Broadleaves	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters	Marestail/Horseweed	Annual Morning Glory	Eastern Black Night Shade	Palmer Amaranth/Waterhemp	Pigweed	Common Ragweed	Giant Ragweed	Smartweed	Spurred Anoda	Velvetleaf
	Maximum Height (inches) at Application													
2,4-D ¹	–	6	3	4	4	6	2	4	4	6	6	–	–	2
Accent Q (0.9 oz)	3	–	3	–	–	2	–	–	4	–	–	4	–	–
Aim (0.5 oz)	–	–	–	4	–	2–3 lvs	4	–	4	–	–	–	–	36
Atrazine ¹ (2 qt)	4	4	4	–	4*	4	4	4	–	4	4	4	–	2
Basagran (2 pt)	–	10	10	2*	–	–	–	–	–	3	6	10	4	5
Basis Blend (0.825 oz)	–	–	–	3	–	–	–	3	3	–	–	3	–	3
Cadet (0.9 fl oz)	3	–	2	3*	–	3	2	2*	4	–	–	2	4*	36
Callisto (3 fl oz)	–	5	5	5	3*	5*	5	3*	5	5*	5	5	–	5
Capreno (3 fl oz)	<6*	<6	<6	<6	–	<6*	<6	<6	<6	<6	<6	<6	–	<6
Clarity/Banvel ¹	4	4	4	4	4	4	4	4	4	4	4	6	–	2
DiFlexx (8 fl oz)	3	3	3	3	3	3	3	3	3	3	3	3	3	3
DiFlexx Duo (32 fl oz)	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6
Glyphosate (0.75 ae)	6	6	6	6	6*	6	6	6	6	6	6	6	3	6
Halex GT (3.6 pt)/Acuron GT (3.75 pt)	<4	<4	<4	<4	<4	<4	<4	<4*	<4	<4	<4	<4	<4	<4
Harmony SG (0.125 oz)	–	–	–	4	–	–	–	4	12	–	–	6	–	6
Impact/Armezon (0.75 fl oz)/Impact Core	–	8	6	6	–	6*	6	6*	6	6	8	3	–	8
Laudis (3 fl oz)	<6*	<6	<6	<6	–	<6*	<6	<6	<6	<6	<6	<6	–	<6
Liberty ² (32 fl oz)	≤3	≤3	≤3	≤3	≤3	≤3	≤3	≤3	≤3	≤3	≤3	≤3	≤3	≤3
Maestro, Moxy (1.5–2 pt)	4	10	6	8	4*	4	6	–	2	6	6	6	–	5
Peak (0.5 oz)	3	6	4	3	3	3	–	3	3	6	3	3	–	4
Permit/Sandea (0.67 oz)	3*	9	–	2*	–	–	–	–	3	9	3	2	–	9
Permit/Sandea (1–1.33 oz)	12*	14	–	2*	–	3*	–	–	6	12	6	2	–	12
Permit Plus (0.75 oz)	3*	9	4*	4	–	3*	–	4	12	9	3	6	–	9
Perpetuo (8 fl oz)	4 lvs	4 lvs	4 lvs	3 lvs	–	–	–	4 lvs	3 lvs	3 lvs	–	–	–	6 lvs
Realm Q (4 oz)	5	5	5	5	5*	5*	5	5	5	5	5	5	–	5
Resolve (1 oz)	–	3*	–	3*	–	3*	–	–	3	3*	–	3*	–	3*
Resolve Q (1.25 oz)	–	1–3*	–	1–3*	–	1–3*	–	–	1–3	1–3*	–	1–3*	–	1–3
Resource ³ (6 oz)	–	–	–	3 lvs	–	–	–	3 lvs	3 lvs	3 lvs	–	–	–	6 lvs

Table 5.20 - Weed Sizes for Postemergence Corn Herbicides (cont.)

This table lists postemergence corn herbicides, their rates, and heights of weed species that are controlled or suppressed. This table is only a “quick reference”; refer to the herbicide label for additional information on application and timing.

Broadleaves	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters	Marestail/Horseweed	Annual Morning Glory	Eastern Black Night Shade	Palmer Amaranth/ Waterhemp	Pigweed	Common Ragweed	Giant Ragweed	Smartweed	Spurred Anoda	Velvetleaf
	Maximum Height (inches) at Application													
Revulin Q (4 oz)	<2	<5	<5	<5	–	<5	<5	<5	<5	<5	<5	<5	–	<5
Roundup PowerMax ⁴ (22 fl oz)	6	6	6	6	6*	6	6	6	6	6	6	6	3	6
Shieldex (1 fl oz)/Restraint	–	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	–	<5
Sinate (28 fl oz)	6	6	6	6	6	4	6	6	4-6	6	6	4	–	6
Status ¹ (5 oz)	4	4	4	4	4	4	4	4	4	4	4	4	–	4
Steadfast Q (1.5 oz)	4	4*	4	4*	–	4	–	–	4	–	–	4*	–	4*
Stout (0.75 oz)	3	–	3	4	–	2–3	–	–	4	–	–	4	–	4
Tough (24 fl oz)	4 lvs	4 lvs	4 lvs	4 lvs	–	–	4 lvs	4 lvs	4 lvs	–	–	–	–	–
Yukon (4–8 oz)	12*	14	4	6	4	6	6	3	12	12	6	3	–	12

*Suppression only, additional control measures may be necessary.

¹ No sizes given on label, sizes listed above are best estimates.

² For use on LibertyLink or glufosinate-resistant corn hybrids only.

³ Resource label refers to weed size by number of leaves (lvs).

⁴ For use on Roundup Ready corn hybrids only.

Table 5.21 - Postemergence Herbicide Application Restrictions for Corn

Trade Name	Over-the-Top Application	Use of Drop Nozzles	Comments
2,4-D	<8 inches tall	0.5 pt: 8–36 inches tall	Some 2,4-D formulations allow application up to tasseling.
Accent Q	20 inches tall (free-standing) or <6 collars (V6 stage)	20–36 inches tall or V6 to V10 stage	—
Aim	Up to 8-leaf collar stage (V8)	Up to 14-leaf collar stage	Use drop nozzles or directed sprayers that target weeds but spray away from the corn whorl.
Armezon PRO	Up to 30 inches tall (or 8-corn leaf stage)	When necessary	Do not make application within 45 days of corn harvest or after V8 corn growth stage
Atrazine	12 inches tall	—	—
Basagran	No restrictions	—	—
Basis Blend	Spike to 4 leaves (2 collars) or 0.5–6 inches tall	—	Do not apply to corn >6 inches tall or having 3 collars.
Cadet	Up to 48 inches tall	When necessary	Apply before tasseling.
Callisto, Callisto GT	Up to 30 inches tall (or 8-corn leaf stage)	—	—

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Table 5.21 - Postemergence Herbicide Application Restrictions for Corn (cont.)

Herbicide	Over-the-Top Application	Use of Drop Nozzles	Comments
Callisto Xtra	12 inches tall	—	—
Capreno	Up to V6 (6 collars)	to V7 (7 collars)	—
Clarity, Engenia or Xtendimax	1 pt: 8 inches tall or 5 leaves 0.5 pt: 8–36 inches tall or 15 days before tassel emergence	—	Do not apply dicamba near soybeans if corn is >24 inches tall, or if soybeans are >10 inches tall or have begun to bloom.
Curtail	<8 inches tall	—	—
DiFlexx/ DiFlexx Duo	Spike to V6 or 36 inches tall	V7-V10	Apply 15 days prior to tasseling.
Ensis Duo	Up to 30 inches tall (V8)	30–48 inches tall	Apply to Enlist corn hybrids only.
Enversa	Up to 30 inches tall	—	Does not control emerged weeds; tank-mix with glyphosate in Roundup Ready corn
Glyphosate products	Up to 30 inches tall (V8 stage)	30 – 48 inches tall	Apply to Roundup Ready hybrids only.
Halex GT/ Acuron GT	Emergence to 30 inches tall (8-leaf stage)	—	—
Harmony SG	2–6 leaves up to 12 inches tall (1 to 4 collars)	—	Do not apply to corn >12 inches tall or having 4 collars.
Harness MAX	Up to 11 inches tall	—	—
Impact/ Armezon	Up to V8 or 45 days prior to corn harvest (whichever is most restrictive)	When necessary	—
Impact Core	Up to 11 inches tall	—	—
Kyro	up to 24 inch	—	—
Laudis	Emergence up to V8 stage	—	—
Liberty	Emergence to V6	When necessary up to 36 inches tall	Apply to Liberty Link or GR corn hybrids only.
Maestro, Moxy	1 pt: emergence to tassel 1.5 pts: 4 leaves to tassel	—	Postemergence application before 3-leaf stage may result in corn leaf burn.
Metribuzin	Emergence to pretassel	When necessary	See tank-mix partner.
Peak	4–20 inches tall	20-30 inches tall (V6)	—
Permit	Spike to 48 inches tall	When necessary	If tank-mixed: with 2,4-D, apply to corn up to 8 inches tall; with Banvel or Clarity, apply to corn up to 36 inches tall.
Permit Plus	2- to 6-leaf corn (1–5 collars)	—	Do not apply to corn with more than 6 leaves (5 collars).
Perpetuo	2-leaf through V6 stage	—	—
Realm Q	Up to 20 inches tall but with no more than 6 collars	—	—
Resicore Resicore XL	Up to 11 inches tall Up to 24 inches tall	—	—
Resolve	Up to 12 inches tall (<6 collars)	—	—

Table 5.21 - Postemergence Herbicide Application Restrictions for Corn (cont.)

Herbicide	Over-the-Top Application	Use of Drop Nozzles	Comments
Resolve Q	Up to 20 inches tall (<6 collars)	—	—
Resource	2-leaf to 10-leaf stage (collars must be visible)	When necessary, to direct below corn leaves	—
Revulin Q	Up to 20 inches tall (<6 collars)	—	—
Roundup products	Up to 48 inches tall	—	Apply to Roundup Ready hybrids only.
Shieldex	Up to V6 or 20 inches tall	—	—
Sinate	Up to 24 inches tall (7 collars)	24-36 inches tall	Apply to LibertyLink or GR corn hybrids only.
Status	4–36 inches tall (V2–V8)	—	Do not apply within 15 days before tassel emergence.
Steadfast Q	Up to 20 inches tall (6 collars)	—	Best if applied when corn is <12 inches tall.
Stout	Up to 16 inches tall (<6 collars)	—	—
Sure Start II/ TripleFLEX II	Up to 11 inches tall	—	—
Surtain	Up to V3 growth stage	—	Does not control emerged weeds
Tough	Up to V8 growth stage	—	—
Warrant	Emergence to 30 inches tall	When necessary	Does not control emerged weeds; tank-mix with glyphosate in RR corn.
Yukon	Spike to 36 inches tall	When necessary	—

Table 5.22 - Spray Additives and Rainfastness for “Burndown” and Postemergence Corn Herbicides

Trade Name	Adjuvant(s) ¹	Rate	Rainfastness (hours)
2,4-D amine	none, except in certain tank-mixes	—	6–8
2,4-D LVE			1–2
Accent Q	crop oil concentrate or nonionic surfactant plus nitrogen solution or ammonium sulfate	1 gal/100 gal 1–2 qt/100 gal 2–4 qt/A or 2–4 lb/A	4
Aim/Cadet	nonionic surfactant or crop oil concentrate plus ammonium sulfate or nitrogen solution (optional)	2 pt/100 gal 1 gal/100 gal 2–4 lb/A 2–4 gal/100 gal	1
Atrazine	crop oil concentrate	1 gal/100 gal	1–2
Basagran ²	crop oil concentrate	2 pt/A	8
	plus nitrogen solution or ammonium sulfate	1 gal/A 2.5 lb/A	
Basis Blend	crop oil concentrate or nonionic surfactant plus nitrogen solution or ammonium sulfate	1–2 gal/100 gal 1–2 qt/100 gal 2–4 qt/A 2–4 lb/A	

Table 5.22 - Spray Additives and Rainfastness for “Burndown” and Postemergence Corn Herbicides (cont.)

Herbicides.	Adjuvant(s) ¹	Rate	Rainfastness (hours)
Callisto [#] , Callisto Xtra [#]	crop oil concentrate plus nitrogen solution or ammonium sulfate	1 gal/100 gal 2.5 gal/100 gal 8.5 lb/100 gal	1
Callisto GT	nonionic surfactant plus ammonium sulfate (optional)	1–2 qt/100 gal 8.5–17 lb/100 gal	1
Capreno [#]	crop oil concentrate plus nitrogen solution or ammonium sulfate	1 gal/100 gal 1.5 qt/A 1.5 lb/A or 8.5 lb/100 gal	1
Clarity ³	nonionic surfactant or crop oil concentrate plus nitrogen solution	1 qt/100 gal 1 gal/100 gal 2–4 qt/A	4
DiFlexx	nonionic surfactant or crop oil concentrate or methylated seed oil plus nitrogen solution or ammonium sulfate	1 qt/100 gal 1–2 pt/A 1–2 pt/A 2–4 qt/A 8.5–17 lb/100 gal	4
DiFlexx Duo [#]	methylated seed oil or crop oil concentrate plus nitrogen solution or ammonium sulfate	1 gal/100 gal 1 gal/100 gal 1.5 qt/A 8.5–17 lb/100 gal	4
Durango/Duramax DMA	no NIS/COC required ammonium sulfate (optional)	8.5–17 lb/100 gal	1
Enlist Duo, Enlist One	See label for details		1–4
Engenia	See label for details		4
Glyphosate (if not fully loaded with formulation adjuvants)	nonionic surfactant plus ammonium sulfate (optional)	2 qt/100 gal 8.5–17 lb/100 gal	6
Gramoxone SL	nonionic surfactant or crop oil concentrate or MSO	2 pt/100 gal 1 gal/100 gal	0.5
Halex GT/Acuron GT	nonionic surfactant plus ammonium sulfate	1–2 qt/100 gal 8.5–17 lb/100 gal	1–6
Harness MAX	non-ionic surfactant or crop oil concentrate plus ammonium sulfate (optional)	1 pt/100 gal 1 gal/100 gal 8.5–17 lb/100 gal	1–6
Harmony SG [#]	nonionic surfactant or crop oil concentrate plus nitrogen solution or ammonium sulfate	1 qt/100 gal 1 gal/100 gal 2–4 qt/A 2–4 lb/A	1
Impact/Armezon	methylated seed oil or crop oil concentrate plus nitrogen solution or ammonium sulfate	1.0–1.5 gal/100 gal 1.0–1.5 gal/100 gal 1.25–2.5 gal/100 gal 8.5 lb/100 gal	1
Impact Core	methylated seed oil plus nitrogen solution or ammonium sulfate	1–2 qt/100 gal 1.25–2.5 gal/100 gal 1.5–2.5 lb/100 gal	1–4
Kyro	methylated seed oil (MSO) or crop oil concentrate + nitrogen solution or ammonium sulfate	0.5–1 gal/100 gal 0.5–1 gal/100 gal 1.25–2.5 gal/100 gal 8.5–17 lb/100 gal	not specified

Table 5.22 - Spray Additives and Rainfastness for “Burndown” and Postemergence Corn Herbicides (cont.)

Herbicides.	Adjuvant(s) ¹	Rate	Rainfastness (hours)
Laudis [#]	methylated seed oil (MSO) or crop oil concentrate plus nitrogen solution or ammonium sulfate	1 gal/100 gal 1 gal/100 gal 1–5 qt/A 1.5 lb/A	1
Liberty	ammonium sulfate	3 lb/A	4
Maestro, Moxy ⁴	nonionic surfactant or crop oil concentrate or nitrogen solution	1 qt/100 gal 1 gal/100 gal 1–4 gal/100 gal	1
Peak	crop oil concentrate or non-ionic surfactant	1 gal/100 gal 1 qt/100 gal	4
Permit/Permit Plus	nonionic surfactant or crop oil concentrate	1–2 qt/100 gal 1 gal/100 gal	4
Perpetuo	crop oil concentrate or methylated seed oil or nonionic surfactant plus nitrogen solution or ammonium sulfate (optional)	1 gal/100 gal 1 gal/100 gal 1 qt/100 gal 1.25–2.5 gal/100 gal 1.5–2.5 lb/100 gal	1
Realm Q	crop oil or modified seed oil concentrate or nonionic surfactant plus nitrogen solution or ammonium sulfate	1 gal/100 gal 1 qt/100 gal 2 qt/A 2 lb/A	4
Resolve/Resolve Q	crop oil or modified seed oil concentrate or nonionic surfactant plus nitrogen solution or ammonium sulfate	1 gal/100 gal 1 qt/100 gal 2 qt/A 2 lb/A	4
Resource	crop oil concentrate plus nitrogen solution (optional)	1 pt/A	1
Revulin Q	crop oil concentrate plus nitrogen solution or ammonium sulfate	1 gal/100 gal 2 qt/A 2 lb/A	4
Roundup/Glyphosate	nonionic surfactant plus ammonium sulfate (optional)	2 qt/100 gal 8.5–17 lb/100 gal	6
Roundup PowerMax/Roundup WeatherMax	no NIS/COC required ammonium sulfate (optional)	— 8.5–17 lb/100 gal	<1
Shieldex	methylated seed oil (MSO) or crop oil concentrate plus nitrogen solution or ammonium sulfate	0.5 - 1 gal/100 gal 0.5 - 1 gal/100 gal 2.5 gal/100 gal 8.5 lb/100 gal	1
Sinate	methylated seed oil or crop oil concentrate plus nitrogen solution or ammonium sulfate	1 gal/100 gal 1 gal/100 gal 1.25–2.5 gal/100 gal 1.5–2.5 lb/100 gal	4
Status	nonionic surfactant or crop oil concentrate or methylated seed oil plus nitrogen solution or ammonium sulfate	1 qt/100 gal 1–2 pt/A 1–2 pt/A 5 qt/100 gal 5–17 lb/100 gal	4

Table 5.22 - Spray Additives and Rainfastness for “Burndown” and Postemergence Corn Herbicides (cont.)

Herbicides.	Adjuvant(s) ¹	Rate	Rainfastness (hours)
Steadfast Q	crop oil concentrate or nonionic surfactant plus nitrogen solution or ammonium sulfate	1 gal/100 gal 1–2 qt/100 gal 2 qt/A 2 lb/A	4
Stinger	none	—	6–8
Stout	crop oil or modified seed oil concentrate or nonionic surfactant plus nitrogen solution or ammonium sulfate	1 gal/100 gal 1 qt/100 gal 2 qt/A 2 lb/A	4
Tough	non-ionic surfactant or crop oil concentrate or methylated seed oil plus nitrogen solution or ammonium sulfate	1 qt/100 gal 1–2 pt/A 1–2 pt/A 2–4 qt/A 2–4 lb/A	1
Yukon	nonionic surfactant or crop oil concentrate plus nitrogen solution or ammonium sulfate (optional)	1–2 qt/100 gal 1 gal/100 gal 2–4 qt/A 2–4 lb/A	

* Refer to the label if tankmixing with glyphosate (Roundup Ready corn) or glufosinate (Liberty Link corn) for additional adjuvant precautions.

¹ In general, non-ionic surfactants should contain at least 80% surface active agent; crop or vegetable oil concentrates should be nonphytotoxic, containing at least 15% approved emulsifier; nitrogen solution is an ammonium-based fertilizer such as 28%, 30%, or 32% N; and ammonium sulfate should be spray-grade dry ammonium sulfate (21-0-0) or other equivalent liquid formulation of AMS (refer to product label for use rate information). 10-34-0 also may be used with some products.

² Use crop oil concentrate if lambsquarters, common ragweed, Canada thistle, yellow nutsedge, or field bindweed are present. Include nitrogen solution if velvetleaf is the primary target.

³ Do not use COC after corn exceeds 5 inches tall. Adjuvant addition depends on tank-mix partner.

⁴ When Maestro or Moxy is applied alone, spray additives generally are not needed and may cause excessive leaf burn.

⁵ Do not use COC if corn has emerged.

Spray Additives When Tank-mixed with Liberty (LibertyLink corn [LL]) or Glyphosate (Roundup Ready corn [RR])

Trade Name	Specific Adjuvant Comments
2,4-D	n/a*
Accent Q	n/a
Aim/Cadet	n/a
Atrazine	n/a
Basagran	n/a
Callisto/Callisto Xtra	LL: Do not use COC RR: Add AMS; if glyphosate calls for an adjuvant, add NIS (do not use UAN, COC or MSO)
DiFlexx/DiFlexx Duo	LL: Do not use MSO or COC; only add AMS at 8.5 lb/100 gal RR: Label allows for additional adjuvant if resistant weeds are present
Harmony SG	LL: n/a RR: Add AMS; if glyphosate calls for an adjuvant, add NIS (1–2 pt/100 gal) (do not use UAN, COC, or MSO)
Impact/Armezon	n/a

*n/a = adjuvants for LibertyLink or glyphosate not addressed.

Spray Additives When Tank-mixed with Liberty (LibertyLink corn [LL]) or Glyphosate (Roundup Ready corn [RR])	
Laudis	LL: Do not use MSO or COC; only add AMS at 8.5 lb/100 gal RR: Label recommends additional adjuvant if fully loaded glyphosate is used; label requires additional adjuvant if partially loaded glyphosate is used
Maestro/Moxy	n/a
Permit/Sandea	n/a
Resource	n/a
Stinger	n/a
Mixtures	
Basis Blend	n/a
Capreno	LL: Do not use MSO or COC; only add AMS at 8.5 lb/100 gal RR: Use of glyphosate compatible high surfactant oil concentrate (HSOC) is recommended with fully loaded glyphosate and required with partially loaded glyphosate; AMS is required; do not use COC or MSO
Curtail	n/a
Halex GT	LL: Not allowed
Permit Plus	n/a
Realm Q	LL: n/a RR: When tank-mixed with glyphosate, ensure total adjuvant load is equivalent to the label recommendation
Resolve Q	When tank-mixed with glyphosate or glufosinate, ensure total adjuvant load is equivalent to the label recommendation
Revulin Q	LL: n/a RR: When tank-mixed with glyphosate, ensure total adjuvant load is equivalent to the label recommendation
Status	n/a
Steadfast Q	n/a
Stout	n/a
Yukon	n/a
*n/a = adjuvants for LibertyLink or glyphosate not addressed.	

The following treatments are applied prior to harvest to control and help desiccate green weed tissue in established weeds in order to aid in the harvesting process. Contact herbicides are usually better at this process; however, it can vary by weed species and usually will require at least a week or more to desiccate weeds or make them more brittle. Some of these herbicides are not that effective on large weeds or certain species. Harvest aids are not intended to (and usually do not) help speed up crop maturity. If applied too early, they can interfere with the natural crop maturation process. Illegal herbicide residues in grain can result if specific application timing and other label guidelines are not followed. See specific product label to determine correct rate, timing, weed species controlled, and other restrictions with this type of application.

Table 5.23 - Comments on Harvest Aid Herbicides for Corn

Trade Name ¹	Common Name	Site of Action Number	Product/A	lb ai/A
2,4-D LV4	2,4-D ester	4	1–2 pt	0.5–1.0
<ul style="list-style-type: none"> • Apply 1–2 pt/A after the hard dough or dent stage to suppress large weeds that may interfere with harvest and to decrease production of weed seeds. • Use higher rate on larger weeds and those under stress. • Do not forage or feed corn fodder for 7 days after application. 				

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Table 5.23 - Comments on Harvest Aid Herbicides for Corn (cont.)

Herbicide Trade Name	Herbicide Common Name	Site of Action Number	Product/A	lb ai/A
Aim 2EC	carfentrazone	14	2 fl oz	0.031
<ul style="list-style-type: none"> • May be applied 3 days before harvest. • Use as a harvest aid to desiccate certain broadleaf weeds. • Apply in 10 gal/A water. • Include necessary adjuvants (MSO or COC plus AMS) and make sure spray coverage is sufficient (≥ 15 gpa), otherwise poor control will result. • Aim tends to be less injurious to surrounding crops compared to Gramoxone. 				
Defol 5 L	sodium chlorate	Not classified	4.8 qt	6
<ul style="list-style-type: none"> • Defol products are labeled for preharvest applications to desiccate problem weeds in early maturing corn. • Apply at least 14 days before anticipated harvest date. • Apply in 10 to 20 gal/A water with an appropriate adjuvant (NIS or COC). • Desiccation of morningglory and other vine-weeds may be erratic. • Do not graze treated fields or feed fodder, forage or residual grain within 14 days of application. • Some universities recommend tank mixing Defol with Aim or Gramoxone for improved activity. 				
Glyphosate	glyphosate	9	see Table 5.2	up to 0.75 lb ae
<ul style="list-style-type: none"> • Glyphosate products are labeled for preharvest applications in corn. • They can be applied from a week or more prior to harvest. • Apply when grain has 35% or less moisture and after maximum kernel fill is complete and corn is physiologically mature. • Adjuvants (NIS or COC plus AMS) can be added to the spray solution to improve performance. • Do not apply to corn for seed. • 0.75 lb glyphosate = 32 fl oz of a 3 lb ae/gal formulation or 22 fl oz of a 4.5 lb ae formulation 				
Gramoxone SL 2.0 Gramoxone SL 3.0	paraquat	22	1.2–2 pt 0.8–1.3 pt	0.3–0.5
<ul style="list-style-type: none"> • Apply after corn is mature and black layer has formed. • Make application at least 7 days before harvest. • Use lower rates in most cases as a harvest aid, otherwise the 0.5 lb ai/A rate can be used to desiccate mature broadleaves and grasses over 18 inches tall. • Include a nonionic surfactant (1 qt/100 gal) in the spray solution. 				
Sharpen 2.85SC	saflufenacil	14	1–2 oz	0.022–0.044
<ul style="list-style-type: none"> • Apply as broadcast spray after corn has reached physiological maturity. • Do not harvest until at least 3 days after application. • Do not apply on field corn grown for seed production. • Dessication-treated corn stover (stalks) may be grazed or fed to livestock. • Include methylated seed oil (MSO) at 1 gal/100 gal (1% v/v) plus ammonium sulfate (AMS) at 8.5 to 17 lb/100 gal. 				

Table 5.24 - Grazing and Forage Pre-harvest Intervals (PHI) and Restrictions for Corn Herbicides¹

These products restrict grazing and/or foraging (silage) following their use in corn.

Corn Herbicide	Graze (Days After Treatment)	Silage/Grain
2,4-D	7	7
Accent Q	30	45/70
Acuron	45	60
Acuron Flexi	45	60
Anthem Maxx	30	70
Atrazine	60	60
Basagran	12	12
Basis Blend	30	30
Cadet	30	70
Callisto	45	45
Callisto GT	45	45
Callisto Xtra	60	60
Capreno	45	45
Clarity, Engenia, Xtendimax	after milk stage	after milk stage
Corvus	45	45
DiFlexx/DiFlexx Duo	45	45
Enlist Duo	not specified	50
Enlist One	not specified	30
Enversa	40	40
Glyphosate (spot treatment)	7	7
Glyphosate ²	7	50/7
Gramoxone (harvest aid)	7	do not graze
Halex GT/Acuron GT	45	45
Harmony SG	30	7/45
Harness MAX	60	60
Impact/Armezon	45	45
Impact Core	45	45
Kyro	60	45
Laudis	45	45
Lexar	45	60
Liberty ³	70	70
Meastro, Moxy	30	30
Maverick	60	30
Metribuzin	60	60
Outlook	40	40
Peak	30	40/60
Permit/Sandea/Permit Plus/Yukon	30	30

Table 5.24 - Grazing and Forage Pre-harvest Intervals (PHI) Restrictions for Corn Herbicides¹ (cont.)

These products restrict grazing and/or foraging (silage) following their use in corn.

Corn Herbicide	Graze (Days After Treatment)	Silage/Grain
Prowl H ₂ O	21	21
Python	45	85
Realm Q	45	45/70
Resicore/Resicore XL	45	45
Resolve/Resolve Q	30	30
Resource/Perpetuo	28	28
Revulin Q	45	45
Sharpen	80	80
Shieldex	21	45
Sinate ³	60	60/70
Status	72	32/72
Steadfast Q	30	30
Stinger	40	40
Storen	45	45
Stout	30	30
SureStart II/TripleFlex II	not specified	not specified
Surtain	no restriction	no restriction
TriVolt	45	45
Tough	68	68
Verdict	80	80
Warrant	40	40
Zidua	not specified	not specified

¹ Products listed restrict grazing and/or foraging (silage) following their use in corn. Preharvest interval (PHI) is the minimum amount of time between applications and harvest. Refer to Tables 5.15 and 5.21 for additional applications restrictions in corn. Use the most restrictive interval that applies.

² For use only with Roundup Ready corn hybrids.

³ For use only with LibertyLink corn hybrids.

Table 5.25 - Corn Herbicide Half-Lives and Their Potential to Injure Fall Cover Crops

This table does not directly address preharvest establishment of cover crops such as interseeding or aerial seeding, which may be more restrictive. Cover crops that are harvested are subject to herbicide residue restrictions, which are not addressed in this table.

Trade Name	Common Name	Normal Rate/acre	Half life (days) ¹	Fall-established Cover Crops		Other
				OK to plant	Concern for	
2,4-D Amine 4 (2,4-D LV 4)	2,4-D	1-2 pt	7	All	Wait 30 days before planting sensitive broadleaves	Amine formulations more water soluble and can leach into seed zone

Table 5.25 - Corn Herbicide Half-Lives and Their Potential to Injure Fall Cover Crops (cont.)

This table does not directly address preharvest establishment of cover crops such as interseeding or aerial seeding, which may be more restrictive. Cover crops that are harvested are subject to herbicide residue restrictions, which are not addressed in this table.

Trade Name	Common Name	Normal Rate/acre	Half life (days) ¹	Fall cover crops		Other
				OK to plant	Concern for	
Accent Q Steadfast Q	nicosulfuron/ nicosulfuron+ rimsulfuron	0.66 oz/ 0.75 oz	21	Cereals, ryegrass	Small seeded legumes, mustards, sorghum	More persistent in high pH soils (> 7)
Armezon/Impact	topramezone	0.75 fl. oz	14	Wheat, barley, oats, and rye are allowed after 3 mo. Ryegrass should also be OK	Although many broadleaves are restricted, Impact does not have much soil activity	We have not seen this herbicide carryover in the Mid-Atlantic region. Clovers might be slightly suppressed.
Atrazine 4L	atrazine	1-2 qt	15-90	Cereals, ryegrass, sorghum species	Legumes and mustards	More persistent in high pH soils (> 7). Rates < 1 lb/acre can allow more flexibility. Half-life in Mid-Atlantic probably closer to 30
Balance Flexx	isoxaflutole	3 fl. oz 6 fl. oz	50-120	Fall cereals grains	Ryegrass, legumes, and mustards	15 inches of cumulative precipitation required from application to planting rotation crops except soybean, barely, wheat, sorghum, and sunflower
Callisto (includes Acuron, Acuron Flexi, Halex GT, Harness Max, Lexar EZ, Lumax EZ, Resicore, Revulin Q, Solstice, Storen, etc.)	mesotrione	3-6 fl. oz	10-50	All grasses	Small seeded legumes, mustards	Sequential applications (PRE fb POST) increase the potential for injury
Capreno	tembotrione + thiencazozone	3 fl. oz	15	Wheat, triticale, rye	Small-seeded legumes, mustards, sorghum	15 inches of cumulative precipitation required from application to planting rotation crops except wheat

Table 5.25 - Corn Herbicide Half-Lives and Their Potential to Injure Fall Cover Crops (cont.)

This table does not directly address preharvest establishment of cover crops such as interseeding or aerial seeding, which may be more restrictive. Cover crops that are harvested are subject to herbicide residue restrictions, which are not addressed in this table.

Trade Name	Common Name	Normal Rate/acre	Half life (days) ¹	Fall cover crops		Other
				OK to plant	Concern for	
Clarity (DiFlexx, Distinct, Engenia, Status, Xtendimax)	dicamba	16 to 24 fl. oz	5-14	All	Only at high rates or less than 120 days after application	Anything can be planted after 120 days with 24 fl. oz/acre or less
Corvus	isoxaflutole+ thiencazone	5.6 fl. oz	50-120	Wheat, triticale, rye	Small seeded legumes, mustards, sorghum	15 to 30 inches of cumulative precipitation from application to planting for sensitive crops
Dual II Mag	metolachlor	1.67 pt	15-50	Cereal grains, legumes	Annual ryegrass or other small seeded grasses	Higher rates and later applications more of a potential problem
Glyphosate 4 Plus	glyphosate	0.75 to 1.25 lb ae	47 ³	All	None	Glyphosate does not have soil activity at normal use rates
Gramoxone SL 2.0	paraquat	2 pt	1000 ³	All	None	Paraquat does not have soil activity at normal use rates
Harmony SG	thifensulfuron	1/8 oz	12	No restrictions for wheat, barley, and oats	None with 45 day waiting interval	Harmony Extra also contains tribenuron
Harness (Degree Xtra, Enversa, Surpass EC, Warrant)	acetochlor	2 pt	10-20	Most crops should be fine	Food or feed residues rather than crop injury may be a concern	Nonfood/feed winter cover crops are allowed after corn harvest
Laudis (Diflexx Duo)	tembotrione	3 fl. oz	14	Cereal grains after 4 mo.	Unknown - Small seeded legumes, mustards could be a problem	Other crops may be seeded after a successful field bioassay
Liberty 2.34L	glufosinate	22 - 36 fl. oz	7 ³	All	Any cover crop can be planted 7 days after application that is not used for food or feed.	Glufosinate does not have soil activity at normal use rates
Metribuzin 75DF (Metricor)	metribuzin	0.33 lb ai	14-60	Cereal grains and ryegrass	Slight risk for small seeded legumes and mustards	Nonfood/feed winter cover crops allowed

Table 5.25 - Corn Herbicide Half-Lives and Their Potential to Injure Fall Cover Crops (cont.)

This table does not directly address preharvest establishment of cover crops such as interseeding or aerial seeding, which may be more restrictive. Cover crops that are harvested are subject to herbicide residue restrictions, which are not addressed in this table.

Trade Name	Common Name	Normal Rate/acre	Half life (days) ¹	Fall cover crops		Other
				OK to plant	Concern for	
Outlook (Armezon Pro)	dimethenamid	16 fl. oz	20	Most crops should be fine	Food or feed residues rather than crop injury may be a concern	Nonfood/feed winter cover crops should be OK after corn harvest
Peak (& Spirit)	prosulfuron	1 oz	9-152	Cereal grains and sorghum are labeled, other grasses	Small seeded legumes, mustards	More persistent in high pH soils (> 7)
Permit/Sandea	halosulfuron	2/3 oz	9-27	Cereal grains and sorghum after 2 mo. and other grasses	Small seeded legumes, mustards	Halosulfuron also an ingredient in Yukon
Prowl H ₂ O	pendimethalin	3 pt	44	Cereal grains	Small seeded legumes and annual ryegrass	We have not seen this herbicide carryover in Mid-Atlantic; nonfood/feed winter cover crops should be OK
Python WDG (Hornet WDG and Surestart)	flumetsulam	1 oz	14-120	Cereal grains	Small seeded legumes, mustards, and annual ryegrass	Cover crops and forage grasses are restricted for 9 mo.
Resolve DF (Resolve Q)	rimsulfuron	2 oz	2-4	Based on the short half-life, most fall cover crops should be OK in Mid-Atlantic	None	More persistent in drought conditions
Sharpen (Verdict)	saflufenacil	3 fl. oz	7-35	All	None	Label has 30-day wait for cover crop.
Shieldex 400 3.33SC	Tolpyralate	1-1.35	1-2	Wheat, barley, oats, and rye are allowed after 3 months; ryegrass should also be OK	Although many broadleaves are restricted, Shieldex does not have much soil activity	Clovers might be slightly suppressed
Simazine 4L (Princep)	simazine	1-2 qt	60	Sorghum species	Cereals, ryegrass, legumes, and mustards	Soil pH > 7 increases persistence
Stinger 3S (Hornet WDG, Resicore, and Surestart)	clopyralid	5 oz	40	All grasses	Small seeded legumes	

Table 5.25 - Corn Herbicide Half-Lives and Their Potential to Injure Fall Cover Crops (cont.)

This table does not directly address preharvest establishment of cover crops such as interseeding or aerial seeding, which may be more restrictive. Cover crops that are harvested are subject to herbicide residue restrictions, which are not addressed in this table.

Trade Name	Common Name	Normal Rate/acre	Half life (days) ¹	Fall cover crops		Other
				OK to plant	Concern for	
Zidua (Anthem)	pyroxasulfone	2.5 oz	20	Most crops should be fine	Ryegrass	Nonfood/feed winter cover crops should be OK after corn harvest

¹ The herbicide half-life is defined the time it takes for 50% of the herbicide active ingredient to dissipate. See the Managing Herbicides Section for additional information. The herbicide half-life estimates are derived for the WSSA Herbicide Handbook and other scientific literature.

² Common small-seeded legumes include alfalfa, clovers, and hairy vetch.

³ This herbicide does not have soil residual activity at normal application rates.

Sorghum Weed Management

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Integrated Weed Management

An integrated approach to managing weeds in sorghum includes using cultural weed control, mechanical controls where applicable, and the judicious use of herbicides. Sorghum fields that are weed free for the first four to six weeks after planting will often yield the same as fields that are weed free for the entire growing season. This approach relies on starting with a clean seedbed and using residual soil-applied herbicides or mechanical control. Weeds that germinate with the crop but are controlled in a timely fashion (four to five weeks after planting) will also not impact final yields. This POST herbicide approach relies on effective and timely postemergence weed control. Also, it is not necessary to control all weeds in a field to achieve maximum yield.

Plant sorghum in a timely fashion to ensure the crop emerges uniformly and achieves rapid early growth. Seeding sorghum in narrow (15-inch) rows will improve overall weed control since the crop canopy will close the rows sooner and help to outcompete smaller weeds.

Chemical Weed Control

Herbicides are useful tools in most weed management programs. This chapter will focus on herbicides available for use in sorghum. They should be used to supplement, not replace, other methods or tools available. Definitions of terms you will find in this and similar publications on herbicides are provided below.

Early preplant (EPP). The herbicide is applied at least 14 days before planting. EPP applications are generally used in no-till systems to control existing vegetation and provide residual control of early emerging weed species.

Preplant. The herbicide is applied from zero to 14 days before planting. Preplant applications are generally used in no-till systems to control emerged weed species.

Preplant Incorporated (PPI). The herbicide is applied to the soil after primary tillage, but before planting, and mechanically mixed with the top 1 to 3 inches of soil with one of a variety of secondary tillage implements.

Preemergence (PRE). The herbicide is applied to the soil after the crop is planted but before emergence. Rainfall or irrigation is needed to move the herbicide into the zone of weed seed germination before weed emergence for maximum effectiveness. If adequate rainfall for herbicide activation does not occur, a shallow cultivation or rotary hoeing should be done to control weeds that have germinated.

Postemergence (POST). The herbicide is applied to the foliage of the crop and weeds after they have emerged.

Post-directed (or directed). Refers to use of special spray equipment to direct the spray at the weeds but avoid it coming in contact with as much of the crop as possible.

Residual activity. Herbicides that can be taken up by a plant's roots and shoots and injure or kill the plant. All soil-applied herbicides, as well as many postemergence herbicides, have residual activity. Herbicide degradation (breakdown) is the result of chemical and/or microbial activity, which can and be dependent on soil pH, soil temperature, and soil moisture levels. Since degradation is dependent on a number of factors, length of residual activity can vary for herbicides based on the specific environmental conditions. Length of residual activity ranges from a few weeks to the entire growing season.

Translocated herbicide. These herbicides move throughout the plant and can cause injury to parts of the plants that do not come in direct contact with the herbicide spray.

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Contact herbicide. These herbicides do not move throughout the plant. They cause injury only to those parts of the plant that come in contact with the spray. Spray coverage is more critical for contact than translocated herbicides.

Non-selective herbicide. This refers to herbicides that control a broad spectrum of plant species, including most crops and weeds. These herbicides are generally used with no-tillage production and sprayed prior to planting when control of all plants is required.

Herbicide-resistant hybrids. This refers to grain sorghum varieties that have been developed to withstand herbicide application that previously would have injured or killed sorghum. These enhanced varieties have been obtained through traditional breeding methods and exclusively include Inzen hybrids.

Inzen grain sorghum is non-GMO and tolerant to nicosulfuron. The companion nicosulfuron product is Zest, a sulfonylurea herbicide (Group 2). Weed biotypes resistant to Group 2 herbicides are widespread in the region. Zest is labeled for use in DE and VA only.

Igrowth grain and forage sorghum is non-GMO and imidazolinone tolerant, which allows the companion herbicide, ImiFlex (imazamox), to be applied PRE or POST for weed control. ImiFlex is a sulfonylurea herbicide (Group 2). Weed biotypes resistant to Group 2 herbicides are widespread in the region. ImiFlex is not labeled for use in NJ. This technology has not been evaluated by universities in the mid-Atlantic region.

Double Team grain sorghum is non-GMO and tolerant to quizalofop. The companion quizalofop product is FirstAct. This technology has not been evaluated by universities in the mid-Atlantic region.

Herbicide-resistant Weeds in Sorghum

Herbicide-resistant weeds are common in sorghum in the Mid-Atlantic region. Populations of herbicide-resistant weeds are selected for by repeated use of the same or similar herbicide over a period of time. Resistance is most likely to occur with residual herbicides having one specific mode of action. Weed species with a very high amount of seed production and a variable genetic pool are more likely to develop resistant populations—for example, common lambsquarters and pigweed species. Resistance management requires using herbicides with multiple modes of action and integrating mechanical (tillage and cultivation) and cultural weed control (cover crops, narrow row spacing, proper crop fertility, etc.) with chemical weed control.

Triazine-resistance (TR). Weeds resistant to the Group 5 herbicides in the Mid-Atlantic region include common lambsquarters, redroot and smooth pigweed, and scattered populations of barnyardgrass, giant foxtail, goosegrass, and suspected populations of common ragweed and velvetleaf. Atrazine is the primary product that is problematic in sorghum. Careful selection of soil-applied and/or POST herbicides can provide good control of triazine-resistant (TR) weeds in sorghum.

For TR pigweed control, include a Group 15 herbicide for residual control (acetochlor, dimethenamid, or metolachlor) at planting. The Group 15 herbicides will suppress initial TR pigweed, but in most years a postemergence application of a non-triazine herbicide will be needed for full-season control.

For TR lambsquarters, some of the Group 15 herbicides will help suppress emergence (acetochlor), but they are not as active on lambsquarters as they are on pigweed. In addition, residual control can be obtained with products such as mesotrione.

ALS-resistance. Weeds resistant to the Group 2 (ALS) herbicides in the Mid-Atlantic region include several pigweed species, common and giant ragweed, common chickweed, horseweed, Italian ryegrass, giant foxtail, Johnsongrass, and shattercane. The principal issue with most ALS-resistant weeds in sorghum is lack of efficacy with POST ALS-inhibitor products. ALS-resistant broadleaves will not be controlled with halosulfuron or prosulfuron, other Group 2 herbicides. Group 2 herbicides can be used in a wide range of crops and application timings. Be sure to consider all herbicide applications when developing an herbicide-resistance management strategy.

Glyphosate-resistance. Weeds resistant to the Group 9 herbicide glyphosate in the Mid-Atlantic region include Palmer amaranth and waterhemp, common and giant ragweed, goosegrass, and horseweed. In sorghum, this could pose a problem in no-till if these biotypes are present at the time of burndown applications. If they are, be sure to include an alternate herbicide group to ensure these species are controlled prior to planting.

No-till Weed Management

Successful production of no-till sorghum requires control of existing vegetation (cover crops and weeds) at planting and summer annual weeds that emerge after planting. Existing vegetation is traditionally controlled by the nonselective herbicides, which are often tank-mixed with residual herbicides. However, in many fields the presence of winter annual weeds, such as horseweed, requires an application while these plants are small and more susceptible to nonselective herbicides; this may require an application three to five weeks prior to planting. Some residual herbicides, such as Lumax or Bicep, can enhance burndown weed control. However, when the products are applied 14 to 28 days before sorghum planting, they provide residual weed control for only a week or two after planting sorghum. In fields with weeds that are difficult to control, an application of a nonselective herbicide and 2, 4-D should be used early to control winter annuals weeds, and a second application of the residual herbicides may be needed at the time of sorghum planting. This second application will improve overall weed control.

Management of Johnsongrass and Shattercane

Johnsongrass, shattercane, and sorghum are closely related, and there are no satisfactory broadcast treatments currently available for controlling either species in grain sorghum. The only alternative available for rhizome Johnsongrass control is spot spraying glyphosate. Grain sorghum should not be planted in fields infested with Johnsongrass or shattercane.

Table 5.26 - Sorghum Herbicides and Their Restrictions

Trade Name	Common Name	Site of Action Number	Manufacturer	Restricted-Use Pesticide ¹	Water Quality Advisory ²	Worker Reentry (Hours) ³
2,4-D amine 4S	2,4-D amine	4	several	—	—	48
2,4-D LV4 4E	2,4-D LVE	4	several	—	—	12
Aatrex, Atrazine 4L/90DF	atrazine	5	Syngenta, others	yes	yes	12
Aim 2EC	carfentrazone-ethyl	14	FMC	—	—	12
Basagran 4S	bentazon	6	Arysta LifeScience	—	yes	12
Bicep II Magnum 5.5SC/Bicep Lite II Magnum 6SC	S-metolachlor + atrazine + safener	15/5	Syngenta/Corteva	yes	yes	24
Callisto 4SC	mesotrione	27	Syngenta	—	—	12
Clarity 4S	dicamba	4	Arysta LifeScience/BASF	—	yes	24
Coyote 3.67SC ⁴	S-metolachlor + mesotrione	15/27	UPL	—	yes	24
Degree Xtra 4.04ME/ FulTime NXT 4.04EC	acetochlor + atrazine	15/5	Bayer CropScience/ Corteva	yes	yes	12
Dual Magnum 7.62EC	S-metolachlor	15	Syngenta	—	yes	24
Dual II Magnum 7.64EC	S-metolachlor + safener	15	Syngenta/Corteva	—	yes	24
Durango DMA/ DuraMax 4S	glyphosate	9	Corteva	—	—	4
Engenia 5SL	dicamba (BAPMA salt)	4	BASF	yes	yes	24
Facet L 1.5L	quinclorac	4	BASF	—	—	12
FirstAct 0.83EC ⁵	quizalofop	1	ADAMA	—	—	12
Gramoxone SL 2.0/3.0	paraquat	22	Syngenta	yes	—	12–24

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Table 5.26 - Sorghum Herbicides and Their Restrictions (cont.)

Trade Name	Common Name	Site of Action Number	Manufacturer	Restricted-Use Pesticide ¹	Water Quality Advisory ²	Worker Reentry (Hours) ³
Halex GT 4.39EC	S-metolachlor + mesotrione + glyphosate	15/27/9	Syngenta	—	yes	24
Huskie 2.06EC	pyrasulfotole + bromoxynil	27/6	Bayer CropScience	—	yes	24
ImiFlex 1SL ⁶	imazamox	2	UPL	—	yes	4
Lorox 50DF/Linex 4L	linuron	5	Nova Source	—	—	24
Lumax EZ 3.67SC/ Lexar EZ 3.7SC	S-metolachlor + mesotrione + atrazine	15, 27, 5	Syngenta	yes	yes	24
Maestro 2EC	bromoxynil	6	NuFarm	—	—	24
Outlook 6EC	dimethenamid	15	BASF	—	yes	12
Peak 57WG	prosulfuron	2	Syngenta	—	yes	12
Permit 75WG/ Sanda 75WG	halosulfuron	2	Gowan	—	—	12
Prowl H ₂ O 3.8CS/ Prowl 3.3E	pendimethalin	3	BASF	—	—	24
Roundup WeatherMax 4.5S/ PowerMax 4.5S	glyphosate	9	Bayer CropScience	—	—	4
Sequence 5.25EW	glyphosate + S-metolachlor	9/ 15	Syngenta	—	yes	24
Sharpen 2.85SC	saflufenacil	14	Corteva	—	yes	12
Starane Ultra 2.8L	fluroxypyr	4	Dow AgroSciences	—	—	24
Verdict 5.57EC	saflufenacil + dimethenamid	14/15	BASF	no	yes	12
Warrant 3CS	acetochlor	15	Bayer CropScience	—	yes	12
Yukon 67.5WDG	halosulfuron + dicamba	2/4	Gowan	—	—	12
Zest 75WDG ⁷	nicosulfuron	2	Corteva	—	yes	4

¹ Only licensed applicators may purchase and apply restricted-use pesticides. To become licensed, contact your state Department of Agriculture.

² These herbicides have properties that may result in groundwater or surface water contamination. Do not apply them in areas where soils are permeable or coarse and groundwater is near the surface. Practices should be followed to minimize the potential for dissolved runoff and/or runoff erosion. See the herbicide label for specific restrictions.

³ If soil-applied products are injected or incorporated at application time, under certain circumstances the Worker Protection Standard allows workers to enter the treated area if they will have no contact with anything that has been treated. Personal protective equipment is required for early entry to treated areas if contact with treated soil, plants, or water is involved.

⁴ Not labeled in MD and NJ.

⁵ For use on grain sorghum containing the Double Team herbicide tolerance trait only.

⁶ For use on grain and forage sorghum containing the igrowth herbicide tolerance trait only. Not labeled in NJ.

⁷ For use on grain sorghum containing the Inzen herbicide tolerance trait only. Labeled in DE and VA only.

Table 5.27 - Sorghum Herbicide Prepackaged Mixes or Co-Packs, and Equivalents

Trade Name	Components (ai/gal or lb)	If you apply (per acre)	You have applied (ai)	Site of Action Number	An equivalent tank-mix of
Bicep II Magnum 5.5SC	2.4 lb S-metolachlor	2.1 qt	1.26 lb S-metolachlor	15	1.33 pt Dual II Magnum 7.64EC
	3.1 lb atrazine		1.63 lb atrazine	5	1.63 qt atrazine 4L
Bicep Lite II Magnum 5.5SC	.33 lb S-metolachlor	1.5 qt	1.25 lb S-metolachlor	15	1.31 pt Dual II Magnum 7.64EC
	2.67 lb atrazine		1 lb atrazine	5	1 qt atrazine 4L
Degree Xtra 4.04ME	2.7 lb acetochlor	2.5 qt	1.67 lb acetochlor	15	31.8 qt Degree 3.8ME
	1.34 lb atrazine		0.83 lb atrazine	5	0.8 qt atrazine 4L
Coyote 3.67SC	0.33 mesotrione	2 qt	0.168 lb mesotrione	27	5.36 fl oz Callisto 4SC
	3.34 S-metolachlor		1.67 lb S-metolachlor	15	1.75 pt Dual II Magnum 7.64 EC
FulTime NXT 4.04CS	2.7 lb acetochlor	3 qt	2 lb acetochlor	15	2.1 qt TopNotch 3.2ME
	1.34 lb atrazine		1 lb atrazine	5	0.8 qt atrazine 4L
Halex GT 4.39EC	2.09 lb S-metolachlor	4 pt	1.05 lb S-metolachlor	15	1.11 pt Dual II Magnum 7.64EC
	0.209 lb mesotrione		0.11 lb mesotrione	27	3.33 oz Callisto 4SC
	2.09 lb glyphosate		1.05 lb ae glyphosate	9	30 fl oz Roundup PowerMAX 4.5S
Huskie 2.06EC	0.31 lb pyrasulfotole	13 fl oz	0.031 lb pyrasulfotole	27	0.031 lb pyrasulfotole
	1.75 bromoxynil		0.178 bromoxynil	6	11.4 fl oz Maestro 2EC (Buctril)
Lexar EZ 3.7SC	1.74 lb S-metolachlor	3 qt	1.3 lb S-metolachlor	15	1.36 pt Dual II Magnum 7.64EC
	0.224 lb mesotrione		0.168 lb mesotrione	27	5.36 oz Callisto 4SC
	1.74 lb atrazine		1.3 lb atrazine	5	1.3 qt atrazine 4L
Lumax EZ 3.67SC	2.49 lb S-metolachlor	2.7 qt	1.67 lb S-metolachlor	15	1.75 pt Dual II Magnum 7.64EC
	0.249 lb mesotrione		0.168 lb mesotrione	27	5.36 oz Callisto 4SC
	0.935 lb atrazine		0.625 lb atrazine	5	0.625 qt atrazine 4L
Verdict 5.57EC	5.0 lb dimethenamid	10 fl oz	0.38 lb dimethenamid	15	8.5 fl oz Outlook 6EC
	0.57 lb saflufenacil		0.045 lb saflufenacil	14	2.0 fl oz Sharpen 2.85L
Yukon 67.2WDG	0.125 lb halosulfuron	4 oz	0.03 lb halosulfuron	2	0.67 Permit/Sandea 75 WG
	0.55 lb dicamba		0.125 lb ae dicamba	4	4 fl oz Clarity 4S

Table 5.28 - Relative Effectiveness of “Burndown” Herbicides for No-Till Sorghum

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rates and weed size or growth stage. Delaying applications, thus treating larger weeds, will result in reduced control. Treatments are rated only for control of vegetation existing at the time of application. Add preemergence herbicides as required for the specific situation.

Weed control rating: 10 = 95–100% 9 = 85–95% 8 = 75–85% 7 = 65–75% 6 = 55–65% N = less than 55% or no control
 -- = no local data available

Trade Name ¹	Site of Action Number	Alfalfa	Brome, Downy	Burdock, Common	Canada Thistle	Chickweed	Dandelion	Dock, Curly	Field Violet/Pansy	Fleabanes, Annual	Foxtail, spp	Garlic, Wild	Geranium, Carolina	Groundsel, Common ²	Hemp, Dogbane, Dewberry, Milkweed, etc.	Henbit/Deadnettle	Horseweed/ Marestail ³	Lambsquarters	Mustards spp.	Quackgrass	Ragweed, Common	Smartweed	Canada Thistle	
Atrazine	5	6	7	6	6	8	N	6	8	7+	7	N	8+	9	N	8	8	9	8	8	9	9	9	6
Dicamba	4	9	N	7	8	6	8	6	6	6	N	7	7	6	N	N	8+	9	N	N	9	7	8	
Glyphosate ⁴	9	7	9	7	8	9	6	6	6	7+	9+	7	8	9	7	6	8	9	9	8	9	7	8	
Glyphosate + Atrazine	5/9	7+	9	7+	8	9	7	6	8	7+	9	6	8+	9	N	9	9	9	9	9	9	9	8	
Glyphosate + dicamba	9/4	8+	9	7+	8+	9	8	7	8	8	9+	8	7	9	7+	8+	9	9	9	9	9	9	8+	
Gramoxone	22	N	7	N	6	8+	N	N	8	6	9	6	8	8+	6	7	7	8	9	6	8	9	6	
Gramoxone + Atrazine	22/5	7	8	6	7	9	N	6	8	7	9	6	9	8+	6	9	8+	9	8	8	9	7	7	
	5/15/																							
Lumax / Lexar	27	6	N	8	7	9	8	8	7	8	6	N	8+	9	N	8	8	9	9	N	8+	7	7	
Sharpen	14	N	N	N	6	6	7	-	N	7+	N	-	-	8	N	6	8	8	9	N	8	9	6	
Sharpen + glyphosate	14/9	7	9	7	8	9	8	6	6	8	9+	-	8	9	7	6	9	9	8	8	9	9	8	

¹ See generic herbicide table for additional formulations or trade names containing some of these same active ingredients; see Table 5.1 (glyphosates table) and Table 5.4 (generics table).
² Certain populations of common groundsel in the northeastern U.S. are resistant to triazine herbicides. Herbicide programs that contain Maestro (Buctril) provide good control of groundsel in-crop.
³ Roundup and other glyphosate products are not effective on glyphosate-resistant horseweed biotypes.
⁴ Activity is reduced if applied in certain tank-mixes; Roundup with photosynthesis inhibitors such as triazine herbicides; dicamba with Gramoxone. May still be tank-mixed for convenience, but burndown is improved if applied separately.

Table 5.29 - Comments on “Burndown” Herbicides for No-Till Sorghum

May need to be combined with residual treatment or postemergence program for complete no-till weed control program.

Trade Name ¹	Common Name	Site of Action Number	Sorghum Type	Product/A	lb ai/A
Atrazine 90DF or 4L	atrazine	5	grain, forage	1.8–2.2 lb or 1.6–2 qts	1.6–2

- Labeled for grain and forage sorghum.
- Sorghum is not as tolerant as corn to atrazine; labels do not recommend use on coarse-textured soils and has precautions for use on medium and fine-textured soils with less than 1% organic matter.
- Controls small emerged annual broadleaves and some grasses.
- Can be applied in liquid nitrogen as the carrier to improve burndown characteristics.
- Tank-mixing with paraquat improves burndown control; however, this can antagonize glyphosate activity on some species.
- Premixes containing atrazine include Bicep II Magnum, Bullet, Degree Xtra, Lumax, Lexar and others; atrazine rates differ among these products, refer to their labels for amount of atrazine.
- Observe atrazine use restrictions; see atrazine entry in the soil-applied comments table.
- *Restricted-use pesticide and water quality advisory.*

Gramoxone SL 2.0				2–4 pt	0.48–1.0
Gramoxone SL 3.0	paraquat	22	grain	1.3–2.7 pt	0.49–1.0

- Apply in 20–60 gal/A for control of emerged annual weeds.
- Addition of atrazine will often improve paraquat performance.
- Adding dicamba improves control of large annual broadleaf weeds and alfalfa. Alfalfa control is improved by applying dicamba separately at least 1 day ahead of paraquat.
- Can be tank-mixed with residual herbicides; adding atrazine to paraquat can improve control of fescue and certain other perennial sods.
- Phosphate-containing liquid fertilizer solutions diminish paraquat activity if used as a carrier.
- Do not use flood jet tips larger than size 20 or spacing greater than 40 inches.

Paraquat Use Restrictions

- *Restricted-use pesticide.*
- Only certified applicators, who successfully complete the paraquat-specific training, can mix, load or apply paraquat.
- Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed, registered technicians cannot apply.
- Required training link (<http://usparaquattraining.com>); certified applicators must repeat training every three years.

Glyphosate²	glyphosate	9	grain, forage	varies with formulation	0.75–1.5 ae
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Use at least 1.13 lbs ae glyphosate or higher, especially if tank-mixing with residual herbicide.

- Spring applications may be used for control of annual weeds.
- Using low-volume sprays may allow for a reduced rate.
- Can be tank-mixed with residual herbicides such as atrazine. When tank-mixing glyphosate with residual herbicides, apply in 10–20 gal water/A or 10–60 gal liquid fertilizer nitrogen/A.
- Adding dicamba improves control of large annual broadleaf weeds, dandelion, and alfalfa.
- Glyphosate may be applied in clear liquid nitrogen fertilizers and clear liquid complete-analysis fertilizers, but may be less effective on certain annual grasses and perennials.
- Do not use glyphosate with suspension-type liquid fertilizers.

Table 5.29 - Comments on “Burndown” Herbicides for No-Till Sorghum (cont.)

May need to be combined with residual treatment or postemergence program for complete no-till weed control program.

Herbicide Trade Name ¹	Herbicide Common Name	Herbicide group # (site of action)	Sorghum type	product/A	lb ai/A
Lexar EZ 3.67SC	mesotrione +	27	grain	3 qt	0.168
	S-metolachlor +	15			1.3
	atrazine	5			1.3
Lumax EZ 3.7SC	mesotrione +	27	grain	2.7 qt	0.168
	S-metolachlor +	15			1.68
	atrazine	5			0.63

- Labeled for grain sorghum only.
- Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (group 15).
- Apply prior to sorghum emergence; application to emerged sorghum will result in severe injury.
- Applying either product less than 7 days before sorghum planting will increase the risk of crop injury, especially if irrigation or rainfall is received following the application.
- Injury symptoms include temporary bleaching of newly emerging sorghum leaves or in extreme conditions, stunting or partial stand loss.
- Lexar or Lumax will improve performance of paraquat but can antagonize glyphosate on some weed species.
- *Restricted-use pesticides and water quality advisory*

Sharpen 2.85SC	saflufenacil	14	grain	1–2 fl oz	0.022– 0.044
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- Labeled for grain sorghum only.
- Sharpen may be applied as a preplant/burndown treatment from 14 days early preplant through preemergence timings. Do not apply to emerged sorghum.
- Apply Sharpen in a typical glyphosate burndown herbicide program to increase weed spectrum control including glyphosate-resistant horseweed.
- Include necessary additives methylated seed oil (MSO) plus nitrogen solution or ammonium sulfate (AMS) to the spray mixture.
- Verdict is a prepackaged mixture containing Sharpen.
- Sharpen will provide very short residual activity at the rates labeled for sorghum.
- Do not apply Sharpen at more than 1.0 fl oz/A within 30 days of planting if organophosphate or carbamate insecticide(s) is used at planting.

¹ See Table 5.3 (generics table) for additional herbicides that contain these active ingredients.

² Consult specific product label for active ingredient concentration and application rate; various formulations of this herbicide are available (e.g., 1 qt/A glyphosate = 22 fl oz/A WeatherMAX); see Table 5.1 (glyphosates table).

Solubility (parts per million; ppm) refers to how many microliters of the herbicide will dissolve in 1 liter of water. The less soluble the herbicide, the more moisture (rain or irrigation) is needed to activate the herbicide and move it into the root zone. Solubility is used as a guideline for rainfall or irrigation required within a short time after application. Moisture needed also depends on the soil moisture at time of application.

Relative moisture levels to move herbicide into the soil to achieve optimum level of control

Relative Moisture to Activate	ppm	Estimate Water to Activate*
Low	>500 ppm (very soluble)	0.33 inch
Medium	250-500 ppm	0.33-0.5 inch
High	100-250 ppm	0.5-0.75 inch
Very High	<100 ppm	>0.75 inch

*More water (additional irrigation) maybe necessary if soil is dry at time of application, soils with higher clay content, or high plant residues are present.

Relative duration of residual control is for comparison only based on herbicide half-life (length of time it takes for half the herbicide to break down). Herbicide breakdown results from chemical and/or microbial activity. Since the speed of breakdown is affected by a number of factors, including soil pH, soil temperature, and soil moisture, duration can vary for herbicides based on the specific conditions. Residual activity is not the same as herbicide carryover.

Duration of residual control assumes 1) good activation; 2) no excessive rain or irrigation; and 3) weed species are sensitive to the herbicide(s) applied

Table 5.30 - Water Solubility and Longevity of Soil-Applied Herbicides

Trade Name	Solubility (ppm)	Relative moisture required to activate	Duration of Residual Weed Control
Atrazine	33	Very High	4-5 weeks
Callisto	1500	Low	2-4 weeks
Dual II Magnum	488	Medium	4-5 weeks
ImiFlex	4,160	Low	2-4 weeks
Linex / Lorox	75	Very High	4-5 weeks
Outlook	1,174	Low	2-4 weeks
Sharpen	pH 5: 30 pH 7: 2,100	Very High Low	1-3 weeks
Warrant/TopNotch	223	High	2-4 weeks
Premixes			
Bicep II Magnum	Dual II Magnum, atrazine		
Bicep Lite II Magnum	Dual II Magnum, atrazine		
Coyote	Dual II Magnum, Callisto		
FulTime NXT	Topnotch, atrazine		
Halex GT	Dual II Magnum, Callisto, glyphosate		
Lumax EZ / Lexar EZ	Dual II Magnum, Callisto, atrazine		
Verdict	Outlook, Sharpen		

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Ratings are based on labeled application rates for the soil type and timely rainfall or irrigation to incorporate the herbicides. Ratings are also based on control 3 to 4 weeks after application. Length of effective control (residual control) beyond 4 weeks after application often declines. Results may differ with variations in soil type, temperature, rainfall, soil moisture, soil organic matter, and soil pH. For ratings on herbicide combinations not listed, see the component parts.

Table 5.31 - Relative Effectiveness of Soil-Applied Herbicides on Individual Species*

Weed control rating:		Crop tolerance:													
10 = 95–100%		E = excellent; almost never any crop injury observed													
9 = 85–95%		VG = very good; on rare occasion is crop injury observed													
8 = 75–85%		G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., seedling depth, seed slit closure, herbicide rate and application timing, adjuvants)													
7 = 65–75%		FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions													
6 = 55–65%		F = fair; some crop injury is commonly observed													
N = less than 55% or no control															
– = no local data															
Grasses															
Trade Name*	Site of Action Number	Barnyardgrass	Bermudagrass	Broadleaf Signalgrass	Crabgrass	Fall Panicum	Foxtail spp.	Goosegrass	Johnsongrass (Seedling)	Johnsongrass (Rhizome)	Quackgrass	Shattercane	Texas panicum	Wirestem Muhly	Yellow Nutsedge
Atrazine	5	7	N	N	7	6	6+	7	N	N	7+	6	N	6	6
Bicep Products	5/15	9	N	8	9	9	9	9+	6	N	6	6	N	6	8+
Degree Xtra, FulTime NXT	5/15	9	N	8	8+	9	9	9+	7	N	6	6	N	6	8+
Dual Products, Cinch	15	9	N	8	9	8+	9	9+	6	N	N	6	N	N	8
Halex GT	15/27/9	9	N	10	9+	9+	9+	10	9+	9	9	9	9	9	8
ImiFlex ¹	2	8	N	N	7	7	8	N	6	N	N	6	N	N	7
Linex / Lorox	7	6	N	N	6	6	6	6	N	N	N	N	N	N	N
Lumax/Lexar	5/15/27	9	N	8	9	9	9	9+	6	N	6	6	N	6	8+
Outlook	15	9	N	8	8	8+	9	9	6	N	N	6	N	N	7+
Verdict	14/15	8	N	N	8	8	8	9	N	N	N	N	N	N	6
Warrant	15	9	N	8	8+	8+	9	9+	7	N	N	6	N	N	7+

* Performance ratings based on full labeled rates. See Table 5-3 (generics table) for additional herbicides that contain these active ingredients.

¹ For use on grain and forage sorghum containing the igrowth herbicide tolerance trait only. Not labeled in NJ.

Table 5.31 - Relative Effectiveness of Soil-Applied (Premergence) Sorghum Herbicides on Individual Weed Species¹ (cont.)

Weed control rating:	Crop tolerance:
10 = 95–100%	E = excellent; almost never any crop injury observed
9 = 85–95%	VG = very good; on rare occasion is crop injury observed
8 = 75–85%	G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., seedling depth, seed slit closure, herbicide rate and application timing, adjuvants)
7 = 65–75%	FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions
6 = 55–65%	F = fair; some crop injury is commonly observed
N = less than 55% or no control	
– = no local data	

Broadleaves

Trade Name ¹	Site of Action Number	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters ³	Horseweed/Marestail	Morningglory, Annual	Nightshade, Eastern Black	Palmer amaranth / Waterhemp ²	Pigweed	Ragweed, Common	Ragweed, Giant	Sida, Prickly	Smartweed	Spurred Anoda	Velvetleaf	Sorghum Tolerance, Medium Soils	Sorghum Tolerance, Coarse Soils
Atrazine	5	6	8+	9	9+	9	8+	9	9+	N	9	8	9	9+	8	8	E	G
Bicep Products	5/15	6	8+	9	9	8+	8+	9	9+	8+	8+	8	9	9	9	8+	G	G
Degree Xtra ⁴ / Fultime NXT	5/15	6	8+	9	9	N	8+	9	9+	9	8+	8	9	9	9	8+	G	FG
Dual Products, Cinch	15	N	N	N	6	N	N	7+	8+	8	6	N	N	N	N	N	G	G
Halex GT	15/27/9	8+	9	9	9	9	7+	9+	8+	9	8+	8	9	9	–	9	G	F
Imiflex	2	6	8	8	8	–	7	8	N	9	7+	6	8	9	N	8	– ⁵	– ⁵
Lexar	5/15/27	7	9	9	9	9	9	9	9	8+	8+	8+	9	9	9	9	G	F
Linex / Lorox	7	6	7	7	8+	–	6	6	9	9	7+	6	7+	8	6	7	G	G
Lumax	5/15/27	6	8+	9	9	9	8+	9	9	8+	9	8	7+	9	9	9	G	F
Outlook	15	N	N	N	6	N	N	7+	8	8	6	N	N	6	N	N	G	G
Verdict	14/15	6	8	8	9	7+	8	9	9	9	8	8	7	9	–	8	G	G
Warrant	15	N	N	N	7	N	N	8+	8	9	7+	N	N	7	N	6	G	FG

¹ See Table 5.3 (generics table) for additional herbicides that contain these active ingredients.

² Biotypes resistant to Group 2 herbicides are common in the region; do not rely on Group 2 herbicides to provide effective control.

³ Triazine-resistant (TR) biotypes of common lambsquarters and redroot/smooth pigweed are widespread in the region, and thus triazine (Group 5) herbicides are not effective against these populations.

⁴ Degree Xtra may be less consistent on TR lambsquarters control compared to other acetochlor products.

⁵ For use on sorghum containing the igrowth herbicide tolerance trait only.

Table 5.32 - Comments on Preplant or Preemergence Herbicides for Conventional, Min-, or No-Till Sorghum

See specific herbicide label to determine correct rate for soil type and weed species found in each field.

These treatments may be used in conventional, reduced-till, and no-till systems; treatments may be applied preplant-incorporated or preemergence, unless stated otherwise.

Incorporation reduces the need for timely rainfall after application and may improve control of certain weeds.

Higher rates for a given soil may be required for no-till.

In no-till situations, “burndown” herbicides may be required to control weeds or cover crops present at time of application.

EPP= early preplant means application prior to plant (in most cases it’s 7-14 days before planting); PPI= applied to conventionally tilled soil than mechanically incorporated; PRE= preemergence (applied before the crop has emerged); EPOST=early postemergence (during the early stages of crop and weed growth)

Trade name ¹	Common name	Site of Action Number	Application	Product/A	lb ai/A
Atrazine 4L	atrazine	5	EPP, PPI, PRE	1–2 qt	1–2
Atrazine 90DF	atrazine	5	EPP, PPI, PRE	1.1–2.2 lb	1–2

- Sorghum is not as tolerant to atrazine as corn.
- Labeled for grain and forage sorghum.
- Atrazine may be used at 1–2 qt/A. Usually used in combination with other herbicides at 1–1.5 qt.
- Can be applied to emerged sorghum up to 12 inches tall.
- On highly erodible ground with less than 30% surface residue, no more than 1.6 qt may be applied prior to crop emergence.
- Heavy rain immediately following application tends to cause excessive concentrations in seed furrow, result in higher risk of injury.
- Do not apply to coarse-textured soils (i.e. sand, loamy sand, and sandy loam), or injury may occur.
- Do not apply to medium- or fine-textured soils having less than 1% organic matter or injury may occur.
- *Restricted-use pesticide and water quality advisory.*

ATRAZINE USE RESTRICTIONS

Preplant or Preemergence

- On highly erodible soils (as defined by the U.S. Natural Resources Conservation Service):
 - Fields where more than 30 percent of the soil surface is covered with plant residue at planting, apply a maximum of 2.0 lb of active ingredient per acre as a broadcast spray.
 - Fields where less than 30 percent of the soil surface is covered with plant residue at planting, apply a maximum of 1.6 lb of active ingredient per acre as a broadcast spray.
 - Apply a maximum of 2.0 lb of active ingredient per acre as a broadcast spray.

Safety Precautions for Using Atrazine

- Do not mix, load, or apply within 50 feet of drinking water wells, livestock wells, agricultural drainage wells, irrigation wells, abandoned wells, or sinkholes.
- Do not mix or load within 50 feet of intermittent streams, perennial streams, rivers, lakes, or reservoirs
- Do not apply within 200 feet of lakes or reservoirs.
- Do not apply within 66 feet of the points where surface water runoff enters intermittent streams, perennial streams, or rivers. The 66-foot buffers should be planted to a crop or seeded with grass on highly erodible land.

Table 5.32 - Comments on Preplant or Preemergence Herbicides for Conventional, Min-, or No-Till Sorghum (cont.)

Trade name ¹	Common name	Site of Action Number	Application	Product/A	lb ai/A
Bicep II Magnum 5.5L	S-metolachlor +	15	EPP, PPI, PRE, EPOST	1.3–2.1 qt	0.78–1.26
	atrazine	5			0.99–1.6
Bicep Lite II Magnum 6SC	S-metolachlor +	15	EPP, PPI, PRE	1.1–1.5 qt	0.92–1.25
	atrazine	5			0.73–1

- Labeled for grain or forage sorghum.
- Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (group 15).
- Not labeled for use on coarse-textured soils with less than 1% organic matter.
- Bicep Lite II Magnum and Cinch ATZ Lite are premixes of reduced-atrazine-rate ratios. .
- See individual component sections in this table and atrazine use restrictions for additional information.
- *Restricted-use pesticides and water quality advisory.*

Callisto 4SC	mesotrione	27	EPP, PRE	6.0–6.4 fl oz	0.188–0.2
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- Labeled for grain sorghum only.
- Do not apply to sorghum grown on sand, loamy sand, or sandy loam soils due to risk of sorghum injury.
- Do not apply to emerged sorghum or injury will occur.
- Applying Callisto less than 7 days before planting will increase risk of crop injury, especially if irrigation or rainfall is received following application. Applying more than 7 days prior to planting will reduce risk of injury.
- Do not apply more than 21 days prior to planting.
- If applied prior to planting, minimize disturbance of the herbicide treated soil during planting process.

Coyote 3.67SC	S-metolachlor +	15	EPP, PRE	2 qt	1.67
	mesotrione	27			0.165

- Labeled for grain sorghum only.
- Do not apply to sorghum grown on sand, loamy sand, or sandy loam soils due to risk of sorghum injury.
- Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (Group 15).
- Do not apply to emerged sorghum, or injury will occur.
- Applying Coyote less than 7 days before planting will increase risk of crop injury, especially if irrigation or rainfall is received following application. Applying more than 7 days prior to planting will reduce risk of injury.
- Do not apply more than 21 days prior to planting.
- *Water quality advisory.*

Degree Xtra 4.04 ME/ FulTime NXT 4.04CS	acetochlor +	15	EPP, PPI, PRE	2.0–3.7 qt	1.3–2.4
	atrazine	5			0.6–1.23

- Labeled for grain sorghum only.
- Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (group 15).
- Do not apply pre-plant incorporated on coarse- or medium-textured soils.
- These products can be applied to emerged sorghum up to 11 inches in height
- See individual component sections in this table and atrazine use restrictions and acetochlor restrictions.
- *Restricted-use pesticides and water quality advisory.*

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Table 5.32 - Comments on Preplant or Preemergence Herbicides for Conventional, Min-, or No-Till Sorghum (cont.)

Trade name ¹	Common name	Site of Action Number	Application	Product/A	lb ai/A
Dual II Magnum 7.64EC	S-metolachlor	15	EPP, PPI, PRE	1–1.67 pt	0.96–1.6

- Labeled for forage and grain sorghum.
- Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (group 15).
- Dual II Magnum/Cinch are similar in activity to Outlook or Warrant.
- Dual II Magnum/Cinch contains a crop-safening agent.
- Incorporation improves control of yellow nutsedge.
- A prepackaged mixture with glyphosate is available as Sequence: label mention preplant or preemergence application only.
- *Water quality advisory.*

Halex GT 4.39EC	S-metolachlor +	15	EPP, PRE	4–6 pt	1.05–1.57
	mesotrione +	27			0.105–0.157
	glyphosate	9			1.05–1.57

- Labeled for grain sorghum only; do not use in production of forage sorghum, sudangrass, or sorghum-sudangrass hybrids.
- Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (Group 15).
- For best results, apply to weeds before they are 4 inches tall and from 21 days before planting up through planting but prior to crop emergence.
- Include NIS and AMS in the spray mixture.
- Atrazine can be tank-mixed with Halex GT.
- Not labeled for use on coarse-textured soils.
- Do not apply Halex GT to ground that has been or will be treated with Callisto in the same season.
- Do not apply more than 6 pt/A Halex GT per season (0.0157 lb mesotrione, 1.57 lb s-metolachlor, and 1.57 lb glyphosate).
- Use caution if applying OP or carbamate insecticides 7 days before or after Halex GT application.
- See label for additional use restrictions.
- *Water quality advisory.*

ImiFlex 1SL	imazamox	2	PRE	6–9 fl oz	0.047–0.07
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- Labeled on igrowth grain and forage sorghum only; conventional sorghum hybrids will be killed if treated with ImiFlex.
- ImiFlex is not labeled for use in NJ.
- Do not plant igrowth sorghum in fields known to have ALS-resistant johnsongrass or shattercane and do not replant igrowth sorghum in consecutive years.
- For best results, apply to weeds before broadleaf weeds exceed a height of 3 inches and grass weeds exceed 4 to 5 leaves.
- ImiFlex should be applied with non-ionic surfactant (NIS), or crop oil concentrate (COC) except when mixed with 2,4-D or dicamba.
- Do not tank mix Huskie or Peak as significant injury can occur.
- ALS-resistant biotypes of marestail/horseweed are found in the region and thus Group 2 herbicides will not be effective against these populations. To prevent herbicide resistance, avoid repeated annual applications of ALS (Group 2) herbicides.
- Regional data suggest that utility of ImiFlex is primarily for postemergence weed control.
- Refer to label for additional information on use and restrictions.
- *Water quality advisory.*

Table 5.32 - Comments on Preplant or Preemergence Herbicides for Conventional, Min-, or No-Till Sorghum (cont.)

Trade name ¹	Common name	Site of Action Number	Application	Product/A	lb ai/A
Linex 4L Lorox 50DF	linuron	7	PRE	0.625–2.0 pts 0.5–2.0 lbs	0.25–1.0
<ul style="list-style-type: none"> • Label does not specify sorghum type. • Apply as tank mixture with other labeled herbicides. • Apply after planting, but before crop emergence. • Plant seed at least 1 inch deep or crop injury may occur. 					
Lexar EZ 3.7SC	S-metolachlor + mesotrione + atrazine	15, 27, 5	EPP, PRE	3.0 qt	1.3 0.168 1.3
Lumax EZ 3.67SC	S-metolachlor + mesotrione + atrazine	15, 27, 5	EPP, PRE	2.7 qt	1.68 0.168 0.63
<ul style="list-style-type: none"> • Labeled for grain sorghum only; do not use in production of forage sorghum, sudangrass, or sorghum-sudangrass hybrids. • Applying less than 7 days before sorghum planting will increase the risk of crop injury, especially if irrigation or rainfall is received shortly after application. • The label does not recommend application to sorghum grown on sandy soils (sand, sandy loam, or loamy sands). • Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (group 15). • Do not apply to emerged sorghum or severe injury will occur. See individual component sections in this table and atrazine use restrictions. • <i>Lexar and Lumax are restricted-use pesticides and have a water quality advisory.</i> 					
Outlook 6.0EC	dimethenamid	15	EPP, PPI or PRE	12–21 fl oz	0.56–0.98
<ul style="list-style-type: none"> • Labeled for grain sorghum only; sorghum forage may be grazed or fed to livestock 60 days after application. • Outlook is similar in activity to Dual II Magnum. • Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (group 15). • Outlook may be applied to sorghum up to 12-inch-tall; Outlook will not control weeds that have emerged. • Outlook is not recommended for coarse-textured soils due to limited residual control. • For early preplant applications or fields with heavy surface plant residue, increase Outlook rate, see label. • Verdict contains dimethenamid, but will need additional Outlook added to provide consistent residual control; see Verdict label. • Incorporation improves control of yellow nutsedge. • <i>Water quality advisory.</i> 					

Table 5.32 - Comments on Preplant or Preemergence Herbicides for Conventional, Min-, or No-Till Sorghum (cont.)

Trade name ¹	Common name	Site of Action Number	Application	Product/A	lb ai/A
Verdict 5.57EC	saflufenacil + dimethenamid	14, 15	EPP, PPI, or PRE	10 fl oz	0.38 + 0.045
<ul style="list-style-type: none"> • Labeled for grain sorghum only; sorghum forage can be harvested, fed or grazed 70 days after application. • Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (group 15). • Verdict can be used in a burndown program or as a preemergence treatment. If used in a burndown program, it is best to include glyphosate and atrazine in addition to the necessary adjuvants (methylated seed oil [MSO] plus ammonium sulfate [AMS] or nitrogen solution) to improve control of emerged weeds including horseweed. • Amount of dimethenamid in Verdict is low, additional Outlook can be included to improve residual control, refer to label for additional Outlook rates. • Do not apply Verdict to emerged sorghum, or severe injury will occur. • The use of Verdict can follow a burndown application of Sharpen (1 fl oz/A). • <i>Water quality advisory</i> 					
Warrant 3CS	acetochlor	15	EPP, PPI, or PRE	1.5–3.0 qt	1.125–2.25
<ul style="list-style-type: none"> • Labeled for forage and grain sorghum • Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (group 15). • Acetochlor is similar in activity to Dual II Magnum or Outlook but is more active on certain broadleaf weeds. • Warrant may be applied on up to 11-inch-tall corn depending on the tank-mix partner but Warrant alone will not control emerged weeds. • For early preplant applications or fields with heavy surface plant residue, the rate of acetochlor may need to be increased, refer to label. • <i>Water quality advisory.</i> <p>Acetochlor Use Restrictions</p> <ul style="list-style-type: none"> • Do not apply within 50 feet of any well where depth to groundwater is 30 feet or less: sands with less than 3% organic matter; loamy sands with less than 2% organic matter; or sandy loams with less than 1% organic matter • Do not mix or load within 50 feet of any wells, streams, rivers, lakes, or reservoirs • Do not apply under conditions that favor runoff or wind erosion of soil containing this product to non-target areas. 					
¹ See Table 5.3 (generics table) for additional herbicides that contain these active ingredients.					

Table 5.33 - Sorghum Herbicide Preplant or Preemergence Rates Per Acre Based on Soil Texture and Organic Matter

This table shows application rates for products applied alone. Rates may vary if tank-mixed with other products, if weed infestations are heavy, or if used in conservation tillage situations. See specific product label for additional information on application rates and use.

Trade Name	Site of Action Number	Unit	< 3% Organic Matter			>3% Organic Matter			Inc. for No-till
			Coarse	Medium	Fine	Coarse	Medium	Fine	
Atrazine 4L	5	qt	Not recommended	1.6	1.6	Not recommended	1.6	1.6	yes
Atrazine 90DF	5	lb	Not recommended	1.8	1.8	Not recommended	1.8	1.8	yes
Bicep II Magnum 5.5SC	5/15	qt	Do not use	2.1	2.1	Do not use	2.1	2.1	yes
Bicep II Lite Magnum 6SC	5/15	qt	Do not use	1.5	1.5	Do not use	1.5	1.5	yes
Callisto 4SC	27	fl oz	Do not use	6.0	6.0	Do not use	6.0	6.0	no
Coyote 3.67SC	15/27	qt	Do not use	2.0	2.0	Do not use	2.0	2.0	no
Degree Xtra 4.04 ME	5/15	qt	2.0	2.5	2.75	2.3	3.0	3.7	no
Dual II Magnum 7.64EC	15	pt	1.33	1.67	1.67	1.3	1.67	1.67	yes
FulTime 4.04CS	5/15	qt	2.0	2.5	2.9	2.5	3.0	3.2	no
Halex GT 4.39EC	15/27/9	qt	Do not use	4.0	4.0	Do not use	4.0	4.0	no
ImiFlex ¹	1	fl oz	Do not use	9.0	9.0	9.0	9.0	9.0	no
Lexar EZ 3.7SC	5/15/27	qt	Do not use	3.0	3.0	Do not use	3.0	3.0	no
Linex 4L	7	pt	1.0	1.25	1.5	1.25	1.5	1.75	no
Lorox 50DF	7	lb	1.0	1.25	1.5	1.25	1.5	1.75	no
Lumax EZ 3.67SC	5/15/27	qt	Do not use	2.7	2.7	Do not use	2.7	2.7	no
Outlook 6.0EC	15	fl oz	14	18	18	16	18	20	yes
Sequence 5.25EW	9/15	pt	3.5	3.75	3.75	3.5	3.75	4.0	no
Verdict 5.57EC	14/15	fl oz	10	10	10	10	10	10	yes
Warrant 3CS	15	qt	1.5	1.75	3.0	2.0	2.5	2.75	no

¹ For use on sorghum containing the igrowth herbicide tolerance trait only. ImiFlex is not labeled for use in NJ.

Table 5.34 - Relative Effectiveness of Postemergence Herbicides on Individual Weed Species

Ratings are based on labeled application rates and weeds at 4-inch height. Results may differ with variations in weed size, temperature, rainfall soil moisture, and good spray coverage. Ratings are based only on postemergence activity and do not reflect possible residual activity. For ratings on herbicide combinations not listed, see the component parts.

Weed control rating:	Crop tolerance:
10 = 95–100%	E = excellent; almost never any crop injury observed
9 = 85–95%	VG = very good; on rare occasion is crop injury observed
8 = 75–85%	G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., seedling depth, seed slit closure, herbicide rate and application timing, adjuvants)
7 = 65–75%	FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions
6 = 55–65%	F = fair; some crop injury is commonly observed
N = less than 55% or no control	
– = no data available for this area	

Grasses

Trade Name* (rate/A)	Site of Action Number	Barnyardgrass	Bermudagrass	Broadleaf signalgrass	Crabgrass	Fall Panicum	Foxtail spp.	Goosegrass	Johnsongrass (Seedling)	Johnsongrass (Rhizome)	Quackgrass	Shattercane	Texas panicum	Wirestem Muhly	Yellow Nutsedge
Atrazine (1 qt)	5	7+	N	7	6	6	7+	6	N	N	7	6	N	6	7
Basagran (1 qt)	6	N	N	N	N	N	N	N	N	N	N	N	N	N	8
Facet (>26 fl oz)	4	8	N	8	7	6	7	N	N	N	N	N	–	N	N
FirstAct (8 fl oz) ²	1	9	9	9	8+	9	9+¹	9	9	9	9	9+	8+	6	N
ImiFlex (6 fl oz) ³	2	8+	N	8	7	8+	8+	N	8+	7	N	8+	6	N	6
Linex/Lorox (POST directed)	7	7	–	8	8	8	8	8+	8	–	–	–	8	–	6
Permit/Sandea (0.67 oz)	2	N	N	N	N	N	N	N	N	N	N	N	N	N	9+
Yukon (4 oz)	2	N	N	N	N	N	N	N	N	N	N	N	N	N	9+
Zest (1.33 oz) ⁴	2	8+	N	9+	7	9	9	N	9	8+	8+	9	9	7	6

* See Table 5.3 (generics table) for additional herbicides that contain these active ingredients.

¹ Herbicide is less effective on yellow foxtail compared to giant foxtail. FirstAct rating for yellow foxtail = 7.

² For use on sorghum containing the Double Team herbicide tolerance trait only.

³ For use on sorghum containing the igrowth herbicide tolerance trait only. ImiFlex is not labeled for use in NJ.

⁴ For use on sorghum containing the Inzen herbicide tolerance trait only. Zest is labeled for use in DE and VA only.

Table 5.34 - Relative Effectiveness of Postemergence Herbicides on Individual Weed Species (cont.)

Broadleaves																
Trade Name* (rate/A)	Herbicide Group (Mode of Action)	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters	Annual Morning Glory	Eastern Black Nightshade	Palmer amaranth / Waterhemp ¹	Pigweed ¹	Common Ragweed ²	Giant Ragweed	Prickly Sida	Smartweed	Spurred anoda	Velvetleaf	Sorghum Safety
2,4-D (1pt)	4	6	9	8	9	9	7	9	9	9	9	9	7	-	8	F
Aim (0.5 oz)	14	N	N	N	6	6	8	7	7	N	N	6	N	-	9	FG
Atrazine (1 qt)	5	8	9	9	9+	9	9	9+	N	9	8	8+	9+	-	8	FG
Basagran (1 qt)	6	N	9	9	8	N	N	N	6+	8	7	8	9	7	8+	FG
Clarity (8 fl oz)	4	7	9	9	9	9	8	9	9	9	9	8	9+	-	8	F
Facet (>26 fl oz)	4	-	-	-	6**	7	-	N	N	6**	6**	-	N	-	6**	G
Huskie (12.8 fl oz)	6/27	-	8+	7+	9	8	8+	8	8	8	7	-	8+	-	8	G
Imiflex (6 fl oz)	2	6	9	8	8+	7	8+	N	9	8	8	6	8	7	9	- ³
Linex / Lorox (POST-directed)	7	-	8+	8+	8+	8	-	9	9	9	-	8	7	-	8+	FG
Maestro (1.5 pt)	6	8	9	9	9	8	9	N	7	7+	8	N	9	-	8+	F
Peak (0.75 oz)	2	-	N	8	8	7	-	9	9	9	6	6	7	-	8+	G
Permit / Sandea (0.67 oz)	2	6	9	N	N	6	6	9	9	9	8	7	8	-	9	G
Starane Ultra (6.4 fl oz)	4	-	8+	-	-	8+	6	7+	7+	8+	8+	-	-	-	8+	G
Yukon (4 oz)	2/4	6	9	9	9	9	8	9	9	9	8	8	9+	-	9	FG
Zest (1.33 oz)	2	7	7	7	6	7	N	N	9	6	N	N	8	-	7	- ⁴

* See Table 5.3 (generics table) for additional herbicides that contain these active ingredients.

** Facet is labeled for suppression of this species on weeds less than 2-inches tall.

¹ Group 2 resistance has been confirmed for this species and widespread in the region

² Common ragweed biotypes resistant to Groups 2 and 14 herbicides have been confirmed in the region. Group 14 resistance is limited to the DelMarVa region and NJ.

³ For use on sorghum containing the igrowth herbicide tolerance trait only.

⁴ For use on sorghum containing the Inzen herbicide tolerance trait only.

Table 5.35 - Comments on Postemergence Herbicides for Sorghum

The following herbicides can be added with postemergence herbicides to improve residual weed control. They will not provide control of emerged weeds, so they should be applied to weed-free soil surface or with products that will provide postemergence control of weeds present at time of application. Consult labels when tank-mixing with any herbicide. Some pesticides or adjuvants used in combination with the following herbicides could increase the chance of soybean injury.

Trade Name ¹	Common Name	Site of Action Number	Sorghum Type	Application Timing	Product/A	lb ai/A
Dual Magnum 7.62EC	S-metolachlor	15	grain, forage	POST	1–1.67pt	0.95–1.59
<ul style="list-style-type: none"> • Application timing is not specified on label. • Do not make more than one application per year. • Make applications at least 75 days before harvest. • <i>Water quality advisory.</i> 						
Prowl 3.3EC/ Prowl H2O 3.8CS	pendimethalin	3	grain only	4-inch growth stage up to layby	2.4–3.6pt 1.5–3pt	1–1.5
<ul style="list-style-type: none"> • Do not apply preplant incorporated or preemergence. • Do not make more than one application per year. • Do not apply on sorghum planted in double-row beds. • Do not replant sorghum if crop loss occurs. • Do not apply in liquid fertilizer. • Use only where adequate tillage is practiced to provide good seed coverage and plant seeds at least 1 inch deep, or crop injury may occur. • Prior to application, crop must be cultivated in such a manner as to throw at least 1 inch of soil over the base of the crop plants to prevent direct contact of Prowl with the zone of brace root formation. 						
Warrant 3CS	acetochlor	15	grain, forage	before 11 inches	1.5–3qt	1.125–2.25
<ul style="list-style-type: none"> • Acetochlor is similar in activity to Dual, but is more active on certain broadleaf weeds. • Do not apply POST using sprayable fluid fertilizer, or injury will occur. • <i>Water quality advisory.</i> 						
<p>The following treatments are applied after sorghum emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.</p>						
2,4-D amine 4S	2,4-D amine	4	grain only	6 to 15 inches Over 8" drops recommended	1 pt	0.5 ae
<ul style="list-style-type: none"> • Sorghum is not as tolerant to 2,4-D as corn. • Apply between 6- and 15-inch tall sorghum; if sorghum is over 8-inches tall consider drop nozzles to keep spray off the foliage; do not treat during the boot, flowering, or dough stages. • Do not apply during periods of rapid growth (high soil moisture, warm temperatures, recent nitrogen application) due to increased risk of crop injury. • Make only one application per season to emerged sorghum. • 2,4-D is volatile, be cautious of off-target movement. • Surfactants can increase risk of injury, be cautious of surfactant use when tank mixing with other herbicides. • 2,4-D does not provide any residual weed control. 						

Table 5.35 - Comments on Postemergence Herbicides for Sorghum (cont.)

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Site of Action Number	Sorghum Type	Application Timing	Product/A	lb ai/A
Aim 2EC	carfentrazone	14	grain only	4 inches to boot stage	0.5 fl oz	0.008
<ul style="list-style-type: none"> • At rate labeled for Aim 2EC, control is limited to weeds less than 3-inches tall, or morningglory with no more than 3 leaves, and velvetleaf up to 4 inches. • Application timing is 4 inches tall to just prior to boot stage; but application should be based on small weeds. • Tank-mix with other herbicides to increase weed control spectrum. • Aim does not provide residual weed control. • Use a non-ionic surfactant (NIS); do not use crop oil concentrate (COC) on emerged sorghum with either formulation. 						
Atrazine 4L	atrazine	5	grain, forage	Before 12 inches	0.75–2.0 qts	0.75–2.0
Atrazine 90DF	atrazine	5		Before 12 inches	0.83–2.2 lbs	0.75–2.0
<ul style="list-style-type: none"> • Apply before sorghum exceeds 12 inches; apply before weeds are 1.5 inches tall. • Sorghum is not as tolerant as corn to atrazine. • If no atrazine was applied prior to sorghum emergence, maximum application rate is 2 qts/A. If POST application is following an earlier atrazine application, total atrazine amount cannot exceed 2.5 lbs active ingredient. • Length of residual control depends on rate applied. • Add 1 qt crop oil concentrate (COC)/A to spray solution. Do not include oil if sorghum is under stress from prolonged cold, wet weather or other factors. 						
ATRAZINE USE RESTRICTIONS						
Safety Precautions for Using Atrazine						
<ul style="list-style-type: none"> • Do not mix, load, or apply within 50 feet of drinking water wells, livestock wells, agricultural drainage wells, irrigation wells, abandoned wells, or sinkholes. • Do not mix or load within 50 feet of intermittent streams, perennial streams, rivers, lakes, or reservoirs. • Do not apply within 200 feet of lakes or reservoirs. • Do not apply within 66 feet of the points where surface water runoff enters intermittent streams, perennial streams, or rivers. The 66-foot buffers should be planted to a crop or seeded with grass on highly erodible land. • <i>Restricted-use pesticide and water quality advisory.</i> 						
Basagran 4S	bentazon	6	grain, forage	Before heading	1.5–2.0 pts	0.75–1.0
<ul style="list-style-type: none"> • Apply to sorghum before heading or blooming; however, Basagran needs to be applied when weeds are small and actively growing. • Basagran is weak on pigweed species, including Palmer amaranth. • Tank-mix with atrazine to broaden spectrum of control • Label recommends use of crop oil concentrate. • Split treatments may be required for yellow nutsedge and Canada thistle. • Basagran does not provide residual weed control. • <i>Water quality advisory.</i> 						

5-120 Weed Control in Field Crops: Sorghum

Table 5.35 - Comments on Postemergence Herbicides for Sorghum (cont.)

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Site of Action Number	Sorghum Type	Application Timing	Product/A	lb ai/A
Bicep II Magnum 5.5SC	S-metolachlor	15	grain, forage	3-leaf growth stage up to 12 inches	1.3–2.1 qt	0.78–1.26
	atrazine	5				0.99–1.6

- Use sorghum seed treated with an approved seed safener for chloroacetamide herbicides (Group 15).
- Do not apply more than a total of 2.58 qt of Bicep II Magnum/A/season (i.e. 1.55 lb ai/A s-metolachlor and 1.97 lb ai/A atrazine).
- If other products containing s-metolachlor have been applied, the combined total amount of s-metolachlor resulting from all applications must not exceed 1.7 lb ai/A/calendar year.
- See individual component sections in this table and atrazine use restrictions for additional information.
- Tank-mix with other herbicides to increase weed control spectrum.
- Make applications at least 75 days before harvest.
- Add 1 qt crop oil concentrate (COC)/A to spray solution. The addition of UAN or AMS is recommended to improve control.
- *Restricted-use pesticides and water quality advisory.*

Facet 1.5L	quinclorac	4	grain only	Before 12 inches tall	22–32 fl oz	0.25–0.375
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- Sorghum stage is from emergence up to 12-inches tall.
- For best activity apply with atrazine at 0.5 to 1 lb ai to weeds less than 2 inches tall.
- Add 1 qt crop oil concentrate or methylated seed soil for better weed control. Ammonium sulfate (AMS) or urea ammonium nitrate (UAN) can also be added for improved efficacy. Non-ionic surfactant (NIS) plus a nitrogen source (AMS) may be used when Facet is tank mixed with products that restrict use of crop oil concentrates.
- Facet can provide residual control of susceptible weed species.

FirstAct 0.83EC	quizalofop	1	grain only		6-10 fl oz	0.039–0.065
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- Labeled on Double Team grain sorghum only; conventional sorghum hybrids will be killed if treated with FirstAct.
- Do not replant Double Team grain sorghum in consecutive years.
- Do not use crop oils manufactured from vegetable oils; when tank-mixing with a broadleaf herbicide, always read both labels to make sure the right surfactant and concentration are used.
- Do not apply initial application of FirstAct until sorghum is 11-12 inches tall (V8 stage) otherwise crop injury may occur.
- Two applications of FirstAct can be applied POST, but there must be an interval greater than 7 days between FirstAct applications.
- Apply when grasses are within the recommended growth stage specified on the label; perennial grasses may require a second application for complete control.
- To avoid antagonism (reduced grass control) from broadleaf herbicides, spray 2 to 3 days before the broadleaf herbicide or wait 7 days after the broadleaf herbicide application.
- FirstAct must be applied at least 45 days before harvest.

Table 5.35 - Comments on Postemergence Herbicides for Sorghum (cont.)

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Site of Action Number	Sorghum Type	Application Timing	Product/A	lb ai/A
Huskie 2.06EC	pyrasulfotole + bromoxynil	27 6	grain, forage	3 leaves to 30 inches tall (prior to flag leaf emergence)	12.8–16 fl oz	0.031–0.038 0.18–0.22
<ul style="list-style-type: none"> • Application timing for sorghum stage is 3-leaf up to 30 inches and/or prior to flag leaf emergence. • Huskie label does not require a surfactant. Nonionic surfactant (NIS) and ammonium sulfate (AMS) can be included under challenging growing conditions, or if tank-mix partner requires an additive. • Huskie can be tank-mixed with atrazine at 0.25 to 1.0 lb ai to improve and broaden spectrum of control; see atrazine entry in this table for precautions. • Addition of atrazine with Huskie is recommended for most situations. • Two applications of Huskie can be applied POST, but there must be an interval of 11 days between Huskie applications. • Crop injury can occur if Huskie is applied to fields treated with mesotrione (Lumax or Lexar). • <i>Water quality advisory.</i> 						
Maestro 2E	bromoxynil	6	grain, forage	4 leaves to preboot stage	1–1.5 pt	0.25–0.375
<ul style="list-style-type: none"> • Apply to sorghum between 4-leaf stage and up to preboot stage; however, Maestro needs to be applied when weeds are small and actively growing. • When applied alone, Maestro does not need any additional surfactant; when tank-mixing, it can be applied in combination with surfactants or crop oil concentrate. • Maestro is weak on pigweed species, including Palmer amaranth. • Maestro does not provide residual weed control. 						
Peak 57WG	prosulfuron	2	grain, forage	5 to 30 inches tall; over 20 inches drops are recommended	0.5–1.0 oz	0.018–0.036
<ul style="list-style-type: none"> • Application timing is between 5 and 30 inches tall, and prior to head emergence; use drop nozzles after sorghum is 20 inches tall. Application should focus on weed size rather than crop stage. • Tank mix with other labeled POST herbicides to broaden spectrum of control. • Peak applications should include a non-ionic surfactant (NIS). Crop oil concentrate can be included if tank mix partner recommends COC. • Refer to label for additional information on use and restrictions. • Peak will provide residual control of susceptible species. • Peak is an ALS (group 2) herbicide and there is wide-spread resistant to group 2 herbicides in the region. To prevent herbicide resistance, avoid repeated annual applications of ALS (group 2) herbicides. • <i>Water quality advisory.</i> 						

Table 5.35 - Comments on Postemergence Herbicides for Sorghum (cont.)

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Site of Action Number	Sorghum Type	Application Timing	Product/A	lb ai/A
Permit 75WG/ Sanda 75WG	halosulfuron	2	grain only	2 leaves to before head emergence	0.67–1.0 oz	0.031–0.047
<ul style="list-style-type: none"> • Apply from 2-leaf stage but before grain head emergence. • The 0.67 oz rate is the standard rate for annual weed control. • Permit/Sanda is excellent on yellow nutsedge, but is weak on common lambsquarters. • Tank mix with other labeled POST herbicides to broaden spectrum of control. Yukon is a prepackaged product containing Permit + dicamba. • Permit/Sanda should be applied with non-ionic surfactant (NIS); use of crop oil concentrate (COC) increases risk of crop injury. • Permit/Sanda will provide residual control of susceptible species. • ALS-resistant biotypes of marestalk/horseweed are found in the region and thus Group 2 herbicides will not be effective against these populations. To prevent herbicide resistance, avoid repeated annual applications of ALS (Group 2) herbicides. 						
Starane Ultra 2.8L	fluroxypyr	4	grain, forage	3- to 7-leaf stage; use drops for 8-leaf to boot stage	0.4 pt	0.14
<ul style="list-style-type: none"> • Timing for broadcast application 3-leaf of sorghum through 7-leaf stage, and drop nozzles from 8-leaf to boot stage. • Can be tank-mixed with other labeled herbicides can be included to broaden spectrum of control. • Surfactants not needed; Starane Ultra is applied alone, but may be used when required by tank-mixed partner. • Two applications of Starane Ultra can be made. • Starane Ultra will not provide residual weed control. 						
Yukon 67.5WDG	halosulfuron + dicamba	2 4	grain only	2 to 15 inches tall; use drops after 8-leaf stage	4–6 oz	0.03–0.045 0.125–0.188
<ul style="list-style-type: none"> • Yukon is a premix of halosulfuron (Permit) plus the sodium salt of dicamba. • Yukon can be applied from 2-leaf through 15 inch tall sorghum; use drop nozzles after sorghum is 8 inches tall. • Include non-ionic surfactant (NIS); crop oil concentrate (COC) can be used, but increases the risk of injury. • See entry for each component of Yukon for more information. • ALS-resistant biotypes of marestalk/horseweed are found in the region and thus Group 2 herbicides will not be effective against these populations. To prevent herbicide resistance, avoid repeated annual applications of ALS (Group 2) herbicides. • Yukon will provide residual control of susceptible species. 						

Table 5.35 - Comments on Postemergence Herbicides for Sorghum (cont.)

The following treatments are applied after corn emergence to control established weeds. See specific product label to determine correct rate for soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Site of Action Number	Sorghum Type	Application Timing	Product/A	lb ai/A
Zest 75WDG	nicosulfuron	2	grain only	5- to flag-leaf stage	0.67–1.33 oz	0.031–0.062

- Labeled on Inzen grain sorghum only; conventional sorghum hybrids will be killed if treated with Zest.
- Zest is labeled for use in DE and VA only.
- Do not plant Inzen grain sorghum in fields known to have ALS-resistant johnsongrass or shattercane.
- Do not tank-mix with Huskie, or injury will occur.
- Two applications of Zest can be applied POST, but there must be an interval of 7 days between Zest applications.
- Zest should be applied with non-ionic surfactant (NIS), or crop oil concentrate (COC) except when mixed with 2,4-D or dicamba.
- Risk of crop injury is higher with early POST application or when cool weather conditions prevail. Zest may cause temporal yellowing to Inzen sorghum but will recover quickly.
- Zest does not provide residual weed control.
- ALS-resistant biotypes of marestalk/horseweed are found in the region and thus Group 2 herbicides will not be effective against these populations. To prevent herbicide resistance, avoid repeated annual applications of ALS (Group 2) herbicides.
- *Water quality advisory.*

POST-DIRECTED

Linex 4L or	linuron	6	label does not specify	1–2 pts	0.5–1.0
Lorox 50DF				1–2 lbs	

- Post-directed application only. Do not apply over the top of emerged sorghum.
- Use only when there is sufficient differential between height of sorghum and weeds so that weeds are thoroughly covered and upper leaves of sorghum and whorl are not exposed to spray or drift.
- Include a non-ionic surfactant (NIS).
- Weeds should be treated prior to 2-inch-tall grass weeds and 6-inch broadleaf weeds.
- Linex/Lorox will provide residual control of susceptible species.

¹ See Table 5.3 (generics table) for additional herbicides that contain these active ingredients.

5-124 Weed Control in Field Crops: Sorghum

Table 5.36 - Weed Sizes for Postemergence Sorghum Herbicides

This table lists postemergence sorghum herbicides, their rates, and height ranges of weed species that are controlled or suppressed. This table is only a “quick reference”; refer to the herbicide label for additional information on application and timing.

Grasses	Barnyardgrass	Bermudagrass	Broadleaf signal grass	Crabgrass spp.	Fall Panicum	Foxtail spp.	Goosegrass	Johnsongrass (Seedling)	Johnsongrass (Rhizome)	Quackgrass	Shattercane	Texas panicum	Wirestem Muhly	Yellow Nutsedge
-----height range (inches) at application -----														
Atrazine (2 pt)	L-s*	—	—	L-s	—	L-s	—	—	—	—	—	—	—	—
Basagran (2 pt)	—	—	—	—	—	—	—	—	—	—	—	—	—	8
Facet (>26 fl oz)	2	—	2	2	—	2	—	—	—	—	—	—	—	—
FirstAct (> 6 fl oz) ¹	6	3	6	6	6	4	6	—	—	10	—	4	8	—
ImiFlex (6 fl oz) ²	3	—	3	3	3	3	3**	—	—	3**	—	3**	—	3**
Linex/Lorox (directed)	2	—	2	2	2	2	2	—	—	—	—	2	—	—
Permit/Sandea (0.67 oz)	—	—	—	—	—	—	—	—	—	—	—	—	—	6
Yukon (4 oz)	—	—	—	—	—	—	—	—	—	—	—	—	—	6
Zest (0.67 oz) ³	4	—	2	2	4	4	—	—	—	—	—	3	—	—

— = weed size is not on the herbicide label.

*L-s species are on the atrazine label as suppression.

**Suppression only; additional control measures may be necessary.

¹ For use on sorghum containing the Double Team herbicide tolerance trait only.

² For use on sorghum containing the igrowth herbicide tolerance trait only. ImiFlex is not labeled for use in NJ.

³ For use on sorghum containing the Inzen herbicide tolerance trait only. Zest is labeled for use in DE and VA only.

Table 5.36 - Weed Sizes for Postemergence Sorghum Herbicides (cont.)

Trade Name (rates/A)	Broadleaves													
	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters	Morningglory, Annual	Nightshade, Eastern Black	Palmer amaranth/ Waterhemp	Pigweed spp.	Ragweed, Common	Ragweed, Giant	Prickly sida	Smartweed	Spurred anoda	Velvetleaf
	----- maximum height at application (inches) -----													
2,4-D ¹	-	6	3	4	6	2	4	4	6	6	-	-	-	2
Aim (0.5 oz)	-	-	-	3	3 lvs	4	2	4	-	-	-	-	-	4
Atrazine ¹ (2 pt)	4	4	4	6	4	4	4	-	4	4	4	4	-	2
Basagran (2 pt)	-	10	10	2*	-	-	-	-	3	6	4	10	4	5
Dicamba ¹	4	4	4	4	4	4	4	4	4	4	4	6	-	2
Facet (>26 fl oz)	-	-	-	-	2	-	-	-	2-s	2-s	-	-	-	2-s
ImiFlex (6 fl oz) ²	-	8	6	5	4	5	4	8	5	5	4*	5	-	8
Huskie (12.8 fl oz)	4	4	-	4	4	4	4	4	4	4	-	-	-	4
Linex / Lorox (directed)	-	6	-	6	6	-	6	6	6	-	6	6	-	-
Maestro / Buctril (1.5-2 pt)	4	10	6	8	4	6	-	2	6	6	-	6	-	5
Peak (0.75 oz)	4-s*	10	6	4	4-s*	-	4	5	10	3	3-s*	4	-	6
Permit/Sandea (0.67 oz)	3*	9	-	2*	-	-	-	3	9	3	3	2	-	9
Starane Ultra ³	-	8	8	-	8	8-s*	-	-	8	8	-	-	-	8
Yukon (4-8 oz)	2-5	9-14	2-4	2-4	2-6	2-4	4-6	3-6	9-12	3-6	2-4	2-4	-	9-12

*Suppression only, additional control measures may be necessary.

¹ No sizes given on label, sizes listed above are best estimates.

² For use on sorghum containing the igrowth herbicide tolerance trait only. ImiFlex is not labeled for use in NJ.

³ Starane Ultra label states that susceptible broadleaf species will be controlled if treated before they reach height of 8 inches.

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Table 5.37 - Herbicide Effectiveness on Perennial Broadleaf Weeds

Performance ratings are based on seasonal control from a postemergence application in sorghum.

Weed control rating: 10 = 95–100% 9 = 85–95% 8 = 75–85% 7 = 65–75% 6 = 55–65% N = less than 55%
or no control – = no local data available

Broadleaves													
Trade Name (rate/A)	Site of Action Number	Canada Thistle	Dandelion	Dewberry spp.	Dock spp.	Hedge Bindweed	Hemp Dogbane	Horsenettle	Jerusalem Artichoke	Milkweed	Mugwort	Poison Ivy	Pokeweed
2,4-D (1 pt)	4	7+	8	6	7+	8	6	6	7	6	6	7	7
Atrazine (1.5 lb ai)	5	6	6	6	7	7+	6	6	N	N	N	6	6
Basagran + atrazine (1 qt + 1 qt)	5/6	8	7	N	7+	7+	6	7	6+	N	N	7	6
Clarity (8 fl oz)	4	8	7+	6	8	8+	7	7	8	6	7+	7+	6
Huskie + atrazine (12.8 fl oz + 0.75 lb ai)	27/6/5	L-s	L-s	–	L-s	–	–	–	L-s*	–	–	–	–
ImiFlex (6 fl oz) ¹	2	6	7	6	7	7+	7	7	7	6	–	–	6
Marksman (1 qt)	4/5	8+	8	6	8	8+	7	8	8	6	7+	7+	7
Peak + Clarity (0.75 oz + 8 fl oz)	2/4	L-s	–	–	–	–	L-s	–	–	–	–	–	–
Starane Ultra (0.4 pt)	4	N	N	N	N	8	8+	N	N	N	N	N	N
Yukon (6 oz)	2/4	8+	8	6	7	8	7	7+	7	8	7+	–	8
Zest (0.67 oz) ²	2	6	N	8	N	7	6	6	6	6	N	–	7

* Herbicide label lists this species for partial control.

¹ For use on sorghum containing the igrowth herbicide tolerance trait only. ImiFlex is not labeled for use in NJ

² For use on sorghum containing the Inzen herbicide tolerance trait only. Zest is labeled for use in DE and VA only.

Table 5.38 - Spray Additives and Rainfastness for Burndown and Postemergence Sorghum Herbicides

Trade Name	Adjuvant(s) ¹	Rate	Rainfastness (hours)
2,4-D amine	none, except in certain tank-mixes	–	6–8
Aim/Cadet	non-ionic surfactant or	2 pt/100 gal	1
	crop oil concentrate	1 gal/100 gal	
	plus ammonium sulfate or	2–4 lb/A	
	nitrogen solution (optional)	2–4 gal/100 gal	
Atrazine	crop oil concentrate	1 gal/100 gal	1–2
Basagran ²	crop oil concentrate	2 pt/A	8
	plus nitrogen solution or	1 gal/A	
	ammonium sulfate	2.5 lb/A	
Clarity ³	non-ionic surfactant or	1 qt/100 gal	4
	crop oil concentrate plus	1 gal/100 gal	
	nitrogen solution	2–4 qt/A	
Engenia	see label for details		4
Facet	crop oil concentrate or	1 gal/100 gal	6
	methylated seed oil	1–2 pt/A	
	plus nitrogen solution or	2.5 gal/100 gal	
	ammonium sulfate	8.5 lb/100 gal	
FirstAct	crop oil concentrate or	1 gal/100 gal	1
	non-ionic surfactant	1 qt/100 gal	
	plus ammonium sulfate (optional)	2 lb/A	
Glyphosate (if not fully loaded with formulation adjuvants)	non-ionic surfactant	2 qt/100 gal	6
	plus ammonium sulfate (optional)	8.5–17 lb/100 gal	
Gramoxone SL	non-ionic surfactant or	1 pt/100 gal	0.5
	crop oil concentrate	1 gal/100 gal	
Huskie	non-ionic surfactant	1–2 qt/100 gal	1–6
	plus nitrogen solution or	1–2 qt/A	
	ammonium sulfate (optional)	0.5–1 lb/A	
ImiFlex	non-ionic surfactant or	1 qt/100 gal	1
	crop oil concentrate or	1–2 gal/100 gal	
	methylated seed oil	1–2 gal/100 gal	
	plus ammonium sulfate (optional)	12–15 lb/100 gal	
Maestro ⁴	crop oil concentrate or	1 gal/100 gal	1
	nitrogen solution	1–4 gal/100 gal	
Peak	crop oil concentrate	1 gal/100 gal	4
Permit/Sandea	non-ionic surfactant or	1–2 qt/100 gal	4
	crop oil concentrate	1 gal/100 gal	
	plus nitrogen solution (optional)		

Table 5.38 - Spray Additives and Rainfastness for Burndown and Postemergence Sorghum Herbicides (con't)

Trade Name	Adjuvant(s) ¹	Rate	Rainfastness (hours)
+ 2,4-D, Clarity, or Maestro	non-ionic surfactant		
+ atrazine	crop oil concentrate	1 gal/100 gal	
Roundup/Glyphosate	non-ionic surfactant	2 qt/100 gal	6
	plus ammonium sulfate (optional)	8.5–17 lb/100 gal	
Roundup PowerMAX/Roundup WeatherMAX	no NIS/COC required	–	<1
	ammonium sulfate (optional)	8.5–17 lb/100 gal	
Sharpen	methylated seed oil	1 gal/100 gal	4
	plus nitrogen solution or	2–4 qt/A	
	ammonium sulfate	8.5–17 lb/100 gal	
Yukon	non-ionic surfactant or	1–2 qt/100 gal	4
	crop oil concentrate	1 gal/100 gal	
	plus nitrogen solution or	2–4 qt/A	
	ammonium sulfate (optional)	2–4 lb/A	
Zest	non-ionic surfactant or	1 qt/100 gal	4
	crop oil concentrate	1 gal/100 gal	
	plus ammonium sulfate (optional)	2 lb/A	

¹ In general, non-ionic surfactants should contain at least 80% surface active agent; crop or vegetable oil concentrates should be nonphytotoxic, containing at least 15% approved emulsifier; nitrogen solution is an ammonium-based fertilizer such as 28%, 30%, or 32% N; and ammonium sulfate should be spray-grade dry ammonium sulfate (21-0-0). 10-34-0 also may be used with some products.

² Use crop oil concentrate if lambsquarters, common ragweed, Canada thistle, yellow nutsedge, or field bindweed are present. Include nitrogen solution if velvetleaf is the primary target.

³ Do not use COC after sorghum exceeds 5 inches tall. Adjuvant addition depends on tank-mix partner.

⁴ When Maestro is applied alone, spray additives generally are not needed and may cause excessive leaf burn.

Table 5.39 - Grain Harvest and Forage Restrictions for Sorghum Herbicides

Trade Name	Forage	Grain
	(Days After Treatment)	
2,4-D amine 4S	30	30
2,4-D LVE 4E	30	30
Aatrex, Atrazine 4L/90DF	60 PRE / 45 POST	60 PRE / 45 POST
Aim 2EC	not specified	not specified
Basagran 4S	12	not specified
Bicep II Magnum 5.5EC	60 PRE/ not specified POST	75
Callisto 4SC	not labeled for forage	not specified
Cinch ATZ	60	not specified
Clarity 4S	do not graze or feed prior to mature grain stage	30
Degree Xtra 4.04ME	not labeled for forage	60
Dual II Magnum 7.64EC/Cinch	75	75
Facet L 1.5L	not specified	not specified
FirstAct 0.83EC	not labeled for forage	45
FulTime NXT 4.04EC	60	not specified
Huskie 2.06EC	7	60
ImiFlex 1SL	not specified	not specified
Lexar EZ 3.7SC	not specified	not specified
Lorox 50DF/Linex 4L	90	75
Lumax EZ 3.67SC	45	not specified
Maestro 2EC	45	not specified
Outlook 6EC	60	80
Peak 57WG	30 graze / 40 silage	60
Permit/Sandea 75WG	30	30
Prowl 3.3EC	not labeled for forage	not specified
Prowl H2O 3.8CS	not labeled for forage	not specified
Sandea 75WG	30	30
Sharpen 2.85SC	70	not specified
Starane Ultra 2.8L	40	70
Verdict 5.57EC	70	not specified
Warrant 3CS	60	not specified
Yukon 67.5WDG	30	30
Zest 75WDG	not labeled for forage	30

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Table 5.40 - Comments on Harvest-Aid Herbicides for Sorghum

Treatments are based on broadcast application, not wiper-bar or rope-wick applications.

Trade Name	Common Name	Site of Action Number	Product/A	lb ai/A
Aim 2EC	carfentrazone	14	1 fl oz	0.016

- Use as a harvest aid to desiccate a limited number of broadleaf weed species.
- Application shall be made when the crop is mature and the grain has begun to dry down.
- Use with a crop oil concentrate @ 1% v/v (1 gal/100 gal).
- Can be tank-mixed with glyphosate to improve the spectrum of control.
- Apply in 10 gal/A water.
- Include necessary adjuvants and make sure spray coverage is sufficient, otherwise poor control will result.
- Allow at least three days between application and harvest.

Defol 5	sodium chlorate		4.8 qt	6.0
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- Labeled to dry weeds and to facilitate harvest.
- Apply to sorghum 7 to 10 days before anticipated harvest, when sorghum is mature and ready to harvest.
- Use lower rates when grain moisture is low and weather is clear and dry; use higher rates when conditions for desiccation is poor.
- Apply in at least 5-10 gallons of water by air, and 10 to 20 gallons of water with ground application.

Glyphosate	glyphosate	9	varies with formulation	0.75–1.5 ae
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- Apply glyphosate to sorghum at 30% grain moisture.
- Apply glyphosate in 10–20 gallons of water/A to control weeds that may interfere with harvest or to control perennials such as quackgrass or Canada thistle.
- Allow a minimum of 7 days between application and harvest.
- Do not use on sorghum grown for seed.
- Will not control glyphosate-resistant weeds.
- See Table 5.1 for more information on various glyphosate formulations.

Soybean Weed Management

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Integrated Weed Management

The foundation of soybean weed management is a residual soil-applied herbicide program followed by a timely postemergence herbicide. Make residual soil-applied herbicide applications as close to planting as possible and postemergence applications three to four weeks after planting, when weeds are 4 inches in height or less. This approach relies on effective and timely postemergence weed control. Also, it is not necessary to control all weeds in a field to achieve maximum yield; weeds that germinate with the crop but are controlled in a timely fashion (three to four weeks after planting) will not impact final yields. Weed populations of 20 to 30 weeds per 100 square feet are sufficient to cause yield loss. However, weed populations of 10 plants per 100 square feet will have no impact on final yield. The impact of weed populations between 10 and 20 per 100 square feet is difficult to predict. The decision to treat the field depends on the weed species present, crop vigor, weather conditions, and herbicide cost.

Planting soybean in narrow rows (15 inches or less) will improve overall weed control since the crop canopy will close the rows sooner than wide rows and help to outcompete smaller weeds

Chemical Weed Control

Herbicides are useful tools in most weed management programs. They should be used to supplement, not replace, other methods or tools available. The following are definitions of terms you will find in this and similar publications on herbicides:

Early preplant (EPP) - These herbicides are applied at least 14 days before planting. EPP applications are generally used in no-till systems to control existing vegetation and provide residual control of early emerging weed species.

Preplant - These herbicides are applied from zero to 14 days before planting. Preplant applications are generally used in no-till systems to control existing vegetation and should include residual herbicides.

Preplant Incorporated (PPI) - These herbicides are applied to the soil after primary tillage but before planting, and mechanically mixed with the top 1 to 3 inches of soil with one of a variety of secondary tillage implements.

Preemergence (PRE) - These herbicides are applied to the soil after the crop is planted but before emergence. Rainfall or irrigation is needed to move the herbicide into the zone of weed seed germination before weed emergence for maximum effectiveness. If adequate rainfall for herbicide activation does not occur, a shallow cultivation or rotary hoeing should be done or postemergence herbicide applied to control weeds that have germinated.

Early postemergence (EPOST) - These herbicides are applied "over-the-top" of the crop to control weeds after they have emerged. The herbicide is applied at early stage, usually within 3 weeks of planting.

Postemergence (POST) - These herbicides are applied to "over-the-top" of the crop and weeds after they have emerged.

Residual activity/soil-applied herbicides - These herbicides can be taken up by emerging plant's roots and shoots and injure or kill the plant. All soil-applied herbicides, as well as many postemergence herbicides, have residual activity. Length of residual activity ranges from a few weeks to the entire growing season but is typically 3 to 5 weeks.

Translocated herbicides - These herbicides move throughout the plant and can cause injury to the parts of the plants that do not come in direct contact with the herbicide spray.

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Contact herbicides - These herbicides do not move throughout the plant. They cause injury only to plant parts that come in contact with the spray. These herbicides are usually called as burners as they burn the point of contact. Spray coverage is more critical to maximize effectiveness for contact than translocated herbicides. Therefore, a spray volume of 15 gallons per acre or more is recommended.

Selective herbicides - These herbicides control some species but not others such that weeds can be controlled without injuring the crop.

Non-selective herbicides - These herbicides control a broad spectrum of plant species, including most crops and weeds. These herbicides are generally used with no-tillage production and sprayed prior to planting when control of all plants is required.

Herbicide-resistant Soybean Varieties

Some soybean varieties have been genetically enhanced to withstand herbicide applications that otherwise would injure or kill soybean. Some of these enhanced varieties were developed by genetic engineering, while others were developed through traditional breeding methods. Genetically enhanced varieties allow herbicides to be used that provide a broader spectrum of control than would otherwise be available while reducing the risk of crop injury. Herbicide-resistant soybean varieties include Enlist E3, LibertyLink, LibertyLink GT27, Roundup Ready, STS and Bolt, Xtend, and Xtendflex soybean.

Enlist E3 are genetically engineered (GMO) to allow preemergence and over-the-top application of 2,4-D choline, glyphosate, and glufosinate. Enlist One and Enlist Duo with Colex-D® technology are the only herbicides containing 2,4-D that are labeled for preemergence and postemergence use with Enlist soybean. Refer to <https://www.enlist.com/> for stewardship requirements. In the Mid-Atlantic region, this technology is best suited for burndown application in no-till for control of winter annual weeds, including horseweed/marestail. Over-the-top application and use in double-crop soybean is not encouraged due to greater concern for off-target movement.

LibertyLink soybeans are GMO soybeans developed for over-the-top application of glufosinate (Liberty, Interline, Scout, others), which is a broad-spectrum postemergence herbicide that does not provide residual weed control.

LibertyLink® GT27™ soybeans are GMO soybeans developed to be resistant to glufosinate, glyphosate, and an HPPD (Group 27) herbicide (Alite 27). Both glufosinate and glyphosate provide nonselective, broad-spectrum postemergence weed control. Alite 27 is not labeled for use in LL GT27 soybean in the mid-Atlantic region.

Roundup Ready soybeans were developed to allow over-the-top application of glyphosate for broad-spectrum control of annual broadleaf, grasses, and perennials weeds. Exclusive use of glyphosate has led to the selection of glyphosate-resistant weed biotypes.

Roundup Ready 2 Xtend and XtendFlex soybeans are genetically engineered (GMOs) to allow preemergence and over-the-top application of dicamba. Roundup Ready 2 Xtend soybeans are also Roundup Ready (glyphosate resistant), and XtendFlex soybeans are resistant to glyphosate and glufosinate (Liberty). At the time of printing this publication, no dicamba products are labeled for use as over-the-top applications in Xtend brand soybean varieties.

STS and Bolt soybeans are non-GMO soybeans developed to be resistant to sulfonylurea herbicides (Group 2). STS were developed for their tolerance to Harmony (thifensulfuron) and Classic (chlorimuron). Bolt soybeans were developed for tolerance to Resolve (rimsulfuron). These varieties have the Roundup Ready trait as well. Weed biotypes resistant to Group 2 herbicides are widespread in the region.

Herbicide-resistant Weeds in Soybean

Herbicide-resistant weeds are common in the Mid-Atlantic region. Populations of herbicide-resistant weeds are selected for by repeated use of the same herbicide site of action over a period of time. Resistance is most likely to occur when one specific mode of action is used repeatedly, exclusively, and frequently. Weed species with a very high amount of seed production and genetic variation are more likely to develop resistant populations—for example, common lambsquarters and pigweed species. Resistance management requires use of herbicides with multiple modes of action and integrating mechanical (tillage and cultivation) and cultural weed control (cover crops, narrow row spacing, proper crop fertility, etc.) with chemical weed control.

ALS resistance - Weeds resistant to the Group 2 herbicides in the Mid-Atlantic region include several pigweed species, common and giant ragweed, common chickweed, horseweed, Italian ryegrass, giant foxtail, Johnsongrass, and shattercane.

Glyphosate resistance - Weeds resistant to the glyphosate herbicide (Group 9) in the Mid-Atlantic region include Palmer amaranth and waterhemp, common and giant ragweed, and horseweed. In soybean, these species can be managed with alternative herbicides, including those in Group 14 (PPO herbicides), Group 5 (triazine), Group 10 (requires LibertyLink soybean), or Group 4 (requires Enlist E3 soybean).

PPO resistance - Weeds resistant to Group 14 herbicides include common ragweed. This is not widespread in the region, but there are a few fields with biotypes resistant to Groups 2, 9, and 14. The only options in these fields are preemergence applications of metribuzin; timely postemergence applications of glufosinate in LibertyLink soybean; or 2,4-D (Enlist One or Enlist Duo) applications in Enlist E3 soybean.

Triazine resistance - Weeds resistant to the Group 5 herbicides in the Mid-Atlantic region include common lambsquarters, red-root and smooth pigweed, horseweed, scattered populations of barnyardgrass, giant foxtail, goosegrass, and suspected populations of common ragweed and velvetleaf. Metribuzin is the primary triazine herbicide in many premixes. For triazine-resistant (TR) pigweed control, include a Group 14 (flumioxazin or sulfentrazone) or Group 15 herbicide (acetochlor, dimethenamid, metolachlor, or pyroxasulfone) at planting.

For TR lambsquarters, some of the Group 15 herbicides will help suppress emergence (acetochlor and pyroxasulfone), but they are not as active on lambsquarters as they are on pigweed. Group 14 herbicides provide better control.

No-till Weed Management

Successful production of no-till soybean requires control of existing vegetation at planting (cover crops and weeds) and summer annual weeds that emerge after planting. Existing vegetation is traditionally controlled by the nonselective herbicides, which are often tank-mixed with residual herbicides. However, in many fields the presence of winter annual weeds, such as horseweed, requires an application while these plants are small and more susceptible to nonselective herbicides; this may require an application three to five weeks prior to planting. Some residual herbicides, such as Canopy or Envive, can enhance burndown weed control. However, when the products are applied 14 to 28 days before soybean planting, they provide residual weed control for only a week or two after planting soybean. In fields with weeds that are difficult to control, an application of a nonselective herbicide and 2,4-D should be used early to control winter annuals weeds, and a second application of the residual herbicides should be made at the time of soybean planting. This second application will improve overall weed control.

In no-till situations, burndown herbicides may be required to control weeds or cover crops present at the time of application. See appropriate tables for relative effectiveness of burndown herbicides.

Fall applications are one strategy to manage difficult-to-control winter annuals. Winter annuals are more susceptible in the fall because they are smaller and have not been stressed by cold weather, and air and soil temperatures are higher than in early spring so plants are “actively” growing. However, many species may have a prolonged germination period and seedlings could emerge after a fall application. There has been interest in including a residual herbicide with the nonselective to reduce the likelihood of weed emergence. Products labeled for this use are Authority First, Authority XL, Autumn Super, Canopy EX, Envive, Fierce XLT, Gangster, and Valor XLT.

Local research has not found a residual herbicide that will consistently provide residual control over the winter and early spring, as most fields will still require an additional burndown application before planting. Furthermore, this approach leaves the soil surface bare over the winter and early spring months and therefore exposed to wind and water erosion.

Residual Herbicides That Can Enhance Preplant Burndown Control

Products containing cloransulam (FirstRate), chlorimuron (Classic), and thifensulfuron (Harmony) have some activity on emerged broadleaf weeds and can improve preplant burndown control. However, these products will not control ALS-resistant (Group 2) weeds. When using an herbicide with one of these active ingredients as part of a burndown program, use full labeled rates, follow label recommendations for adjuvants, and apply to small, actively growing weeds. If relying on these herbicides to provide residual weed control, applications should be made within seven to ten days of planting. Prepackage mixtures containing these specific active ingredients include the following:

- Cloransulam (FirstRate): Authority First, Gangster, Sonic, and Surveil
- Chlorimuron (Classic): Authority XL, Canopy DF/ Blend, Canopy EX, Envive, Fierce XLT, Synchrony XP, and Trivence

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- Thifensulfuron (Harmony): Afforia, Canopy EX, Envive, Synchrony
- Flumioxazin (Valor): Afforia, Envive, Fierce/Fierce EZ, Fierce XLT, Gangster, Surveil, and Trivence

Weed Management for Double-Crop Soybean Planted After Wheat or Barley

Weed control for soybean grown after a small grain crop has additional considerations. As with full-season no-till, the fields should be treated to kill all weeds present at the time of planting. This includes winter annual weeds as well as summer annual weeds. The situation may involve controlling weeds that have been cut off and damaged during the small grain harvest operation, leaving little leaf surface to be treated. Local research indicates that paraquat alone or in combination with 2,4-D (in Enlist E3) can be effective at controlling horseweed “stumps” or those “topped” at harvest. Plants maybe present that are resistant to both glyphosate and Group 2 herbicides (e.g., Palmer amaranth and horseweed). Summer annual grass species may be present that require an application of glyphosate or a Group 1 herbicide (Select, etc.). Herbicides that delay soybean planting, such as Sharpen on coarse-textured soils, are seldom used. Local research shows that a combination of glyphosate plus glufosinate (Liberty, Interline, Scout, others) before planting provides good control of many troublesome species without impacting grass control.

Postemergence weed control needs timely application. The late emerging weeds are often not as competitive as weeds emerging in the early summer, plants emerging four weeks after planting soybean often do not impact yields. Since double-cropped soybeans are treated in the late summer, be sure to observe plant back time periods for crop after specific herbicides. A nine-month crop rotation may be too short of an interval to treat soybeans postemergence and allow for an early spring-planted crop.

Management of Herbicide-resistant Horseweed

Many of the horseweed populations in the region are resistant to glyphosate, but many populations in the region are also resistant to the ALS-inhibitors (Classic, FirstRate, etc.). The most economical treatments for control include 2,4-D ester at 2 pints per acre applied to small plants (less than 3-inch rosettes) to ensure effective control. Enlist One or Enlist Duo are effective options when applied to small plants and do not have a planting restriction for Enlist E3 soybean. Elevore is also an effective option, but it has a 14-day planting restriction. Herbicides containing saflufenacil, such as Sharpen, will also provide excellent horseweed control if applied to small plants, but observe plant-back restrictions on coarse soils or at higher rates. A primary goal for horseweed management in soybean should be effective control of emerged plants prior to planting since there are very few options to control it once soybeans have emerged.

Management of Herbicide-resistant Palmer Amaranth and Common Waterhemp

Palmer amaranth control is difficult because (1) it emerges throughout the summer, (2) it grows rapidly, so once the plants emerge there are only a few weeks before it becomes too tall to control, and (3) many of the populations are resistant to glyphosate as well as Group 2 herbicides.

Effective management of Palmer amaranth requires a residual soil-applied herbicide applied within seven to ten days of planting and at the full labeled rates. Applying residual herbicides two weeks or more ahead of planting means there is a limited period of control once soybeans are planted. Postemergence applications must be made timely to small susceptible Palmer amaranth plants—according to various trials, within four weeks after the soil-applied herbicides were applied. The most consistent options have been fomesafen (Reflex or Flexstar GT), Liberty/Interline/Scout/others (with LibertyLink soybean), dicamba (XtendiMax, Engenia, and others) in Xtend soybean, and 2,4-D (Enlist One or Enlist Duo) in Enlist E3 soybean. The postemergence herbicide applications should include a product that provides residual control of Palmer amaranth, such as fomesafen (Reflex), Dual, Outlook, Warrant, or Zidua. In double-cropped soybeans, rotation intervals may limit the use of Reflex.

Table 5.41 - Soybean Herbicides and Their Restrictions

Restricted Use pesticides can be purchased and used only by licensed applicators. To become licensed, contact your state's Department of Agriculture.

Herbicides with Water Quality Advisory have properties that may result in ground or surface water contamination. Do not apply them in areas where soils are permeable or coarse and groundwater is near the surface. Practices should be followed to minimize the potential for runoff in ground water and/or runoff erosion. See the herbicide label for specific restrictions.

Worker Reentry is the minimum time between application and reentry into a treated area. If soil-applied products are injected or incorporated at application time, under certain circumstances the Worker Protection Standard allows workers to enter the treated area if they will have no contact with anything that has been treated. Personal protective equipment is required for early entry to treated areas if contact with treated soil, plants, or water is involved.

Trade Name ¹	Common Name	Site of Action Number	Manufacturer	Restricted-Use Pesticide	Water Quality Advisory	Worker Reentry (hours)
2,4-D amine 4S	2,4-D amine	4	several	–	–	48
2,4-D LVE 4E	2,4-D LVE	4	several	–	–	12
Afforia 50.8WG	flumioxazin + thifensulfuron + tribenuron	14, 2, 2	Corteva	–	–	12
Aim 2EC	carfentrazone ethyl	14	FMC	–	–	12
Antares Complete	sulfentrazone + metribuzin + S-metolachlor	14,5,15	Helena	–	yes	24
Anthem Maxx 4.3SC	pyroxasulfone + fluthiacet	15, 14	MC	–	yes	12
Assure II 0.88E/Targa	quizalofop	1	AMVAC/Gowan	–	–	12
Authority Assist 4L	sulfentrazone + imazethapyr	14, 2	FMC	–	yes	12
Authority Edge 4.25SC	sulfentrazone + pyroxasulfone	14, 15	FMC	–	yes	12
Authority Elite/BroadAxe XC 7E	sulfentrazone + S-metolachlor	14, 15	FMC/Syngenta	–	yes	24
Authority First 70DF/Sonic	sulfentrazone + cloransulam	14, 2	FMC	–	yes	12
Authority MTZ 45DF	sulfentrazone + metribuzin	14, 5	FMC	yes	yes	12
Authority Supreme 4.16SC	sulfentrazone + pyroxasulfone	14, 15	FMC	–	yes	12
Authority XL 70WG/ Authority Maxx 66WG	sulfentrazone + chlorimuron	14, 2	FMC	–	yes	12
Basagran 4S	bentazon	6	Arysta LifeScience	–	yes	12
Boundary 6.5EC	S-metolachlor + metribuzin	15, 5	Syngenta	–	yes	12
BroadAxe XC 7E/Authority Elite	sulfentrazone + S-metolachlor	14, 15	Syngenta/FMC	–	yes	24
Butyrac 200 2E	2,4-DB	4	Bayer CropScience	–	yes	48
Cadet 0.91EC	fluthiacet	14	FMC	–	yes	12

5-136 *Weed Control in Field Crops: Soybeans*

Table 5.41 - Soybean Herbicides and Their Restrictions (cont.)

Trade Name ¹	Common Name	Site of Action Number	Manufacturer	Restricted-Use Pesticide	Water Quality Advisory	Worker Reentry (hours)
Canopy 75DF	chlorimuron + metribuzin	2, 5	Corteva	–	yes	12
Canopy Blend 58.3DG	chlorimuron + metribuzin	2, 5	Corteva	–	yes	12
Canopy EX 29.5WDG/ Cloak 29.5 EX	chlorimuron + tribenuron	2, 2	Corteva/Nufarm	–	–	12
Clarity 4S	dicamba (DGA Salt)	4	BASF	–	yes	24
Classic 25DF	chlorimuron	2	AMVAC	–	–	12
Cloak 75WG	chlorimuron + metribuzin	2, 5	Nufarm	–	yes	12
Cobra 2E	lactofen	14	Valent	–	–	12
Command 3ME	clomazone	13	FMC	–	–	12
Dual II Magnum 7.62EC	S-metolachlor	15	Syngenta	–	yes	24
Durango DMA/Duramax 4S ²	glyphosate	9	Corteva	–	–	4
Elevore 0.572SC	halauxifen	4	Corteva	–	yes	12
Enlist One 3.8SL ⁵	2,4-D choline	4	Corteva	–	–	48
Enlist Duo 3.3SL ⁵	2,4-D choline + glyphosate	4, 9	Corteva	–	–	48
Enlite 48WDG	chlorimuron + flumioxazin + thifensulfuron	2, 14, 2	Corteva	–	–	12
Enversa 3CS	acetochlor	15	Corteva	–	yes	12
Envive 41.3WDG	chlorimuron + flumioxazin + thifensulfuron	2, 14, 2	Corteva	–	–	12
EverpreX 7.62EC	S-metolachlor	15	Corteva	–	–	4
Extreme 2.17L ²	imazethapyr + glyphosate	2, 9	BASF	–	yes	48
Fierce 76WDG/Fierce EZ 3.04SC	pyroxasulfone + flumioxazin	15, 14	Valent	–	yes	12
Fierce MTZ 2.64SC	flumioxazin + metribuzin + pyroxasulfone	14, 5, 15	Valent	–	yes	12
Fierce XLT 62.41WDG	pyroxasulfone + flumioxazin + chlorimuron	15, 14, 2	Valent	–	yes	12
FirstRate 84WDG	cloransulam	2	AMVAC	–	yes	12
Flexstar GT 3.5 2.82L ²	fomesafen + glyphosate	14, 9	Syngenta	–	yes	24
Fusilade DX 2E	fluazifop	1	Syngenta	–	–	12
Fusion 2.56E	fluazifop + fenoxaprop	1, 1	Syngenta	–	–	24
Gramoxone 2SL/3SL	paraquat	22	Syngenta	yes	–	12

Table 5.41 - Soybean Herbicides and Their Restrictions (cont.)

Trade Name ¹	Common Name	Site of Action Number	Manufacturer	Restricted-Use Pesticide	Water Quality Advisory	Worker Reentry (hours)
Harmony SG 50WDG	thifensulfuron	2	Corteva	–	–	4
Harmony Extra SG/Audit 1:1	thifensulfuron + tribenuron	2,2	FMC/UPL	–	yes	12
Intermoc 3.57L	glufosinate + S-metolachlor	10, 5	UPL	–	yes	24
LeadOff 33.4WDG	rimsulfuron + thifensulfuron	2, 2	Corteva	–	–	4
Liberty 2.34SL ³ /Interline 2.34SL/others	glufosinate	10	various	–	–	12
Lorox 50DF/Linex 4L	linuron	7	Nova Source	–	–	24
Marvel 3L	fluthiacet + fomesafen	14, 14	FMC	–	yes	24
Metribuzin 75DF/4L	metribuzin	5	various	–	yes	12
Moccasin MTZ 4.5SC	S-metolachlor + metribuzin	15, 5	UPL	–	yes	24
OpTill 68WG	saflufenacil + imazethapyr	14, 2	BASF	–	yes	12
Optill PRO (co-pack)	saflufenacil + imazethapyr + dimethenamid	14, 2, 15	BASF	–	yes	12
Outlook 6EC	dimethenamid	15	BASF	–	yes	12
Panther MTZ	flumioxazin + metribuzin	14, 5	Nufarm	–	yes	12
Panther Pro	flumioxazin + metribuzin + imazethapyr	14, 5, 2	Nufarm	–	yes	12
Panoflex 50WDG	thifensulfuron + tribenuron	2, 2	Corteva	–	–	12
Permit Plus 74WDG ⁴	halosulfuron + thifensulfuron	2, 2	Gowan	–	–	12
Perpetuo 2.3SC	flumiclorac + pyroxasulfone	14, 15	Valent	–	yes	12
Preview 2:1SC	metribuzin + sulfentrazone	5, 14	UPL	–	yes	12
Poast 1.5E	sethoxydim	1	BASF	–	–	12
Poast Plus 1E	sethoxydim	1	BASF	–	–	12
Prefix 5.3EC	S-metolachlor + fomesafen	15, 14	Syngenta	–	yes	24
Prowl 3.3E / Prowl H ₂ O 3.8CS	pendimethalin	3	BASF	–	–	12
Pursuit 2S	imazethapyr	2	BASF	–	yes	12
Python 80WDG	flumetsulam	2	AMVAC	–	yes	12
Raptor/Beyond Xtra 1S	imazamox	2	BASF	–	–	4
Reflex 2E / Flexstar 1.88E	fomesafen	14	Syngenta	–	yes	24

Table 5.41 - Soybean Herbicides and Their Restrictions (cont.)

Trade Name ¹	Common Name	Site of Action Number	Manufacturer	Restricted-Use Pesticide	Water Quality Advisory	Worker Reentry (hours)
Resource 0.86EC	flumiclorac	14	Valent	–	–	12
Reviton SC	tiafenacil	14	Helm Agro US	–	yes	12
Roundup WeatherMax/ PowerMax 4.5S ²	glyphosate	9	Bayer	–	–	4
Scepter 70DG	imazaquin	2	AMVAC	–	–	12
Select 2E/Max 0.97E	clethodim	1	Valent	–	–	12
Sequence 5.25EW ²	S-metolachlor + glyphosate	15, 9	Syngenta	–	yes	24
Sharpen 2.85SC	saflufenacil	14	BASF	–	yes	12
Sonic 70WG/Authority First 70DF	sulfentrazone + cloransulam	14, 2	Corteva	–	yes	12
Spartan 4F	sulfentrazone	14	FMC	–	yes	12
Spartan Charge	sulfentrazone + carfentrazone	14, 14	FMC	–	yes	12
Storm 4S	acifluorfen + bentazon	14, 6	UPL	–	yes	48
Surveil 48WG	flumioxazin + cloransulam	14, 2	Corteva	–	yes	12
Synchrony XP 28.4WDG ⁴	chlorimuron + thifensulfuron	2, 2	Corteva	–	–	12
Tendovo 4.12 ZC	S-metolachlor + metribuzin + cloransulam-methyl	15, 5, 2	Syngenta	–	yes	12
Treflan 4E, Tri-4, Trific, Trilin	trifluralin	3	Corteva	–	–	12
Tripzin ZC 4ZC	pendimethalin + metribuzin	3, 5	United Phosphorus, Inc.	–	yes	24
Trivence 61.3WDG	chlorimuron + flumioxazin + metribuzin	2, 14, 5	Corteva	–	yes	12
Ultra Blazer 2S	acifluorfen	14	UPL	–	yes	48
Up-Stage 3CS	clomazone	3	UPL	–	yes	12
Valor SX 51WDG/Valor EZ 4SC	flumioxazin	14	Valent	–	–	12
Valor XLT 40.3WDG	chlorimuron + flumioxazin	2, 14	Valent	–	–	12
Verdict 5.57EC	saflufenacil + dimethenamid	14, 15	BASF	–	yes	12
Warrant 3CS	acetochlor	15	Bayer	–	yes	12
Warrant Ultra 3.45CS	acetochlor + fomesafen	14, 15	Bayer	–	yes	24
Zalo 2.52S	quizalofop + glufosinate	1, 10	AMVAC	–	–	12

Table 5.41 - Soybean Herbicides and Their Restrictions (cont.)

Trade Name ¹	Common Name	Site of Action Number	Manufacturer	Restricted-Use Pesticide	Water Quality Advisory	Worker Reentry (hours)
Zidua 85WDG/ Zidua SC 4.17SC	pyroxasulfone	15	BASF	–	yes	12
Zidua PRO 4.09SC	imazethapyr + pyroxasulfone + saflufenacil	2, 15, 14	BASF	–	yes	12
Zone Defense	sulfentrazone + flumioxazin	14, 14	Helm Agro US	–	yes	12

¹ Generic alternatives to some of these products are available. See Table 5.3 (generics table) for additional herbicides that contain these active ingredients.

² May be applied over the top on glyphosate-resistant soybean varieties only.

³ For use on glufosinate-resistant soybean varieties only.

⁴ For use on STS or Bolt soybean varieties only.

⁵ For use on 2,4-D resistant soybean varieties only.

Table 5.42 - Soybean Herbicide Prepackaged Mixes, or Co-Packs, and Equivalents

Trade Name	Components (ai or ae/gal or lb)	If you apply (per acre)	You have applied (ai or ae lb / A)	Site of Action Number	An equivalent tank-mix of
Afforia 50.8 WG	0.408 lb flumioxazin		0.064 lb flumioxazin	14	2 oz Valor SX 51WDG
	0.05 lb thifensulfuron	2.5 oz	0.008 lb thifensulfuron	2	0.25 oz Harmony 50DF
	0.05 lb tribenuron		0.008 lb tribenuron	2	0.25 oz Express 50DF
Antares Complete	0.4 lb sulfentrazone		0.15 lb sulfentrazone	14	4.8 fl oz Spartan 4F
	1.0 lb metribuzin	3 pt	0.38 lb metribuzin	5	8.11 oz mertribuzin 75 DF
Anthem 2.15SE	4.7 lb S-metolachlor		1.76 lb S-metolachlor	15	1.85 pt Dual Magnum 7.62EC
	2.087 lb pyroxasulfone	6 fl oz	0.098 lb pyroxasulfone	15	3.02 fl oz Zidua 4.17SC
Anthem Maxx 4.3SC	0.063 lb fluthiacet		0.003 lb fluthiacet	14	0.42 fl oz Cadet 0.91E
	4.174 lb pyroxasulfone	3 fl oz	0.098 lb pyroxasulfone	15	3.02 fl oz Zidua 4.17SC
Authority Edge 4.25SC	0.126 lb fluthiacet		0.003 lb fluthiacet	14	0.42 fl oz Cadet 0.91E
	1.52 lb pyroxasulfone	6.6 fl oz	0.078 lb pyroxasulfone	15	2.39 fl oz Zidua 4.17SC
Authority Elite 7SE or BroadAxe XC	2.73 lb sulfentrazone		0.141 lb sulfentrazone	14	4.5 fl oz Spartan 4F
	0.7 lb sulfentrazone	28 fl oz	0.153 lb sulfentrazone	14	4.9 fl oz Spartan 4F
Authority First70DF	6.3 lb S-metolachlor		1.38 lb S-metolachlor	15	1.45 pt Dual Magnum 7.62EC
	0.621 lb sulfentrazone	6.45 oz	0.25 lb sulfentrazone	14	8 fl oz Spartan 4F
Authority MTZ 45DF	0.079 lb cloransulam		0.032 lb cloransulam	2	0.6 oz FirstRate 84WDG
	0.18 lb sulfentrazone	16 oz	0.18 lb sulfentrazone	14	5.76 fl oz Spartan 4F
Authority Supreme 4.16SC	0.27 lb metribuzin		0.27 lb metribuzin	5	5.8 oz metribuzin 75DF
	2.08 lb sulfentrazone	7 fl oz	0.114 lb sulfentrazone	14	3.65 fl oz Spartan 4F
	2.08 lb pyroxasulfone		0.114 lb pyroxasulfone	15	3.5 fl oz Zidua 4.17SC

5-140 *Weed Control in Field Crops: Soybeans*

Table 5.42 - Soybean Herbicide Prepackaged Mixes or Co-Packs, and Equivalents (cont.)

Trade Name	Components (ai or ae/gal or lb)	If you apply (per acre)	You have applied (ai or ae lb / A)	Site of Action Number	An equivalent tank-mix of
Authority XL 70WG	0.62 lb sulfentrazone	7.0 oz	0.27 lb sulfentrazone	14	5.8 fl oz Spartan 4F
	0.08 lb chlorimuron		0.035 lb chlorimuron	2	2.1 oz Classic 25DF
Boundary 6.5L	5.25 lb S-metolachlor	2 pt	1.24 lb S-metolachlor	15	1.3 pt Dual Magnum 7.26EC
	1.25 lb metribuzin		0.314 lb metribuzin	5	6.7 oz metribuzin 75DF
Canopy 75DF/Cloak 75WG	0.107 lb chlorimuron	5 oz	0.033 lb chlorimuron	2	2.14 oz Classic 25DF
	0.643 lb metribuzin		0.2 lb metribuzin	5	4.27 oz metribuzin 75DF
Canopy Blend 58.3DG/Cloak 58.3WDG	0.083 lb chlorimuron	6.5 oz	0.033 lb chlorimuron	2	2.14 oz Classic 25DF
	0.5 lb metribuzin		0.2 lb metribuzin	5	4.27 oz metribuzin 75DF
Canopy EX 29.5WDG	0.227 lb chlorimuron	2.2 oz	0.031 lb chlorimuron	2	2 oz Classic 25DF
	0.068 lb tribenuron		0.009 lb tribenuron	2	0.2 oz Express 75DF
Enlist Duo	1.6 lb 2,4-D choline	4.75 pt	0.95 lb ae 2,4-D choline	4	2 pt Enlist One
	1.7 lb ae glyphosate		1.00 lb ae glyphosate	9	28.4 oz Roundup PowerMax
Envive 41.3WDG	0.292 lb flumioxazin	3.5 oz	0.064 lb flumioxazin	14	2.0 oz Valor SX 51WDG
	0.029 lb thifensulfuron		0.006 lb thifensulfuron	2	0.14 oz Harmony 75DF
	0.092 lb chlorimuron		0.020 lb chlorimuron	2	1.3 oz Classic 25DF
Fierce 76WDG	0.335 lb flumioxazin	3 oz	0.063 lb flumioxazin	14	2.0 oz Valor SX 51WDG
	0.425 lb pyroxasulfone		0.08 lb pyroxasulfone	15	2.46 fl oz Zidua 4.17SC
Fierce EZ 3.04SC	1.34 lb flumioxazin	6.0 fl oz	0.063 lb flumioxazin	14	2 oz Valor SX 51WDG
	1.70 lb pyroxasulfone		0.08 lb pyroxasulfone	15	2.46 fl oz Zidua 4.17SC
Fierce MTZ	0.5 lb flumioxazin	1.25 pt	0.078 lb flumioxazin	14	2.45 oz Valor SX 51WDG
	1.5 lb metribuzin		0.234 lb metribuzin	5	4.99 fl oz metribuzin 75DF
	0.64 lb pyroxasulfone		0.10 lb pyroxasulfone	15	3.07 fl oz Zidua 4.17SC
Fierce XLT 62.41WDG	0.3117 lb pyroxasulfone	4 oz	0.78 lb pyroxasulfone	15	2.39 fl oz Zidua 4.17SC
	0.2457 lb flumioxazin		0.061 lb flumioxazin	14	1.93 oz Valor SX 51WDG
	0.0667 lb chlorimuron		0.017 lb chlorimuron	2	1.07 oz Classic 25DF
Flexstar GT3.5L	0.56 lb fomesafen	4.5 pt	0.315 lb fomesafen	14	1.3 pt Reflex 2E
	2.26 lb ae glyphosate		1.28 lb ae glyphosate	9	36.4 fl oz Roundup PowerMax
Fusion 2.67E	2 lb fluazifop	8 fl oz	0.125 lb fluazifop	1	8.0 fl oz Fusilade DX 2E
	0.67 lb fenoxaprop		0.042 lb fenoxaprop	1	0.042 lb fenoxaprop
InterMoc 3.57L	1.07 lb glufosinate	64 fl oz	0.54 lb glufosinate	10	30 fl oz Interline 2.34SL
	2.5 lb S-metolachlor		1.25 lb S-metolachlor	15	1.3 pt Dual Magnum 7.62EC
Marvel 3L	0.117 lb fluthiacet	7.25 fl oz	0.007 lb fluthiacet	14	0.9 fl oz Cadet 0.91E
	2.883 lb fomesafen		0.163 lb fomesafen	14	10.4 fl oz Reflex 2E
Moccasin MTZ	3.35 lb S-metolachlor	42 fl oz	1.10 lb S-metolachlor	15	1.15 pt Dual Magnum 7.62EC
	1.11 lb metribuzin		0.36 lb metribuzin	5	7.68 oz metribuzin 75DF

Table 5.42 - Soybean Herbicide Prepackaged Mixes or Co-Packs, and Equivalentents (cont.)

Trade Name	Components (ai or ae/gal or lb)	If you apply (per acre)	You have applied (ai or ae lb / A)	Site of Action Number	An equivalent tank-mix of
OpTill 68WG	0.502 lb imazethapyr	2.0 oz	0.063 lb imazethapyr	2	4.0 fl oz Pursuit 2L
	0.178 lb saflufenacil		0.022 lb saflufenacil	14	1.0 fl oz Sharpen 2.85SC
Optill PRO (co-pack)	0.502 lb imazethapyr	2 oz	0.063 lb imazethapyr	2	4 fl oz Pursuit 2L
	0.178 lb saflufenacil		0.022 lb saflufenacil	14	1 fl oz Sharpen 2.85SC
Panther MTZ	6.0 lb dimethenamid	10 fl oz	0.47 lb dimethenamid	15	10 fl oz Outlook 6.0EC
	3.0 lb metribuzin	12 fl oz	0.28 lb metribuzin	5	5.97 oz metribuzin 75DF
Panther Pro 4.23SC	0.67 lb flumioxazin	12 fl oz	0.063 lb flumioxazin	14	1.98 oz Valor SX 51WDG
	3.0 lb metribuzin		0.28 lb metribuzin	5	5.97 oz metribuzin 75DF
Perpetuo 2.3SC	0.59 lb flumiclorac	8 fl oz	0.037 lb flumiclorac	14	5.5 fl oz Resource 0.86EC
	1.71 lb pyroxasulfone		0.107 lb pyroxasulfone	15	3.28 fl oz Zidua 4.17SC
Permit Plus	0.662 lb halosulfuron	1.25 oz	0.052 lb halosulfuron	2	1.1 oz Permit 75WDG
	0.078 lb thifensulfuron		0.006 lb thifensulfuron	2	0.128 oz Harmony 75DF
Prefix 5.3EC	4.34 lb S-metolachlor	2 pt	1.05 lb S-metolachlor	15	1.1 pt Dual Magnum 7.62EC
	0.95 lb fomesafen		0.24 lb fomesafen	14	0.95 pt Reflex 2E
Preview 2:1 SC	2.23 lb metribuzin	16 fl oz	0.279 lb metribuzin	5	5.95 oz metribuzin 75DF
	1.12 lb sulfentrazone		0.14 lb sulfentrazone	14	3.0 fl oz Spartan 4F
Sequence 5.25EW	2.25 lb ae glyphosate	3.5 pt	0.98 lb ae glyphosate	9	28 fl oz Roundup PowerMax
	3 lb S-metolachlor		1.31 lb S-metolachlor	15	1.38 pt Dual Magnum 7.62EC
Sonic 70DF	0.621 lb sulfentrazone	6.45 oz	0.25 lb sulfentrazone	14	8 fl oz Spartan 4F
	0.079 lb cloransulam		0.032 lb cloransulam	2	0.6 oz FirstRate 84WDG
Spartan Charge	3.15 lb sulfentrazone	8.5 fl oz	0.21 lb sulfentrazone	14	6.69 fl oz Spartan 4F
	0.35 lb carfentrazone		0.023 lb carfentrazone	14	1.49 fl oz Aim 2EC
Storm 4S	2.67 lb bentazon	1.5 pt	0.50 lb bentazon	6	1.0 pt Basagran 4S
	1.33 lb acifluorfen		0.25 lb acifluorfen	14	1.0 pt Blazer 2S
Surveil 48WDG	0.36 lb flumioxazin	3.5 oz	0.080 lb flumioxazin	14	2.5 oz Valor SX 51WDG
	0.12 lb cloransulam		0.026 lb cloransulam	2	0.5 oz FirstRate 84WDG
Synchrony XP 28.4WDG	0.215 lb chlorimuron	0.375 oz	0.005 lb chlorimuron	2	0.32 oz Classic 25DF
	0.069 lb thifensulfuron		0.0014 lb thifensulfuron	2	0.03 oz Harmony 75DF
Tendovo 4.12 ZC	3.47 lb S-metolachlor	48 fl oz	1.30 lb S-metolachlor	15	1.37 pt Dual Magnum 7.62EC
	0.642 lb metribuzin		0.241 lb metribuzin	5	5.14 oz metribuzin 75DF
Tripzin	0.065 lb chloransulam	44 fl oz	0.024 lb chloransulam	2	0.46 FirstRate 84WDG
	2.9 lb pendimethalin		1.00 lb pendimethalin	3	2.1 pt Prowl H20 3.8CS
	1.1 lb metribuzin		0.38 lb metribuzin	5	8.0 oz metribuzin 75DF

5-142 *Weed Control in Field Crops: Soybeans*

Table 5.42 - Soybean Herbicide Prepackaged Mixes or Co-Packs, and Equivalents (cont.)

Trade Name	Components (ai or ae/gal or lb)	If you apply (per acre)	You have applied (ai or ae lb / A)	Site of Action Number	An equivalent tank-mix of
Trivence 61.3WDG	0.039 lb chlorimuron		0.020 lb chlorimuron	2	1.25 oz Classic 25DF
	0.128 lb flumioxazin	8 oz	0.064 lb flumioxazin	14	2.0 oz Valor 51WDG
	0.446 lb metribuzin		0.22 lb metribuzin	5	4.7 oz metribuzin 75DF
Valor XLT 40.3WDG or Rowel FX	0.3 lb flumioxazin	3.5 oz	0.065 lb flumioxazin	14	2.1 oz Valor SX 51WDG
	0.103 lb chlorimuron		0.022 lb chlorimuron	2	1.44 oz Classic 25DF
Verdict 5.57EC	5.0 lb dimethenamid	5.0 fl oz	0.19 lb dimethenamid	15	4.0 fl oz Outlook 6EC
	0.57 lb saflufenacil		0.022 lb saflufenacil	14	1.0 fl oz Sharpen 2.85SC
Warrant Ultra 3.45CS	2.82 lb acetochlor	3 pt	1.06 lb acetochlor	15	2.8 pt Warrant 3CS
	0.631 lb fomesafen		0.24 lb fomesafen	14	15 fl oz Reflex 2E
Zidua PRO 4.09SC	2.28 lb pyroxasulfone		0.107 lb pyroxasulfone	15	3.28 fl oz Zidua 4.17SC
	1.33 lb imazethapyr	6 fl oz	0.063 lb imazethapyr	2	4 fl oz Pursuit 2L
	0.48 lb saflufenacil		0.022 lb saflufenacil	14	1 fl oz Sharpen 2.85SC
Zone Defense	0.62 lb sulfentrazone	5.0 oz	0.194 lb sulfentrazone	14	6.21 fl oz Spartan 4F
	0.15 lb flumioxazin		0.047 lb flumioxazin	14	1.47 oz Valor SX 51WDG

Table 5.43 - Relative Effectiveness of “Burndown” Herbicides for Control of Weeds in No-Till Full-Season Soybean

Relative effectiveness of herbicides on individual weeds which are commonly present prior to planting soybeans are listed in this table. Ratings are based on labeled application rates and weed size or growth stage; which often means an application is made weeks prior to planting. Delaying applications will result in reduced control. Treatments are rated only for control of vegetation existing at the time of application.

Weed control rating:

10 = 95–100% 9 = 85–95% 8 = 75–85% 7 = 65–75% 6 = 55–65% N = less than 55% or no control

— = not applicable or no local data available + = upper end of rating scale

Herbicide ¹	Site of Action Number	Brome, Downy	Burdock, Common	Chickweed ²	Dandelion	Dock, Curly	Evening Primrose, Cutleaf	Field Violet/Pansy	Fleabanes, Annual	Foxtail, spp.	Garlic, Wild	Geranium, Carolina	Groundsel, common	Hemp, Dogbane, Dewberry, Milkweed, etc.	Henbit/Deadnettle	Horseweed/Marestail ^{2,3}	Lambsquarters	Mustards spp.	Quackgrass Sod	Ragweed, Common ^{2,3}	Smartweed	Thistle, Canada
2,4 (spring-applied) (1 lb ae/a)	4	N	7	6	8	7	9	6	7	N	7	—	6	N	N	8+	9	9	N	9	7	8
Dicamba (spring-applied) (0.5 lb ae/a) ⁴	4	N	7	6	7	8	8	6	7	N	7	—	6	N	N	9	9+	6	N	9	8	8
Elevore	4	N	—	N	—	N	N	N	6	N	6	—	—	—	8+	9	9	6	N	9	—	6
Glyphosate (fall-applied) ³	9	9	8+	9	9	7	7	7	8	—	9	8	9	8+	8	8+ ³	—	9	9	—	—	9
Glyphosate (spring-applied) ³	9	9	7	9	6	6	6	6	7+	9+	8	7	9	7	6	8 ³	9	8	8	9	7	8
Glyphosate + 2,4-D or dicamba (fall-applied) ³	9/4	9	9+	9	9	7	9+	7	9 ⁶	—	9	8	9	9	8+ ⁵	9+ ³	—	9 ⁴	9	—	—	9+
Glyphosate + 2,4-D or dicamba (spring-applied) ³	9/4	9	7+	9	8	7	9	7+	8	9+	8	7	9	7+	8+	9 ³	9	9	9	9	8+	8+
Glyphosate + Metribuzin	9/5	9	7	9	6	6	6	8	8	9	8	7	9	7	8+	8+ ³	9	9	9	9	9	8
Gramoxone	22	7	N	8+	N	N	7	8	6	9	6	8	8+	6	7	7	8	8	6	8	7	6
Gramoxone + 2,4-D or dicamba ³	22/4	7	7	9	7	7	9	8+	7	9	7	8	8+	6	8	8+	9	9	6	9	8+	8
Gramoxone + Metribuzin	22/5	7	6	9	N	N	8	8	6	9	6	9	8+	6	8	8	8	8+	6	9	9+	6

Table 5.43 - Relative Effectiveness of “Burndown” Herbicides for Control of Weeds in No-Till Full-Season Soybeans (cont.)

Herbicide ¹	Site of Action Number	Brome, Downy	Burdock, Common	Chickweed ²	Dandelion	Dock, Curly	Evening Primrose, Cutleaf	Field Violet/Pansy	Fleabanes, Annual	Foxtail, spp.	Garlic, Wild	Geranium, Carolina	Groundsel, Common ³	Hemp, Dogbane, Dewberry, Milkweed, etc.	Henbit/Deadnettle	Horseweed/Marestail ^{2,3}	Lambsquarters	Mustards spp.	Quackgrass Sod	Ragweed, Common ²	Smartweed	Thistle, Canada
Harmony Extra/FirstShot/Audit	2/2	N	6	9 ²	6	8	7	N	N	N	8+	-	9	6	8	8+ ²	9	9	N	6 ²	9+	8
Harmony Extra/FirstShot/Audit + 2,4-D	2/4	N	7	9	9	9	9	7	6	N	8+	-	9	6+	9	8+	9	9	N	9	9	8+
Liberty / Interline/ Scout/others	10	6	6	8	6	-	9	N	8	8	-	-	7	N	7	8	8	8	6	8	8	6
Reviton (2 oz)	14	7	-	8	7	-	8	8	7+	7	-	-	-	-	7	7	8	8	-	8	-	-
Sharpen (1 fl oz)	14	N	N	6	7	-	N	N	7+	N	-	-	8	N	6	8	8	8	N	8	8	6
Sharpen + glyphosate	14/9	9	7	9	8	-	6	6	8	9+	-	-	9	7	8	9 ³	9	9	8	9 ³	9	8
Valor	14	-	N	9	7 ⁵	N	6	8+	N	N	-	-	7	N	7	6	9	8	N	7	7	N

¹ See Table 5.3 (generics table) for additional herbicides that contain these active ingredients.

² Harmony Extra will not control ALS (group 2) resistant chickweed, horseweed/marestail, or common ragweed.

³ Roundup and other glyphosate products are not effective on glyphosate-resistant (Group 9) horseweed/marestail or common ragweed.

⁴ Ratings based on dicamba rate (0.5 lb ae/a) for dicamba resistant soybean.

⁵ Effectiveness is reduced if applied in certain tank-mixes such as Roundup and other glyphosate products with photosynthesis inhibitors such as triazine herbicides, or 2,4-D/dicamba with Gramoxone. May still be tank-mixed for convenience, but burndown is improved if applied separately.

⁶ Based on control in early spring. Emergence of seedlings in the spring will reduce full-season control.

⁷ Valor provides control of germinating dandelion seedling; however, it is weak on dandelion when applied POST.

Table 5.44 - Relative Effectiveness of Herbicides for Control of Common Cash or Cover Crops in the Spring before Planting Soybeans

Cover crop control rating: 10 = 95–100% 9 = 85–95% 8 = 75–85% 7 = 65–75% 6 = 55–65%

L = listed as controlled on herbicide label, but local data are limited

N = less than 55% or no control + = upper end of rating scale — = not applicable or no local data available

Herbicide	Rate (lb ai/acre) ¹	Site of Action Number	Broadleaf species							Grass species					
			Alfalfa ²	Austrian Winter Pea	Clover, Crimson	Clover, Red ²	Clover, White	Vetch, Hairy	Mustards/Radish/Rapeseed	Bluegrass/Timothy ²	Bromegrass/Orchardgrass ²	Ryegrass, Annual	Rye, Cereal	Triticale	Wheat, Winter
2,4-D ester	0.5	4	7+	N	7	8	6	9	8	N	N	N	N	N	N
	1	4	8	N	8	9	7	9+	9	N	N	N	N	N	N
dicamba	0.5	4	9	7	8	9	9	9	6	N	N	N	N	N	N
Elevore	0.004	4	—	7	N	—	—	8	N	N	N	N	N	N	N
glyphosate	0.75	9	6	8	8+	7	6	7	7+	9	8	8	9	9	9
	1.5	9	7	8+	9	7+	7	8	8+	9+	8+	9	9	9	9
paraquat	0.5	22	N	7	8	7	7	7	8	7	6	6	7	7	8
	0.75	22	N	8	9	8	7	8	8+	7+	7	6	8	7+	8+
Liberty, others ⁴	0.59	10	N	8+	9	L	—	9	6	—	N	6	6	7	7
Reviton (2 fl oz)	0.04	14	N	6+	8	—	—	N	—	N	N	N	N	N	N
Sharpen (1 fl oz)	0.02	14	N	6	N	—	—	N	N	N	N	N	N	N	N
Mixtures															
2,4-D ester + dicamba	0.5 + 0.5	4 + 4	9+	7	8+	9	9	9+	8	N	N	N	N	N	N
2,4-D ester + Liberty, others ⁴	0.5 + 0.59	4 + 10	N	9	9	—	—	9+	8	—	N	6	6	6	7
glyphosate + 2,4-D ester	0.75 + 0.5	9 + 4	8+	9	9	8	8	9+	9	9	8	8	9	9	9
glyphosate + dicamba	0.75 + 0.5	9 + 4	9	9	9	9	9	9+	8	9	8	8	9	9	9
glyphosate + Liberty, others ⁴	0.75 + 0.59	9 + 10	—	9	—	—	—	9	6	—	—	8	9	9	9
glyphosate + Reviton	0.75 + 0.02	9 + 14	—	9	8	—	—	8	7	—	8	8+	9	9	9
glyphosate + Sharpen	0.75 + 0.04	9 + 14	6	8	9+	—	—	7	9	9	8	8	9	9	9
paraquat + metribuzin	0.5 + 0.25	22 + 5	7	8+	9+	8+	7	9	8+	9	8	7	8+	7+	8+
paraquat + 2,4-D or dicamba	0.75 + 0.5	22 + 4	7+	8	9	8+	8	9+	9	7	6	6	8	7	8+

Table 5.44 - Relative Effectiveness of Herbicides for Control of Common Cash or Cover Crops in the Spring before Planting Soybeans (cont.)

Herbicide	Rate (lb ai/acre) ¹	Alfalfa ²	Austrian Winter Pea	Clover, Crimson	Clover, Red ²	Clover, White	Vetch, Hairy	Mustards/Radish/Rapeseed	Bluegrass/Timothy ²	Bromegrass/Orchardgrass ²	Ryegrass, Annual	Rye, Cereal	Triticale	Wheat, Winter
¹ 0.75 lb Glyphosate = 32 fl. oz of a 41% glyphosate; 0.5 lb paraquat = 2 pt Gramoxone SL 2.0 or 1.33 pt Gramoxone SL 3.0; see Table 5.2 (glyphosate table) for more information on glyphosate formulations. ² Application in the fall can improve control with some herbicides. ³ Tank mixing clethodim (Select, etc.) or rimsulfuron (Resolve, Basis Blend) with glyphosate has shown improved burndown activity on annual ryegrass cover crop control in university field trials. Consult herbicide label for use guidelines. ⁴ Warm temperatures, high humidity, and bright sunlight improve the performance of Liberty. Weed control may be reduced when applications are made to weeds under stress from drought or cool temperatures.														

Table 5.45 - Comments on “Burndown” Herbicides for No-till Soybeans

In no-till situations, “burndown” herbicides may be required to control weeds or cover crops present at the time of application. See appropriate tables for relative effectiveness of “burndown” herbicides.

Fall applications are one strategy to manage difficult-to-control winter annuals. Winter annuals are more susceptible in the fall because they are (1) smaller; (2) have not been stressed by cold weather; and (3) air and soil temperatures are higher than in early spring so plants are “actively” growing. However, many species may have a prolonged germination period and seedlings could emerge after a fall application. There has been interest in including a residual herbicide with the non-selective to reduce the likelihood of weed emergence. Products labeled for this use are:

Authority First	Authority XL	Autumn Super	Canopy EX
Envive	Fierce XLT	Gangster	Valor XLT

Refer to product label for rates and precautions for fall applications. Note, many of these products have rotational restrictions that require only soybeans can be planted in the spring after fall applications.

University of Delaware and University of Maryland research has not found a residual herbicide that will consistently provide residual control over the winter and early spring, as most fields will still require an additional “burndown” application before planting. Furthermore, this approach leaves the soil surface bare over the winter and early spring months and therefore exposed to wind and water erosion.

Residual Herbicides That Can Enhance Pre-Plant Burndown Control

Products containing cloransulam (FirstRate), chlorimuron (Classic), and thifensulfuron (Harmony) have some activity on emerged broadleaf weeds and can improve pre-plant burndown control. However, these products will not control ALS-resistant (group 2) weeds. When using a herbicide with one of these active ingredients as part of a burndown program, use full-labeled rates, follow label recommendations for adjuvants, and apply to small, actively growing weeds. If relying on these herbicides to provide residual weed control, applications should be made within 7 to 10 days of planting.

Prepackage mixtures containing these specific active ingredients include:

cloransulam (FirstRate)	chlorimuron (Classic)	thifensulfuron (Harmony)	flumioxazin (Valor)
Authority First	Authority XL	Afforia	Afforia
Gangster	Canopy DF/Blend	Canopy EX	Envive
Sonic	Canopy EX	Envive	Fierce/Fierce EZ
Surveil	Envive	Synchrony	Fierce XLT
	Fierce XLT		Gangster
	Synchrony XP		Surveil
	Trivence		Trivence

Table 5.45 - Comments for “Burndown” Herbicides for No-Till Soybean (cont.)

Trade Name	Common Name	Site of Action Number	Product/A	lb ai/A
2,4-D 4L formulations ** (many trade names)	2,4-D	4	0.5–2.0 pt	0.25–1.0 lb ae
Enlist One 3.8SL	2,4-D choline	4	1.5–2 pt	0.71–0.95 lb ae

- For spring applications, the 2 pt rate of 2,4-D has been more effective and more consistent than lower rates. Applications made 30 days preplant have been more effective on horseweed than applications made 14 days preplant.
- Apply 2,4-D ester (LVE) at 2 pt at least 30 days before planting, 1 pt or less at least 7 days ahead of planting or up to 2 pt at least 30 days before planting; some LVE formulations allow a 15-day interval between application and planting soybean (i.e. Salvo, Shredder E-99, Weedone 650).
- Enlist One may be applied through planting of Enlist E3 soybean varieties only.
- 2,4-D amine at 2 pt should be applied 30 days before planting and at 1 pt or less at least 15 days ahead of planting.
- Add 2,4-D to paraquat or glyphosate for added burndown of hard to control broadleaf weeds.
- Use 2,4-D for added control or suppression of mustard spp., plantains, horseweed, and 2,4-D susceptible annual broadleaf weeds.
- Do not apply 2,4-D prior to planting soybeans if you are not prepared to accept the results of soybean injury, including possible loss of stand and yield.
- The risk of injuring sensitive plants via off-target movement is much less when these products are used early burndown prior to planting full-season soybean in the spring compared to burndown applications prior to planting double-crop soybean during the summer months.
- Spray droplet size plays an important role in minimizing off-target movement. Nozzles that produce extremely coarse or ultra coarse droplets while limiting the amount of driftable fine droplets are necessary to limit spray drift. Consult labels for approved nozzles.
- 2,4-D can be difficult to completely remove from spray equipment and residue is capable of injuring sensitive plants. Follow label instructions concerning sprayer cleanout.
- Cotton, grapes, pepper, sweetpotato, tobacco, tomato, watermelon, and many other crops are very sensitive to 2,4-D. Follow application instructions on label to avoid injuring neighboring plants.
- See labels for details on drift management, including recommended nozzles and pressures, wind speed, boom height, temperature inversions, buffers, susceptible plants, and spray equipment cleanout.

Table 5.45 - Comments for “Burndown” Herbicides for No-Till Soybean (cont.)

Trade Name	Common Name	Site of Action Number	Product/A	lb ai/A
Clarity 4S	dicamba DGA Salt	4	0.5–1pt	0.25–0.5 lb ae
<ul style="list-style-type: none"> • Applications made 30 days preplant have been more effective on horseweed than applications made 14 days preplant. • Following application of Clarity and a minimum accumulation of 1 inch of rainfall or overhead irrigation, wait at least 14 days before planting for 0.25 lb ae per acre or less and 28 days for 0.5 lb ae per acre. Do not apply dicamba prior to planting soybeans if you are not prepared to accept the results of soybean injury, including the possible loss of stand and yield. • Add dicamba to paraquat or glyphosate for added burndown of hard-to-control broadleaf weeds. • Use dicamba for added control of horseweed and dicamba-susceptible annual broadleaf weeds. • Dicamba has little to no activity on mustard species including rapeseed and is not recommended for control of these weeds, even when tank-mixed with glyphosate. • The risk of injuring sensitive plants via off-target movement is much less when these products are used early burndown or prior to planting full-season soybean in the spring compared to burndown applications prior to planting double-crop soybean during the summer months. • Spray droplet size plays an important role in minimizing off-target movement. Nozzles that produce extremely coarse or ultra-coarse droplets while limiting the amount of driftable fine droplets are necessary to limit spray drift. Consult labels for approved nozzles. • Dicamba can be difficult to completely remove from spray equipment and residue is capable of injuring sensitive plants. Follow label instructions concerning sprayer cleanout. • <i>Water quality advisory.</i> 				
Canopy 75DF Canopy Blend 58.3DG	chlorimuron + metribuzin	2/5	4–8 oz 5–9 oz	0.026–0.053 0.16–0.32
<ul style="list-style-type: none"> • Metribuzin will enhance the activity of paraquat or glufosinate when used as a tankmixture for burndown weed control. • See comments in preemergence section. 				
Canopy EX 29.5DG	chlorimuron + tribenuron	2	1.1–3.3 oz	0.016–0.047 0.0047–0.013
<ul style="list-style-type: none"> • Apply with glyphosate or Gramoxone to no-till fields, any time after harvest in the fall at 2.2 to 3.3 oz/A up to 14 days before soybean planting, or 1.1 to 2.2 oz/A up to 7 days before soybean planting; consult label for details. • For best results apply to annual weeds less than 3 inches in height or diameter and perennial weeds less than 6 inches in height or diameter. • The addition of 1 pint/A of 2,4-D ester is recommended and is required for some species. • Applications must include either a crop oil concentrate or a nonionic surfactant. Crop oil concentrate is the required adjuvant unless tank-mixing with a product that precludes its use. • On soils with pH 7.0 or less, Canopy EX can be applied at rates of 1.5 - 3.3 oz/A., and will provide residual control or suppression of several winter and summer annual weeds through normal planting dates, but will not provide season-long control. 				

Table 5.45 - Comments for “Burndown” Herbicides for No-Till Soybean (cont.)

Trade Name	Common name	Site of Action Number	product/A	lb ai/A
Elevore 0.572SC	halauxifen-methyl	4	1 oz	0.004 lb ae
<ul style="list-style-type: none"> • Must be applied at least 14 days prior to planting. • Tank-mix with glyphosate or Gramoxone to improve spectrum of control. • Use Elevore for marestalk/horseweed control. 				
Glyphosate¹	glyphosate	9	varies by formulation and acid equivalent	0.36–3 lb ae
<ul style="list-style-type: none"> • Fall applications of glyphosate are better than spring applications for control of orchardgrass sods and quackgrass. Spring applications of may be used to control annual weeds. For control of most annual weeds, apply 0.75–1.13 lb ae/acre. • Glyphosate may be applied in clear liquid nitrogen fertilizers and clear liquid complete-analysis fertilizers. Do not use glyphosate with suspension-type liquid fertilizers. • Use rates vary by product, formulation, and weed size. Higher rates are usually recommended for annual weeds taller than 6 inches. • To aid in the control of marestalk/horseweed, mustard species, common lambsquarters, common ragweed, and other emerged, susceptible broadleaf weeds, 2,4-D or dicamba should be added. • Glyphosate is available in some pre-packaged mixtures, but glyphosate rate may not be adequate for “burndown” control. <p>¹Consult specific product label for active ingredient concentration and application rate; various formulations of this herbicide are available (e.g., 1 qt/A glyphosate = 22 fl oz/A WeatherMax).</p>				
Gramoxone SL 2.0	paraquat	22	2.0–4.0 pt	0.48–1.0
Gramoxone SL 3.0			1.3–2.7 pt	0.49–1.0
<ul style="list-style-type: none"> • Use appropriate precautions when handling paraquat to minimize exposure to the herbicide. • Apply in 20 to 60 gallons of water per acre; increase gallonage as density of stubble, crop residue or weeds increases. • Rate is dependent on weed size (see label). Paraquat may not control weeds taller than 6 inches. • 2,4-D at 0.5-0.75 pint per acre may be added to this program for additional control of marestalk (horseweed), common lambsquarters, common ragweed, and other emerged, susceptible broadleaf weeds. • Phosphate-containing liquid fertilizers diminish paraquat activity. • The addition of metribuzin will improve overall control with paraquat (this includes Glory, TriCor, Boundary, Canopy, Trivence, and Authority MTZ). <p>Paraquat Use Restrictions</p> <ul style="list-style-type: none"> • <i>Restricted Use Pesticide.</i> • Only certified applicators, who successfully complete the paraquat-specific training, can mix, load or apply paraquat. • Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed; registered technicians cannot apply. • Required training link (http://usparaquattraining.com); certified applicators must repeat training every three years. 				

5-150 Weed Control in Field Crops: Soybeans

Table 5.45 - Comments for “Burndown” Herbicides for No-Till Soybean (cont.)

Trade Name	Common Name	Site of Action Number	product/A	lb ai/A
Liberty 2.34 SL	glufosinate	10	32–43 oz	0.59–0.79
<ul style="list-style-type: none"> • Liberty may be applied as a burndown treatment prior to the planting or emergence of any soybean variety. • Apply a minimum of 32 fl oz/A to young, actively growing weeds; burndown and in-crop applications may not exceed 87 fl oz/A per season. • Warm temperatures, high humidity, and bright sunlight improve the performance of Liberty. Weed control may be reduced when applications are made to weeds under stress from drought or cool temperatures. • Applications should be made between 2 hours after sunrise and 1 hour before sunset to avoid the possibility of reduced weed control. • Liberty performs better as a POST herbicide or burndown for double-cropped soybeans compared to burndown applications in April. • Liberty must be applied with ammonium sulfate at the rate of 3 lb/A. • Uniform, thorough spray coverage is necessary to achieve consistent weed control; do not use nozzles that produce large droplets; use at least 15 gal/A, 20 gal/A if dense vegetation is present. 				
Reviton	tiafenacil	14	1–3 oz	0.022-0.066
<ul style="list-style-type: none"> • Reviton may be applied as a burndown treatment prior to soybean planting. • Apply as a broadcast spray using conventional low-pressure ground spray equipment. • The maximum single application rate is 3 oz/A. DO NOT exceed 6 oz/A/year. • DO NOT reapply within 14 days. • No plant-back restriction at 1 oz. 7 day plant-back restriction at 2 to 3 oz. • Use higher rate for dense and/or mature weed infestations. • <i>Water quality advisory.</i> 				
Sharpen 2.85SC	saflufenacil	4	1.0–2.0 oz	0.022–0.044
<ul style="list-style-type: none"> • Sharpen may be applied as a burndown treatment from 44 days early preplant through preemergence timings as directed on the label. • Apply Sharpen in a typical glyphosate or glufosinate burndown herbicide program to increase weed spectrum, including glyphosate-resistant horseweed; 1.5 oz provides more consistent horseweed control than lower rates. • The label requires use of methylated seed oil (MSO) plus a nitrogen source such as ammonium sulfate (AMS). • On coarse-textured soils with less than 2% organic matter: a minimum of 30 days between application of 1 to 1.5 oz of Sharpen and soybean planting is required; minimum of 44 days between application of 2.0 oz of Sharpen and soybean planting. • All other soils: no waiting period of 1 oz of Sharpen is applied; minimum of 14 days between applications of 1.5 oz of Sharpen and planting on all other soil types; and 30 days if 2 oz of Sharpen is used. • Do not apply during soybean cracking stage or after emergence as severe crop damage will occur. Control of emerged grasses will require adding an additional herbicide. • Do not apply Sharpen with other Group 14 herbicides such as sulfentrazone or flumioxazin as a tank-mix or sequential application within 30 days or crop injury may result with coarse-textured soils with less than 2% o.m.; and a minimum of 14 days on all other soil types (see label). • Local research indicates limited residual control with Sharpen at rates and use pattern for soybeans. • Sharpen is a Group 14 herbicide and due to concerns for long-term viability of this herbicide mode of action, extension specialists in the Mid-Atlantic region recommend not using it every year. This mode of action has greater utility in soybeans than corn and especially for control of glyphosate-resistant horseweed (marestail). As such, we suggest that Sharpen and other saflufenacil-containing products (e.g., Verdict, OpTill) be used in soybean and only in alternate years. The use of Sharpen in continuous corn should also be limited to every other year (alternating years with HPPD-containing herbicide [Group 27]). 				

Table 5.45 - Comments for “Burndown” Herbicides for No-Till Soybean (cont.)

Trade Name	Common Name	Site of Action Number	product/A	lb ai/A
Valor SX 51WDG	flumioxazin	14	1–2.5 oz	0.032–0.08 lb

- Valor may be included in a typical burndown herbicide program to enhance the speed of burndown and increase weed spectrum.
- Valor has fair to good postemergence activity on field pansy/violet.
- Premixes containing Valor: Valor XLT contains chlorimuron (Classic) and can also be used as a PRE/burndown treatment; Fierce XLT is similar to Valor XLT but also contains pyroxasulfone (Zidua); Envive contains chlorimuron (Classic) and thifensulfuron (Harmony); Gangster or Surveil contain (cloransulam (FirstRate).

¹ See Table 5.1 (glyphosate formulations) for information on various formulations of this herbicide.

Table 5.46 - Water Solubility and Longevity of Soil-Applied Herbicides

Solubility (parts per million; ppm): How many microliters of the herbicide will dissolve in 1 liter of water. The less soluble the herbicide, the more moisture (rain or irrigation) is needed to activate the herbicide and move it into the root zone. Solubility is used as a guideline for rainfall or irrigation required within a short time after application. Moisture needed also depends on the soil moisture at time of application.

Relative moisture levels to move herbicide into the soil to achieve optimum level of control.

Relative Moisture to Activate	ppm	Estimate Water to Activate*
Low	>500 ppm (very soluble)	0.33 inch
Medium	250-500 ppm	0.33-0.5 inch
High	100-250 ppm	0.5-0.75 inch
Very High	<100 ppm	>0.75 inch

*More water (additional irrigation) maybe necessary if soil is dry at time of application, soils with higher clay content, or high plant residues are present.

Relative duration of residual control is for comparison only. Based on herbicide half-life (length of time it takes for half the herbicide to break down). Herbicide breakdown results from chemical and/or microbial activity. Since the speed of breakdown is affected by a number of factors including soil pH, soil temperature, and soil moisture, duration can vary for herbicides based on the specific conditions. Residual activity is not the same as herbicide carryover. Duration of residual control assumes 1) good activation; 2) no excessive rain or irrigation; and 3) weed species are sensitive to the herbicide(s) applied.

Table 5.46 - Water Solubility and Longevity of Soil-Applied Herbicides (cont.)

Trade Name	Solubility (ppm)	Relative Moisture Amount Required to Activate	Duration of Residual Control
Classic	pH 5: 11	Very High	4-5 weeks
	pH 6.5: 450	Medium	
	pH 7: 1,200	Low	
Command	1,100	Low	2-4 weeks
Dual Magnum	530	Medium	4-5 weeks
Express	pH 5: 48	Very High	1-2 weeks
	>pH 7: >2040	Low	
FirstRate	pH 5: 3	Very High	2-4 weeks
	pH 7: 184	High	
Harmony SG	pH 5: 223	High	1-2 weeks
	>pH 7: >2,240	Low	
Lorox / Linex	75	Very High	4-5 weeks
Metribuzin	1,200	Low	4-5 weeks
Outlook	1,174	Low	2-4 weeks
Prowl / other pendimethalin formulations	1	Very High	4-5 weeks
Pursuit	1,400	Low	4-6 weeks
Python	5,600	Low	4-6 weeks
Reflex / Flexstar	600,000	Low	2-4 weeks
Sharpen	pH5 : 30	Very High	1-3 weeks
	pH7 : 2100	Low	
Spartan	780	Low	4-6 weeks
Treflan/other formulations	1	Very High	4-5 weeks
Valor SX	2	Very High	4-5 weeks
Warrant/Enversa	223	Medium	4-5 weeks
Zidua	3.49	Very High	4-5 weeks

Table 5.46 - Water Solubility and Longevity of Soil-Applied Herbicides (cont.)

Premix	Constituents
Afforia	Valor SX, Harmony SG, Express
Antares Complete	Spartan, metribuzin, Dual Magnum
Anthem / Anthem Maxx	Cadet, Zidua
Authority Edge	Spartan, Zidua
Authority Elite / BroadAxe XC	Spartan, Dual Magnum
Authority First / Sonic	Spartan, FirstRate
Authority MTZ	Spartan, metribuzin
Authority Supreme	Spartan, Zidua
Authority XL	Spartan, Classic
Boundary	Dual Magnum, metribuzin
Canopy DF / Blend	Classic, metribuzin
Canopy EX	Classic, Express
Envive	Classic, Valor SX, Harmony SG
Fierce / Fierce EZ	Valor SX, Zidua
Fierce MTZ	Valor, Zidua metribuzin
Fierce XLT	Zidua, Valor, Classic
Gangster / Surveil	Valor SX, FirstRate
Moccasin MTZ	Dual Magnum, metribuzin
OpTill	Sharpen, Pursuit
OpTill PRO	Sharpen, Pursuit, Outlook
Panther MTZ	Metribuzin, Valor
Panther Pro	Metribuzin, Valor, Pursuit
Permit Plus	Harmony SG, Sandea
Prefix	Dual Magnum, Reflex
Preview 2:1	Metribuzin, Spartan
Sequence	Dual Magnum, glyphosate
Synchrony XP	Classic, Harmony SG
Tendovo	Dual Magnum, metribuzin, FirstRate
Tripzin	Prowl, metribuzin
Trivence	Classic, Valor SX, metribuzin
Valor XLT	Valor SX, Classic
Verdict	Sharpen, Outlook
Warrant Ultra	Warrant, Reflex
Zidua Pro	Zidua, Pursuit, Sharpen
Zone Defense	Spartan, Valor

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Table 5.47 - Relative Effectiveness of Soil-Applied Herbicides

Ratings are based on labeled application rates for the soil type and timely rainfall or irrigation to incorporate the herbicides. Ratings are also based on weed control 3 to 4 weeks after application. Length of effective control (residual control) beyond 4 weeks after application often declines. Results may differ with variations in soil type, temperature, rainfall, soil moisture, soil organic matter, and soil pH. For ratings on herbicide combinations not listed, see the component parts.

Weed control rating:

10 = 95–100%
 9 = 85–95%
 8 = 75–85%
 7 = 65–75%
 6 = 55–65%
 N = less than 55% or no control
 + = upper end of rating scale

Crop tolerance:

E = excellent; almost never any crop injury observed
 VG = very good; on rare occasion is crop injury observed
 G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., seedling depth, seed slit closure, herbicide rate and application timing, adjuvants)
 FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions
 F = fair; some crop injury is commonly observed

Trade Name	Site of Action Number	Grasses														
		Barrydgrass	Bermudagrass	Broadleaf signalgrass	Crabgrass	Fall Panicum	Foxtails	Goosegrass	Johnsongrass (Seedling)	Johnsongrass (Rhizome)	Quackgrass	Shattercane	Texas panicum	Volunteer Corn	Wirestem Muhly	Yellow Nutsedge
Command ¹	13	8+	6	9+	8+	9	9	9+	8	N	7	7	8	7	N	N
Dual products	15	9	N	8	9	8+	9	9+	6	N	N	6	6	N	N	8
Lorox / Linex	7	6	N	N	6	N	N	7	6	N	N	6	N	N	6	6
Metribuzin	5	6	N	N	6	N	N	6	6	N	N	6	N	N	N	6
Outlook	15	9	N	7	8+	8+	9	9	6	N	N	6	6	N	N	7+
Prowl	3	8+	N	9	8+	9	8+	9	7	N	N	7	8	N	N	6
Pursuit	2	8	N	N	7	7	8	–	6	N	N	6	–	6	N	7
Treflan ¹	3	9	N	9	9	9	9	9	8	7	7	8	8+	6	N	N
Warrant/Enversa	15	8+	N	7	8	8	8+	8+	6	N	N	N	N	N	N	6
Zidua	15	9	N	8+	9	8+	9	9+	6	N	N	6	7	N	N	6
Mixtures																
Anthem Maxx	14/15	9	N	8+	9	8+	9	9+	6	N	N	6	7	N	N	6
Authority Edge	14/15	8+	N	8	8+	8	8+	9	6	N	N	6	6	N	N	7
Authority Elite / BroadAxe XC	14/15	9	N	8	9	8+	9	9+	6	N	N	6	6	N	N	7
Authority Supreme	14/15	9	N	8+	9	8+	9	9+	6	N	N	6	7	N	N	7
Boundary	5/15	8	N	6	8	7	8	8+	N	N	N	N	N	N	N	7
Canopy DF / Canopy Blend	2/5	6	N	6	6	N	N	–	N	N	N	8	N	7	N	7
Fierce / Fierce EZ / Fierce XLT	14/15/ 14/15/(2)	9	N	8	9	8+	9	9+	6	N	N	6	7	N	N	6
OpTill	2/15	7	N	N	7	6	7	–	6	N	N	6	6	6	N	6
Prefix	14/15	8	N	6	8	7	9	8+	N	N	N	N	N	N	N	7
Tendovo	15/5/2	9	N	8	9	8+	9	9+	6	N	N	6	6	6	N	8
Warrant Ultra	14/15	8+	N	7	8	8	8+	8+	6	N	N	N	N	N	N	6
Zidua PRO	15/2/14	9	N	8+	9	8+	9	9+	6	N	N	6	7	N	N	7

¹ Command 4E, Treflan and trifluralin require incorporation; Command 3ME may be applied preemergence and not incorporated.

Table 5.47 - Relative Effectiveness of Soil-Applied Herbicides on Individual Weed Species (cont.)

Broadleaves																		
Trade Names	Herbicide Group (Mode of Action)	Burcucumber	Cocklebur	Horseweed / Marestalk ¹	Jimsonweed	Lambsquarters ²	Morningglory, Annual	Nightshade, Eastern Black	Palmer Amaranth / Waterhemp ¹	Pigweed ²	Ragweed, Common ³	Ragweed, Giant	Sida, Prickly	Smartweed	Spurred Anoda	Velvetleaf	Soybean Tolerance / Med. Soils	Soybean Tolerance / Coarse Soils
Command ⁴	13	N	7+	N	9	9+	N	6	6	6	8	N	8+	8+	9+	9+	E	E
Dual products/ Cinch	15	N	N	N	N	6	N	7+	8+	8	6	N	N	N	N	N	E	E
FirstRate	2	N	8+	9 ²	8	9	8	N	N	9 ²	9 ³	8	7	8	9	8+	E	E
Lorox / Linex	7	N	7+	7	7	8+	N	7	7	8	8	N	7+	9	N	7	G	FG
Metribuzin	5	6	8	8+	8	9	N	N	8+	8+	7	N	8+	9	7	8	G	FG
Outlook	15	N	N	N	N	6	N	7+	8	8	6	N	N	6	N	N	VG	VG
Prowl	3	N	N	N	6	9	N	N	8	8	N	N	N	8	N	8+	VG	G
Pursuit	2	6	8	-	8	8	7	8	N	9 ²	7+ ³	6	8	9	-	8	VG	VG
Reflex	14	N	8	N	8	8	7	8	9	9	9	6	7	7	N	6	E	VG
Spartan	1	N	N	8+	6	8+	9	8	9	9	7+	6	6	7	-	8	VG	VG
Treflan ⁴	3	N	N	N	N	9	N	N	9	9	N	N	N	6	N	7+	E	E
Valor	14	N	6	8+	8	9	7+	9	9	9	7+	6	8	7	8	7	VG	G
Warrant/Envers	15	N	N	N	N	6	N	7	8	8	6	N	N	N	N	N	VG	G
Zidua	15	N	N	N	7	8	N	8	9	9	7	6	6	7	N	6	VG	VG
Mixtures																		
Afforia	2/2/14	N	6	8+	8	9	7+	9	9	9	8	7	8	7	8	7	G	FG
Anthem / Anthem Maxx	14/15	N	N	N	7	8	N	8	9	9	7	6	6	7	N	6	VG	VG
Authority Edge	14/15	N	6	8+	7	9	8	8+	9	9	7	6	6	7	N	7	VG	VG
Authority Elite / BroadAxe XC	14/15	N	6	8+	6	9	7	7+	8	8	6	6	6	7	N	7	VG	VG
Authority First / Sonic	2/14	N	8	8+	8	8+	8	8	9	9	8+	7	7+	7+	9	8	VG	VG
Authority Supreme	14/15	N	6	8+	7	8+	7	8	9	9	7	6	6	7	N	7	VG	VG
Authority MTZ	5/15	6	8	8+	8+	9	8	8	9	9	8	N	8+	9	7	8	G	FG
Authority XL	2/14	7	8+	8+	8	8+	9	8	9	9	8	6	8	8+	8	8	G	FG
Boundary	5/15	N	7+	8+	7+	8+	N	6	8+	8+	7	N	8+	8+	7	7	G	G
Canopy DF / Canopy Blend	2/5	7	9	8+	9	9	7+	6	9	9+	7+	8	9	9	8	9	FG	F
Envive	2/2/14	7	8+	8+	9	9	7+	9	9	9	8	7	8+	8+	8	8+	G	F
Fierce / Fierce EZ	14/15	N	6	8+	8	9	7+	9	9	9	7	6	8	7	8	7	G	F
Fierce XLT	2/14/15	7	8+	8+	9	9	8	9	9	9	8	8	8+	8+	8	8+	G	F

Table 5.47 - Relative Effectiveness of Soil-Applied Herbicides on Individual Weed Species (cont.)

Broadleaves																		
Trade Names	Herbicide Group (Mode of Action)	Burcucumber	Cocklebur	Horseweed / Marestalk ¹	Jimsonweed	Lambsquarters ²	Morningglory, Annual	Nightshade, Eastern Black	Palmer Amaranth / Waterhemp ¹	Pigweed ²	Ragweed, Common ³	Ragweed, Giant	Sida, Prickly	Smartweed	Spurred Anoda	Velvetleaf	Soybean Tolerance / Med. Soils	Soybean Tolerance / Coarse Soils
Gangster (co-pack)/Surveil	2/14	N	8+	8+	8	9	8	9	9	9	9	8	8	8	8	8+	G	F
OpTill	2/14	6	8	6	8	8	7	8	6	9	7+	6	8	9	N	8	G	G-F
Prefix	14/15	N	N	N	6	6	6	7+	8+	8+	7	N	6	6	N	6	E	E
Tendovo	15/5/2	6	8+	8+	8	9	9	7+	9	8+	9 ³	8	8+	9	9	8+	G	FG
Trivence	2/5/14	7	9	8+	9	9	8	9	9	9	8	7	9	9	8	9	G	F
Valor XLT	2/14	7	8+	8+	9	9	7+	9	9	9	8	7	8+	8+	8	8+	G	F
Verdict	14/15	N	N	N	N	7	7+	7	7	7	6	N	N	6	N	N	G	- ⁵
Warrant Ultra	14/15	N	N	N	8	8	7	8	8+	8+	8	6	7	7	N	6	VG	G
Zidua PRO	15/2/14	N	N	8+	7	8+	7	8	9	9	7	6	6	7	N	8	VG	- ⁵

See Table 5.3 (generics table) for additional herbicides that contain these active ingredients

¹ Biotypes resistant to Group 2 herbicides are common in the region; do not rely on Group 2 herbicides to provide effective control.

² Triazine-resistant (Group 5) lambsquarters and pigweed are common in the region; metribuzin will not control these biotypes.

³ Common ragweed biotypes resistant to Group 2 herbicides have been confirmed in Delaware, Maryland, and Virginia.

⁴ Command 4E, Treflan, and trifluralin require incorporation; Command 3ME may be applied preemergence and not incorporated.

⁵ Not labeled for application on this soil type.

Table 5.48 - Comments on Preplant or Preemergence Herbicides for Conventional, Minimum, or No-Till Soybeans

See specific product label to determine correct rate for soil type, tillage practices, and weed species found in each field.

Mechanical incorporation reduces the need for timely rainfall after application and may improve control of certain weeds. Mechanical incorporation will improve weed control when no rainfall or irrigation occurs within 7 to 10 days after planting.

In no-till situations, “burndown” herbicides may be required to control weeds or cover crops present at time of application.

EPP= early preplant means application at least 7 days prior to plant; PPI= applied to conventionally tilled soil than mechanically incorporated; PRE= preemergence (applied before the crop has emerged).

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Anthem Maxx 4.3SC	pyroxasulfone + fluthiacet	15 14	EPP, PPI, or PRE	2–5.5 oz	0.04–0.088

- Fluthiacet (Cadet) does not provide any residual weed control.
- See Zidua entry for more comments.

Authority products	sulfentrazone	14	EPP, PPI, or PRE	varies	0.132–0.309
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- Spartan contains the single active ingredient sulfentrazone, but products that include sulfentrazone are branded as “Authority”; several premixed products contain sulfentrazone (Authority/Spartan).
- Each of these products contains different active ingredients and/or ratios. See various tables in this guide and product labels for additional details about these products.
- Rates are based on region, soil type, and soil organic matter. Applications made after soil-cracking occurs or crop emergence will result in severe crop injury; soybean stunting may occur if excessive rainfall occurs after application but before soybeans emerge.
- Sulfentrazone provides good control of yellow nutsedge.
- Observe labeled rotational crop restrictions for all products containing sulfentrazone.
- Sulfentrazone becomes more available when soil pH exceeds 7.0, increasing the risk of soybean injury.
- Refer to label regarding applications with/or in sequence with Sharpen and other group 14 herbicides.
- Products that contain sulfentrazone include Antares Complete (Authority + metribuzin + Dual), Authority Assist (Authority + Pursuit), Authority Edge (Authority + Zidua), Authority Elite/BroadAxe XC (Authority + Dual), Authority First/Sonic (Authority + FirstRate), Authority MTZ (Authority + metribuzin), Authority Supreme (Authority + Zidua), Authority XL/Maxx (Authority + Classic), and Spartan Charge (Authority + Aim).
- *Water quality advisory.*

Authority Edge 4.25SC	sulfentrazone + pyroxasulfone	14 15	EPP, PPI, or PRE	5.9–15.7 fl oz	0.126–0.335 0.070–0.186
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- See entries for Authority and Zidua entries for more comments.
- *Water quality advisory.*

Authority Elite 7E or BroadAxe XC	sulfentrazone + S-metolachlor	14 15	EPP, PPI, or PRE	19.0–38.7 fl oz	0.104–0.153 0.94–1.87
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- Authority Elite and BroadAxe XC are the same products.
- See Dual and Authority entries for more comments.
- *Water quality advisory.*

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Table 5.48 - Comments on Preplant or Preemergence Herbicides for Conventional, Minimum, or No-Till Soybeans (cont.)

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Authority First 70DF / Sonic	sulfentrazone + cloransulam	14 2	EPP, PPI, or PRE	6.45–8 oz	0.25–0.31 0.032–0.04
<ul style="list-style-type: none"> • Authority First and Sonic are identical products. • See entries for FirstRate and Authority for more comments. 					
Authority MTZ 45WDG	sulfentrazone + metribuzin	14 5	EPP, PPI, or PRE	12–18 oz	0.135–0.202 0.202–0.304
<ul style="list-style-type: none"> • See Authority and metribuzin entries for comments. • <i>Water quality advisory.</i> 					
Authority Supreme 4.16SC	sulfentrazone pyroxasulfone	14 15	EPP, PPI, or PRE	6–11.5 fl oz	0.098–0.187 0.098–0.187
<ul style="list-style-type: none"> • See entries for Authority and Zidua entries for more comments. • <i>Water quality advisory.</i> 					
Authority XL 70WG	sulfentrazone + chlorimuron	14 2	EPP, PPI, or PRE	3.0–9.0 oz	0.116–0.347 0.015–0.045
<ul style="list-style-type: none"> • Authority XL is a premix of Authority (sulfentrazone) + Classic (chlorimuron) and can be used as a burndown and/or preemergence application. • For burndown, Authority XL may be tankmixed with glyphosate, Gramoxone, or 2,4D plus COC or MSO to increase activity. • See Authority entry for more comments. 					
Boundary 6.5EC	S-metolachlor + metribuzin	15 5	EPP, PPI, or PRE	1.2–3 pt	0.74–1.9 0.188–0.469
<ul style="list-style-type: none"> • See metribuzin and Dual entry for comments. • The amount of Dual in this premix is low compared to amount recommended when applied by itself. • <i>Water quality advisory.</i> 					
Canopy 75DF Canopy Blend 58.3 WDG	chlorimuron + metribuzin	2/5	EPP, PPI, or PRE	4.0–7.0 oz 5.1–9.0 oz	0.027–0.047 0.16–0.28
<ul style="list-style-type: none"> • Apply prior to soybean emergence. Do not use on sand or any soil with less than 0.5% organic matter • Do not apply more than 2.25 oz/A if soil pH is 7.0 or higher. • Observe rotational crop restrictions. Do not use on soils with a pH greater than 6.8, or carryover injury may result the following year. • Observe labeled rotational crop restrictions for all products containing chlorimuron (Classic). • Adding chlorimuron to metribuzin improves control of common ragweed, cocklebur, velvetleaf, jimsonweed, and annual morningglory. • <i>Water quality advisory.</i> 					

Table 5.48 - Comments on Preplant or Preemergence Herbicides for Conventional, Minimum, or No-Till Soybeans (cont.)

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Command 3ME	clomazone	13	EPP or PRE	1.33–2.67 pt	0.5–1.0
<ul style="list-style-type: none"> • Command 3ME must be used as a preemergence soil-applied treatment without incorporation. • Do not apply within 1,200 feet of towns; residential areas; commercial fruit, nut, or vegetable production; or commercial greenhouses or nurseries. • Do not apply during temperature inversions or when wind speed is greater than 10 mph. Apply in a minimum spray volume of 10 gal/A. Use coarse sprays to reduce drift. • Observe labeled rotational crop restrictions. 					
Dual II Magnum 7.62EC					
Dual II Magnum 7.64EC	S-metolachlor	15	EPP, PPI, or PRE	1.0–2.0 pt	0.95–1.9
<ul style="list-style-type: none"> • Dual is similar in activity to Outlook, Zidua, and Warrant. Dual II Magnum contains a crop safening agent for corn. • For early preplant applications or fields with heavy surface plant residue, Dual rate may need to be increased by up to 20%. • Incorporation improves control of yellow nutsedge. • Dual can be applied after soybean emergence, but Dual will not control emerged weeds. • For extended residual or control of heavy weed infestations up to 2.6 pt/A is allowed. • DO NOT exceed 3.71 lb ai/A/year of any S-metolachlor containing product • <i>Water quality advisory.</i> 					
Inversa 3CS	acetochlor	15	EPP or PRE	1.25–2qt	0.94–1.5
<ul style="list-style-type: none"> • Encapsulated acetochlor for enhanced crop safety and residual control of weeds before they germinate. • Can be applied preplant through R2. POST application should be made after soybeans are completely emerged but before soybeans reach growth stage R2. • The optimum timing and rate of application is when soybeans are V2-V3 at 1.5 qts/acre. • Weeds emerged at the time of application are not controlled by this product. • <i>Water quality advisory.</i> 					
Envive 41.3DG	flumioxazin +	14	EPP or PRE	2.5–5.3 oz /A	0.044–0.094
	chlorimuron +	2			0.015–0.031
	thifensulfuron	2			0.004–0.009
<ul style="list-style-type: none"> • Do not mechanically incorporate into the soil after application. • Can be tank-mixed with products such as Command or pendimethalin for improved grass control. • If Envive is tank-mixed with group 15 herbicides and applied within 14 days of planting, plant under no-till or minimum tillage conditions on wheat stubble or field corn stubble. • Products containing flumioxazin have specific tank-cleaning instructions on the label or in technical bulletins to help avoid contaminant injury from spray tank residues. • Envive can to provide some burndown and residual weed control when applied 2 weeks before planting up to 3 days after planting (before soybean emergence), but often needs to be tank-mixed with glyphosate and/or 2,4-D to achieve complete burndown. • Refer to label regarding applications with/or in sequence with Sharpen and other group 14 herbicides. • See Valor entry for more information. 					

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Table 5.48 - Comments on Preplant or Preemergence Herbicides for Conventional, Minimum, or No-Till Soybeans (cont.)

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Fierce 76WDG	pyroxasulfone + flumioxazin	15	EPP or PRE	3–3.75 oz	0.08–0.10
		14			0.063–0.78
Fierce EZ 3.04SC	pyroxasulfone + flumioxazin	15	EPP or PRE	6–7.5 fl oz	0.08–0.100
		14			0.064–0.079
Fierce XLT 62.41WDG	pyroxasulfone + flumioxazin+ chlorimuron	15	EPP or PRE	3.75–5.25 oz	0.073–0.102
		14			0.057–0.08
		2			0.016–0.022

- See Zidua and Valor entry for comments.
- Fierce XLT improves morningglory control compared to Fierce or Fierce EZ due to addition of chlorimuron.
- Products containing flumioxazin have specific tank-cleaning instructions on the label or in technical bulletins to help avoid contaminant injury from spray tank residues.
- *Water quality advisory.*

FirstRate 84WDG	cloransulam	2	EPP, PPI, or PRE	0.6–0.75 oz	0.031–0.039
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- Cloransulam provides good control of several annual broadleaves including common lambsquarters, pigweed, common ragweed, velvetleaf, and cocklebur. Common ragweed is commonly resistant to FirstRate and other group 2 herbicides in the region.
- FirstRate water-dispersible packets are not soluble in liquid fertilizer solutions; premixing in water is required.
- Gangster and Surveil are copacks that contain flumioxazin (Valor) and cloransulam (FirstRate).
- Gangster/Surveil can be applied as a fall (after October 15) or spring preplant treatment or preemergence.
- *Water quality advisory.*

Gangster / Surveil (co-pack) / Surveil 48WDG	flumioxazin + cloransulam	14	EPP or PRE	2.5–3.0 oz	0.08–0.096
		2		0.5–0.6 oz /3.5–4.2 oz	0.026–0.031

- Gangster and Surveil are co-packs that contain flumioxazin (Valor) and cloransulam (FirstRate); Surveil 48WDG is a single product containing both active ingredients.
- Do not mechanically incorporate.
- Products containing flumioxazin have specific tank-cleaning instructions on the label or in technical bulletins to help avoid contaminant injury from spray tank residues.
- See FirstRate and Valor entries for more comments.
- *Water quality advisory*

Intermoc	S-metolachlor + glufosinate	15	EPP or PRE	64-80 fl oz	1.79-2.23
		10			

- Intermoc may be applied as burndown treatment prior to planting any soybean variety.
- Apply a minimum of 64 fl oz/A to young, actively growing weeds.
- Include AMS 2-4 lb/A.
- Do not use nitrogen solutions as spray carriers.
- Do not apply within 2 weeks of planting on course-textured soils.
- Do not apply more than 2 applications per year, and do not apply more than 5 days apart.
- Do not apply more than 122 fl oz/A per year.

Table 5.48 - Comments on Preplant or Preemergence Herbicides for Conventional, Minimum, or No-Till Soybeans (cont.)

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Lorox 50DF / Linex 4L	linuron	7	EPP or PRE	0.75–2.0 lb 1 to 2 pt	0.38–1.0
<ul style="list-style-type: none"> • Do not mechanically incorporate. • Do not use on sands or loamy sands, or on soils with less than 0.5% organic matter. • Do not apply after soybean emergence. • Provide good agitation in tank before and during application. • Follow labeled directions regarding soybean planting depth. • Do not plant any crop not on label within 4 months of application. 					
Metribuzin 75DF	metribuzin	5	EPP, PPI, or PRE	4–8 oz	0.2–0.4
<ul style="list-style-type: none"> • Do not use on sands or loamy sands or on soils with less than 0.5% organic matter, or crop injury may result. If used on coarse textured soils with less than 2% organic matter or if heavy rainfall follows soon after application, severe stand losses can occur. • Rates on coarse-textured soils in lower portion of the Eastern Shore and Delaware should be no more than 4 oz. • Soybean varieties have different levels of tolerance to metribuzin; refer to product label for list of susceptible varieties. • Do not apply after soybean emergence. • Metribuzin is a triazine (Group 5) herbicide and does not control triazine-resistant weeds. • Potential for crop injury may increase if atrazine was used the previous year due to the additive effect of residual atrazine and metribuzin. • Plant at least 1.5 inches deep. • <i>Water quality advisory.</i> 					
OpTill 68WG	saflufenacil + imazethapyr	14 2	EPP or PRE	2.0 oz	0.022 0.063
<ul style="list-style-type: none"> • On coarse-textured soils with less than 2% organic matter, a minimum of 30 days between application of Optill and soybean planting is required. • Optill may be applied as a preplant burndown application from early spring through preemergence; do not apply if soil cracking has begun or soybeans have emerged. • In a burndown program it is best to include glyphosate or glufosinate in addition to the necessary adjuvants (COC or MSO plus AMS or nitrogen solution) to improve control of emerged weeds, including horseweed. • Do not apply Optill with any other Group 14 herbicide (flumioxazin, sulfentrazone, fomesafen) as a tank mixture or sequential application within 14 days of planting, or crop injury may result. • Postemergence herbicides containing a Group 14 herbicide (Reflex or Flexstar GT) can be applied 14 days after soybean emergence. • Adequate soil moisture is necessary for optimum activity. • Do not plant corn until 8.5 months after application. Consult label for other rotation restrictions. Do not apply products containing chlorimuron during the same season, or injury to rotational crops may result. • OpTill PRO is a co-pack of OpTill and Outlook. • <i>Water quality advisory.</i> 					

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Table 5.48 - Comments on Preplant or Preemergence Herbicides for Conventional, Minimum, or No-Till Soybeans (cont.)

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Outlook 6.0EC	dimethenamid	15	EPP, PPI, or PRE	10–21 fl oz	0.47–0.98
<ul style="list-style-type: none"> • Outlook is similar in activity to Dual, Zidua, and Warrant. • For early preplant applications or fields with heavy surface plant residue, use 21 fl oz/A. • Incorporation improves control of yellow nutsedge. • Do not exceed a rate of 12 oz/A of Outlook on coarse soils with less than 1.5% organic matter. PPI applications are not recommended on these soils. Outlook will have very short residual when used on coarse-textured soils. • Outlook can be applied after soybean emergence (up to 5PthP trifoliolate), but Outlook will not control emerged weeds. • OpTill PRO is a co-pack of OpTill and Outlook. • <i>Water quality advisory.</i> 					
Prefix 5.3EC	S-metolachlor + fomesafen	15 4	EPP, PPI, or PRE	2–3 pt	0.73–1.1 0.16–0.24
<ul style="list-style-type: none"> • See Dual entry for more comments. • Prefix contains S-metolachlor (Dual Magnum) and fomesafen (Reflex) for annual grass, nutsedge, and broadleaf control. The ratio of fomesafen in this product is relatively low, below what is typically recommended for soil-applications. • In most situations, Prefix provides foundational weed control but will likely need to be followed by additional weed control measures. • Be cautious of restrictions associated with fomesafen use in consecutive years and use rates that vary across the region. Refer to label for additional use restrictions. • Prefix followed by sequential applications of Reflex are prohibited; use of fomesafen as a postemergence treatment is preferable to use as a soil-application. • Refer to label regarding applications with/or in sequence with Sharpen and other group 14 herbicides. 					
Prowl 3.3E	pendimethalin	3	EPP, PPI, or PRE	1.2–3.6 pt	0.5–1.5
Prowl H₂O 3.8CS	pendimethalin	3	EPP, PPI, or PRE	2–3 pt	0.95–1.4
<ul style="list-style-type: none"> • Prowl 3.3E: do not exceed 2.4 pt/A rate when using surface application. • Under certain environmental conditions, preemergence applications may cause callus tissue development at soil line, resulting in brittle soybean stems and increase incidence of lodging. • Prowl (all formulations) should be applied pre-plant incorporated (PPI) north of I-80 due to stem callus and possible lodging concerns. • Do not apply to emerged soybeans. • Generic EC formulations are available; consult individual labels for rates and restrictions. 					
Pursuit 2S	imazethapyr	2	EPP, PPI, or PRE	4 fl oz	0.063
<ul style="list-style-type: none"> • Adequate soil moisture is necessary for optimum activity. • Do not plant corn until 8.5 months after application. Consult label for other rotational restrictions. Do not apply products containing chlorimuron during the same season, or injury to rotational crops may result. • <i>Water quality advisory.</i> 					

Table 5.48 - Comments on Preplant or Preemergence Herbicides for Conventional, Minimum, or No-Till Soybeans (cont.)

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Python 80WDG	flumetsulam	2	EPP or PRE	0.8–1.33 oz	0.04–0.066
<ul style="list-style-type: none"> • Python may be tank mixed with other herbicides to broaden the spectrum of control. Check individual herbicide labels for potential tankmix partners. • Do not apply where soil pH is greater than 7.8. • Do not apply to emerged soybeans. • <i>Water quality advisory.</i> 					
Reflex 2E	fomesafen	14	EPP or PRE	1–1.5 pt	0.25–0.375
Flexstar 1.88E				1.06–1.6 pt	
<ul style="list-style-type: none"> • Apply Reflex/Flexstar for broadleaf weed control; tank mix with residuals that will improve annual grass activity. • Be cautious of restrictions associated with fomesafen use in consecutive years and the use rates that vary across the region. Refer to label for additional use restrictions. • Use of fomesafen as a postemergence treatment is preferable to use as a soil application. • Refer to label regarding tank-mixtures. • <i>Water quality advisory.</i> 					
	S-metolachlor	15			1.041–4.077
	metribuzin	5	EPP, PPI, or PRE	1.2–2.35 qt	0.193–0.377
Tendovo	chloransulam	2			0.020–0.038
<ul style="list-style-type: none"> • See comments for Dual Magnum, metribuzin, and FirstRate • Incorporation improves control of yellow nutsedge. • Do not exceed 3.71 lb ai/A per year of any S-metolachlor containing product • Soybean injury may occur on soils with less than 0.5% organic matter. • Soybean injury may occur if used on coarse-textured soils with less than 1% organic matter or if heavy rainfall follows soon after application. • Soybean varieties have different levels of tolerance to metribuzin; refer to product label for list of susceptible varieties. • Plant at least 1.5 inches deep. • <i>Water quality advisory.</i> 					
Treflan 4E	trifluralin	3	PPI	1.0–2.0 pt	0.5–1.0
<ul style="list-style-type: none"> • Incorporate thoroughly to a depth of 2–3 inches within 24 hours of application. Label recommends twopass incorporation. • Plant soybeans after early season adverse weather has passed. • Do not plant deeper than 2 inches. 					

Table 5.48 - Comments on Preplant or Preemergence Herbicides for Conventional, Minimum, or No-Till Soybeans (cont.)

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Trivence 61.3WDG	chlorimuron +	2	EPP or PRE	6.0–10.0 oz	0.014–0.023
	flumioxazin +	14			0.048–008
	metribuzin	5			0.169–0.282

- Do not mechanically incorporate Trivence into the soil after application.
- Do not apply Trivence if beans have begun to emerge.
- Trivence has some burndown activity, but it should be tankmixed with glyphosate or paraquat in most cases.
- Trivence can be tankmixed with products such as Command or pendimethalin for improved grass control.
- If Trivence is tank-mixed with group 15 herbicides and applied within 14 days of planting, plant under no-till or minimum tillage conditions on wheat stubble or field corn stubble.
- Splashing soil from irrigation or heavy rainfall may cause injury to newly emerged soybeans. Do not irrigate when soybeans are cracking.
- Products containing flumioxazin have specific tankcleaning instructions on the label or in technical bulletins to help avoid contaminant injury from spray tank residues.
- Refer to label regarding applications with/or in sequence with Sharpen and other Group 14 herbicides.
- See Valor SX entry for additional information and mode of action statement.

Valor SX 51WDG	flumioxazin	14	EPP or PRE	2.0–2.5 oz	0.063–0.08 oz
Valor EZ 4SC				2.0–2.5 fl oz	

- Valor products may be tankmixed with certain herbicides to broaden weed control spectrum.
- Do not use more than 3 oz/A of Valor SX or Valor EZ per season.
- Rate is dependent upon weed species targeted, soil type, and soil organic matter; refer to label.
- Do not mechanically incorporate Valor products into the soil after application.
- Do not apply products containing flumioxazin if beans have begun to emerge. Splashing soil from irrigation or heavy rainfall may cause injury to newly emerged soybeans.
- If Valor SX or Valor EZ is tank-mixed with Group 15 herbicides and applied within 14 days of planting, plant under no-till or minimum tillage conditions on wheat stubble or field corn stubble.
- Valor SX or EZ at 1–2.5 oz/A, can enhance the speed of burndown and increase weed spectrum of typical burndown herbicide programs.
- Refer to label regarding applications with, or in sequence, with Sharpen and other group 14 herbicides.
- Gangster and Surveil are co-packs that contain flumioxazin (Valor) and cloransulam (FirstRate). Other premix products that contain flumioxazin include Afforia, Envive, Fierce, Trivence, Valor XLT, and others.
- Products containing flumioxazin have specific tank cleaning instructions on the label or in technical bulletins to help avoid contaminant injury from spray tank residues.

Table 5.48 - Comments on Preplant or Preemergence Herbicides for Conventional, Minimum, or No-Till Soybeans (cont.)

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Valor XLT 40WDG	flumioxazin + chlorimuron	14 + 2	EPP or PRE	3.0–5.0 oz/A	0.056–0.094
<ul style="list-style-type: none"> • Do not mechanically incorporate into the soil after application. • Can be tank-mixed with products such as Command or pendimethalin for improved grass control. • If Valor XLT is tank-mixed with group 15 herbicides and applied within 14 days of planting, plant under no-till or minimum tillage conditions on wheat stubble or field corn stubble. • Products containing flumioxazin have specific tank-cleaning instructions on the label or in technical bulletins to help avoid contaminant injury from spray tank residues. • Refer to label regarding applications with, or in sequence, with Sharpen and other Group 14 herbicides. • See Valor entry for more information. 					
Warrant 3CS	acetochlor	15	EPP or PRE	1.25–2.0 qt	0.94–1.5
<ul style="list-style-type: none"> • Warrant can be soil applied for residual control of certain annual grasses and broadleaves. • Warrant can be applied after soybean emergence (up to R2 stage) but will not control emerged weed seedlings. • Do not mechanically incorporate Warrant prior to planting (PPI). • Warrant Ultra is a prepackaged mixture of Warrant and Reflex; however, the ratio of fomesafen in this product is relatively low, below what is typically recommended for soil-applications. • <i>Water quality advisory.</i> 					
Zidua 85WDG	pyroxasulfone	15	EPP, PPI, or PRE	1.5–3.5 oz	0.08–0.186
Zidua 4.17SC				2.5–5.75 fl oz	0.081–0.187
<ul style="list-style-type: none"> • Zidua has annual grass activity similar to Dual, Outlook, Warrant, etc., but it also provides control of several annual broadleaves. • Zidua can be applied as an early pre-plant application up through planting and then as an early POST application from emergence to sixth trifoliolate stage. Zidua will not control emerged weed seedlings. • Must be activated by at least 0.5 inch of rainfall prior to weed germination or effectiveness may be reduced. • Zidua can be tankmixed with other herbicides to increase the spectrum of control. • Refer to the labels for rotations restrictions (most vegetables have an 18-month rotational restriction); see Table 5.5 (crop rotation table). • Fierce is a prepackaged mixture of Zidua and Valor; Fierce XLT is Zidua, Valor, and Classic. 					
	pyroxasulfone + imazethapyr + saflufenacil	15 2 14	EPP or PRE	4.5–6.0 fl oz	0.08–0.107 0.047–0.062 0.017–0.023
Zidua PRO 4.09SC					
<ul style="list-style-type: none"> • On coarse-textured soils with less than 2% organic matter, a minimum of 30 days between application of Zidua PRO and soybean planting is required. • Zidua PRO may be applied as a preplant burndown application from early spring through preemergence; do not apply if soil cracking has begun or soybeans have emerged. • In a burndown program it is best to include glyphosate or glufosinate in addition to the necessary adjuvants (COC or MSO plus AMS or nitrogen solution) to improve control of emerged weeds, including horseweed. • Do not apply Zidua PRO with any other Group 14 herbicide (flumioxazin, sulfentrazone, fomesafen) as a tank-mixture or sequential application within 14 days of planting, or crop injury may result. • Postemergence herbicides containing a Group 14 herbicide (Reflex or Flexstar GT) can be applied 14 days after soybean emergence. • Outlook at 10 fl oz is lower than recommended rates for medium- and fine-textured soils. 					

¹ See Table 5.3 (generics table) for additional herbicides that contain these active ingredients.

Table 5.49 - Soybean Herbicide Preplant or Preemergence Rates Based on Soil Texture and Organic Matter

The herbicide rates presented are for conventionally tilled soils for the given soil texture and organic matter levels. This table shows application rates for products applied alone. Rates may vary if tank-mixed with other products and/or if weed infestations are heavy, or if used in conservation tillage situations. See specific product label for additional information on application rates and uses. Rates are based on regional university experience and potential crop injury.

Trade Name	Site of Action	Unit/A	<3% Organic Matter			≥3% Organic Matter			Inc. for No-Till ¹
			Coarse	Medium	Fine	Coarse	Medium	Fine	
Afforia 50.8WG	2, 2, 14	oz	2.5	2.5	2.5	2.5	2.5	2.5	no
Antares Complete	14, 15, 5	pt	do not use ³	2.5	3.0	do not use ³	3.0	3.0	no
Anthem Max 4.3SC	14,15	fl oz	3	4	4.5	3.25	4.5	5.25	no
Authority Edge 4.25SC	14,15	fl oz	8.8	11.0	12.0	9.4	12.0	15.7	no
Authority Elite 7E / BroadAxe XC	14, 15	fl oz	25	28	28	25	28	34	no
Authority First 70WDG or Sonic	2, 14	oz	6.45	6.45	6.45	8.0	8.0	8.0	no
Authority MTZ 45WG	5, 14	oz	12	16	18	14	18	20	no
Authority Supreme 4.16SC	14, 15	fl oz	6.9	7.8	10	6.9	7.8	10	no
Authority XL 70WG	2, 14	oz	5.3	7	8	5.3	7.5	8.5	no
Boundary 6.5EC	5, 15	pt	1.25	2	2.5	1.5	2.5	2.75	yes
Canopy 75DF	2, 5	oz	4	5	6	4	5	7	no
Canopy Blend 58.3WDG	2, 5	oz	5.1	6.4	7.75	5.1	6.4	9.0	no
Command 3ME	13	pt	1.25	2	2.67	1.25	2.67	2.67	no
Dual II Magnum 7.62EC	15	pt	1.25	1.33	1.33	1.25	1.33	1.67	yes
Envive 41.3WDG	2, 2, 14	oz	3.5	3.5	4	3.5	4	5	no
Fierce 76WDG	14, 15	oz	3	3	3	3	3	3	no
Fierce EZ 3.04SC	14, 15	fl oz	6.0	6.0	6.0	6.0	6.0	6.0	no
Fierce MTZ 2.64SC/Kyber	5, 14, 15	pt	1	1.5	1.5	1	1.5	1.5	no
Fierce XLT 62.41WDG	2, 14, 15	oz	4	4	4.75	4	4.5	5	no
FirstRate 84WDG	2	oz	0.6	0.6	0.6	0.75	0.75	0.75	no
Gangster / Surveil (co-pack)	2, 14	oz	3	3.6	3.6	3	3.6	3.6	no
Linex 4L	7	pt	1.25	1.3	1.75	1.5	1.75	2.0	no
Lorox 50DF	7	lb	1.25	1.3	1.75	1.5	1.75	2.0	no
Metribuzin 75DF	5	oz	4	8	10	4	11	12	no
OpTill 68WG	2, 14	oz	2.0	2.0	2.0	2.0	2.0	2.0	no

Table 5.49 - Soybean Herbicide Preplant or Preemergence Rates Based on Soil Texture and Organic Matter (cont.)

The herbicide rates presented are for conventionally tilled soils for the given soil texture and organic matter levels. This table shows application rates for products applied alone. Rates may vary if tank-mixed with other products and/or if weed infestations are heavy, or if used in conservation tillage situations. See specific product label for additional information on application rates and uses. Rates are based on regional university experience and potential crop injury.

Herbicide	Herbicide group #	Unit	<3% Organic Matter			≥3% Organic Matter			Inc. for No-Till ¹
			Coarse	Medium	Fine	Coarse	Medium	Fine	
Outlook 6.0E	15	fl oz	14	16	18	14	16	18	no
Panther MTZ	5, 14	fl oz	do not use ³	15	18	12	15–18	18	no
Panther Pro	5, 14, 2	fl oz	do not use ³	12	15	do not use ³	12	15	no
Perpetuo 2.3SC	14, 15	fl oz	8.0	10.0	10.0	8.0	10.0	10.0	no
Prefix 5.3E	14, 15	pt	2.0	2.25	2.5	2.25	2.5	2.5	yes
Preview 2:1SC	5, 14	fl oz	11	16	22	14	22	26	no
Prowl 3.3E	3	pt	1.8	2.4	2.4	1.8	2.4	3	yes
Prowl H ₂ O 3.8CS	3	pt	1.5	2.0	2.0	1.5	2.0	2.5	yes
Pursuit 2S	2	fl oz	4.0	4.0	4.0	4.0	4.0	4.0	no
Reflex 2E	14	pt	1.25	1.25	1.25	1.25	1.25	1.25	no
Spartan 4F	14	fl oz	6	8	10	8	10	12	no
Surveil 48WG	2, 14	oz	3.5	4.2	4.2	3.5	4.2	4.2	no
Tendovo 4.12 ZC	15, 5, 2	qt	1.2	1.5	1.9	1.5	2.0	2.3	no
Treflan 4E	3	pt	1.0	1.5	2.0	1.5	1.5	2.0	no
Trivence 61.3WDG	2, 5, 14	oz	7	8	8	7	8	8	no
Valor SX 51WDG	14	oz	2.5	2.5	2.5	2.5	2.5	2.5	no
Valor EZ 4SC	14	fl oz	2.5	2.5	2.5	2.5	2.5	2.5	no
Valor XLT 40.3WDG	2, 14	oz	3	3.5	4	3	4	4.5	no
Warrant/Enversa 3CS	15	qt	1.5	1.5	1.5	1.5	1.5	1.5	no
Warrant Ultra 3.45CS	14, 15	fl oz	48	55	60 ²	60	60 ²	60 ²	no
Zidua 81WDG	15	oz	2	2.5	3	2	2.5	3	no
Zidua SC 4.17SC	15	fl oz	3.3	4.1	4.9	3.3	4.1	4.9	no
Zidua PRO 4.09SC	15, 2, 14	fl oz	6	6	6	6	6	6	no
Zone Defense	14, 14	oz	4.0	5.0	5.0	5.0	5.0	–	no

¹ In general, when increasing the product rate for no-till or reduced tillage, use the upper end of the rate range if applicable. See specific product label for additional information on application rates and uses.

² Maximum rate depends on the location; refer to label for rates based on area use map.

³ Not recommended on coarse-textured soils due to potential crop injury.

Table 5.50 - Herbicides Commonly Used after Soybean Emergence (POST)

Comparable residual activity is given for comparison purposes only. The data are based on herbicide half-life, which is the length of time it takes for half the herbicide to break down. Herbicide degradation (break-down) is the result of chemical and/or microbial activity, which can be dependent on soil pH, soil temperature and soil moisture levels. Since degradation is dependent on a number of factors, length of time can vary for herbicides based on the specific environmental conditions. Residual activity is not the same as herbicide carryover. Herbicide rates maybe less with POST applications than PRE so duration of residual control may not be as long.

Postemergence (POST) Activity

Translocated herbicide These herbicides move throughout the plant and can cause injury to parts of the plants that are did not come in direct contact with the herbicide spray.

Contact herbicide These herbicides do not move throughout the plant. They cause injury only to those parts of the plant that comes in contact with the spray. Spray coverage is more critical for contact than translocated herbicides.

Group 1 herbicides only control grass weed species (no activity on yellow nutsedge).

Group 15 herbicides do not control weeds that are emerged at time of application.

Residual Activity

none

short= 1 to 2 weeks of residual control

yes= over 2 weeks of residual control

Trade Name	Site of Action Number	POST Activity	Residual Activity ¹
Assure II / Targa	1	translocated	none
Basagran	6	contact	none
Cadet	14	contact	none
Classic	2	translocated	broadleaf only
Cobra	14	contact	none
Dual Magnum	15	none	yes
Enlist One	4	translocated	none
FirstRate	2	translocated	yes
Fusilade DX	1	translocated	none
glyphosate	9	translocated	none
Harmony SG	2	contact	none
Liberty/Interline/ Scout/others	10	contact	none
Permit/Sandea	10	translocated	broadleaf only
Poast	1	translocated	none
Pursuit	2	translocated	yes
Raptor/Beyond Xtra	2	translocated	yes
Reflex/Flexstar	14	contact	Broadleaf only
Resource	14	contact	none
Select Max	1	translocated	none
Ultra Blazer	14	contact	none
Warrant/Enversa	15	none	yes
Zidua	15	none	yes

¹ Residual activity: none; short = 1 to 2 weeks of residual control; yes = over 2 weeks of residual control. See Table 5-59 for more information.

Table 5.50 - Herbicides Commonly Used after Soybean Emergence (POST) (cont.)

Herbicide Pre-mixes	Site of Action Number	Constituent Products
Anthem Maxx	14, 15	fluthiacet, pyroxasulfone
Enlist Duo	4, 9	Enlist One, glyphosate
Extreme	9, 2	glyphosate, Pursuit
Flexstar GT	9, 14	glyphosate, Reflex
Intermoc	10, 15	Liberty/Interline/Scout/others, Dual Magnum
Permit Plus	2, 2	halosulfuron (Permit/Sandea), Harmony
Prefix	15, 14	Dual Magnum, Reflex
Sequence	9, 15	glyphosate, Dual Magnum
Storm	6, 14	Basagran, Ultra Blazer
Synchrony	2, 2	Harmony, Classic
Warrant Ultra	15, 14	Warrant, Reflex

Table 5.51 - Relative Effectiveness of Postemergence Herbicides on Individual Weed Species

Ratings are based on labeled application rates and weeds at 4 inches in height. Results may differ with variations in weed size, temperature, rainfall, soil moisture, and spray coverage. Ratings are based only on postemergence (POST) activity and do not reflect possible residual activity. For ratings on herbicide combinations not listed, see the component parts. Ratings assume good growing conditions and proper usage of adjuvants.

Weed control rating:	Crop tolerance:
10 = 95–100%	E = excellent; almost never any crop injury observed
9 = 85–95%	VG = very good; on rare occasion is crop injury observed
8 = 75–85%	G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., herbicide rate and application timing, adjuvants)
7 = 65–75%	FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions
6 = 55–65%	F = fair; some crop injury is commonly observed
N = less than 55% or no control	
+ = upper end of rating scale	

Trade Name (rates/A)	Site of Action Number	Grasses														
		Barnyard-grass	Bermudagrass	Broadleaf signalgrass	Crabgrass	Fall Panicum	Foxtails, spp. ¹	Goosegrass	Johnsongrass (Seedling)	Johnsongrass (Rhizome)	Quackgrass	Shattercane	Texas panicum	Volunteer Corn	Wirestem Muhly	Yellow Nutsedge
Assure II (8 fl oz)	1	9	9	9	8+	9	9+ ¹	9	9	9	9	9+	8+	9+	6	N
Basagran (1 qt)	6	N	N	N	N	N	N	N	N	N	N	N	N	N	N	7+
Classic (0.67 oz)	2	N	N	N	N	N	N	N	N	N	N	6	N	6	N	8
Fusilade DX (12 fl oz)	1	9	9	9	8+	9	8+	9	9	9	9	9+	8+	9+	8+	N
Glyphosate (0.75 lb ae) ²	9	9+	9	9+	9+	9	9+	9+	9+	9	9	9	9+	9+ ³	9	7
Liberty/Interline/Scout/ others (32 fl oz) ⁴	10	8	6	8+	8+	8+	8+ ¹	6	9	6	6	9	8	7 ⁵	7	6
Poast (1 – 1.5 pt) ⁶	1	9+	8+	9+	9	9	9+	9	8+	8	8	8+	9+	8	7	N
Pursuit (4 fl oz)	2	8	N	8	7	8	8+ ¹	N	9	7	6	9	6	6	N	7
Raptor/Beyond Xtra (5 fl oz)	2	8	N	8	7	8	8+ ¹	N	8+	7	N	8+	6	8	N	6
Select (8 fl oz)	1	9	9	9+	9	9	9+	9	9	9	8+	9	9+	9	8+	N
Mixtures																
Flexstar GT (4.5 pt) ²	9/14	9+	9	9+	9+	9	9+	9+	9+	9	9	9	9+	9+ ³	9	7
Fusion (8 fl oz)	1/1	9	9	9	8+	9	9 ¹	9	8	8	8	8	8+	8	6	N
Permit Plus (0.75 oz) ⁷	2/2	N	N	N	N	N	N	N	N	N	N	N	N	N	N	9+
Storm (1.5 pt)	6/14	N	N	N	N	N	N	N	N	N	N	N	N	N	N	7+
Synchrony (0.75 oz) ⁷	2/2	N	N	N	N	N	N	N	6	N	N	6	N	6	N	8

¹ Herbicide is less effective on yellow foxtail compared to giant foxtail. Ratings for yellow foxtail: Assure II/Targa = 7; Fusion = 8; Liberty = 6 Pursuit = 6; Raptor = 6

² For use on glyphosate-resistant soybean varieties only.

³ Glyphosate will not control glyphosate-resistant corn.

⁴ For use on glufosinate-resistant soybean varieties only.

⁵ Liberty will not control glufosinate-resistant corn, nor many hybrids with Bt traits.

⁶ Rates for Poast on annual grasses is 1 pt and 1.5 pt for perennial grasses.

⁷ For use on STS, Bolt, or non-STS soybean varieties; a lower rate must be used on non-STS varieties.

Table 5.51 - Relative Effectiveness of Postemergence Herbicides on Individual Weed Species (cont.)

Broadleaves																		
Trade Name (rates/A)	Site of Action Number	Burcucumber	Cocklebur	Horseweed / Marestalk^{1,2}	Jimsonweed	Lambsquarters	Morningglory, Annual	Nightshade, Eastern Black	Palmer Amaranth / Waterhemp^{1,2}	Pigweed¹	Ragweed, Common^{2,3}	Ragweed, Giant	Sicklepod	Sida, Prickly	Smartweed	Spurred Anoda	Velvetleaf	Soybean Tolerance
Basagran (1 qt)	6	N	9	N	9	8	N	N	6	6	8	7	N	8	9	8+	8+	FG
Cadet (0.9 oz)	14	N	N	N	N	7	7	7	7	7	N	N	N	7	N	7	9+	F
Classic (0.67 oz)	2	8	9+	7 ¹	9	7	7	N	N ¹	9 ¹	8 ³	7+	8	N	8+	N	8	F
Cobra (12.5 fl oz)	14	8	8	N	9	7	8	8+	9	9	9 ³	8+	6	6	7	7	8+	F
Enlist One (2 pt) ⁴	4	7	9	8+	8+	9	8	8	8+	8+	8+	7+	8	8	7+	8	8	E
FirstRate (0.3 oz)	2	6	9	8 ¹	8	N	8+	N	N	N	9 ³	9	6	N	8	9	9	VG
Glyphosate (0.75 lb ae) ⁵	9	8+	9	6 ²	9	8+	8	8	N ²	9+	9 ²	8	9	8	8+	9	8	E
Harmony SG (0.125 oz) ⁶	2	7	7+	N	7	9	N	N	N	9 ¹	6 ³	N	N	N	9	N	8+	- ⁷
Liberty, Interline, Scout, others (32 fl oz) ⁶	10	8	9	8+	9	9	8	8	8+	8+	9	8+	8+	8	8+	7+	8	VG
Pursuit (4 fl oz) ¹	2	6	9	N	8	7	7+	8+	N ¹	9 ¹	8 ³	6	N	6	8+	7	9	FG
Raptor/Beyond Xtra (5 fl oz) ¹	2	6	9	N	8	8+	7	8+	N ¹	9 ¹	8 ³	8	N	6	8	7	9	G
Reflex/Flexstar (1.25 pt)	14	7	8	N	9	6	8	8+	9	9	9 ³	8	N	N	8	6	7+	FG
Resource (6 fl oz)	14	6	6	N	7	7	N	8	7+	7+	7+ ³	6	N	6	6	6	9+	FG
Ultra Blazer (1.5 pt)	14	7	8	N	9	7	8	8	9	9	9 ³	8	N	N	8+	6	7+	F
Mixtures																		
Flexstar GT (4.5 pt) ⁴	9/14	8+	9	6 ²	9	8+	8	8	9 ²	9	9 ^{2,3}	9	9	8	8+	9	8+	F
Permit Plus (0.75 oz) ⁷	2/2	7	9	N	7	9	6	6	N ¹	9 ¹	9 ³	8	N	7	9	-	9	- ⁸
Storm (1.5 pt)	6/14	6	8	N	9	7	7+	7	8+	8+	8+ ³	7	6	7	8+	8	8	FG
Synchrony (0.75 oz) ⁷	2/2	8+	9+	8 ¹	9	9	7	N	N ¹	9+ ¹	8 ³	7+	8+	N	9	N	9	- ⁸

¹ Group 2 resistance has been confirmed for this species and it is widespread in the region; Group 2 herbicides will not control these biotypes.

² Glyphosate resistance has been confirmed for this species and is widespread in the region.

³ Common ragweed biotypes resistant to Groups 2 and 14 herbicides have been confirmed in the region. Group 14 resistance is limited to the DelMarVa region and New Jersey.

⁴ For use on 2,4-D resistant (Enlist E3) soybean varieties only.

⁵ For use on glyphosate-resistant soybean varieties only.

⁶ For use on glufosinate-resistant soybean varieties only.

⁷ For use on STS, Bolt, or non-STS soybean varieties; a lower rate must be used on non-STS varieties.

⁸ Excellent crop tolerance for STS or Bolt varieties, but fair or worse ratings if used on non-STS varieties.

5-172 *Weed Control in Field Crops: Soybeans*

Table 5.52 - Effectiveness of Postemergence Herbicides on Perennial Broadleaf Weeds in Soybean (Based on Seasonal Control)

Weed control rating:

10 = 95–100% 9 = 85–95% 8 = 75–85% 7 = 65–75% 6 = 55–65% N = less than 55% or no control

– = no local data available + = upper end of rating scale L-S = labeled as suppressed

Trade Name	Site of Action Number	Canada Thistle	Dandelion	Dewberry	Dock spp.	Groundcherry	Hedge Bindweed	Hemp Dogbane	Horsenettle	Jerusalem Artichoke	Common Milkweed	Poison Ivy	Pokeweed
Basagran	6	7	N	N	7	N	7	N	6	6+	N	N	N
Classic	2	7	7	7	7	–	8	7	7	7+	6	6	7+
Cobra, Reflex, Ultra Blazer	14	6	N	N	6	6	7	6	7	6	6	N	7
Enlist One ¹	4	7	9+	6	8	7	9	6	6	–	6	7	7
FirstRate	2	L-S	–	–	–	–	–	–	6	–	–	–	6
Glyphosate (broadcast) ²	9	9	7	8	8	7+	8	8+	8	8	8	8	8+
Glyphosate (wiper application) ³	9	7	N	N	N	6	N	7+	N	7+	7+	6	8+
Liberty/ Interline/ Scout/others	10	6	7	–	6	6	N	6	7	–	6	–	6
Pursuit/ Raptor/ Beyond Xtra	2	6	7	6	7	–	7+	7	8	7	6	6	6
Synchrony	2/2	7+	7	7	6	–	7	7	N	7+	7+	6	7+

¹ For use on 2,4-D-resistant (Enlist E3) soybean varieties only.

² Broadcast applications of certain glyphosate products for use on glyphosate-resistant soybean varieties only. Refer to product label use restrictions. Information on various glyphosate formulations can be found in Table 5-2 (glyphosate table).

³ Mix 1/3 glyphosate product with 2/3 water. Two passes in opposite directions is most effective.

Table 5.53 - Weed Sizes for Postemergence Soybean Herbicides

This table lists postemergence soybean herbicides, their rates, and height ranges of weed species that are controlled or suppressed. This table is only a "quick reference"; refer to the herbicide label for additional information on application and timing. Postemergence grass herbicide rates may vary if tank-mixed with broadleaf herbicides due to antagonism. Split applications should be made if target growth stages for broadleaves and grasses do not correspond or if grasses to be managed are difficult-to-control species such as perennials. For split-applications, it is best to apply post-grass herbicides 24 hours before or about 7 days after broadleaf herbicide application.

Herbicides	Assure II/Targa ¹		Fusillade DX ^{1,2}		Fusion ^{1,2}		Liberty		Poast ¹		Pursuit 2L Xtra		Raptor/ Beyond		Glyphosate Select/Clethodim ^{4,5}							
	alone	w/BH	alone	w/BH	alone	w/BH	alone	w/BH	alone	w/BH	alone	w/BH	alone	w/BH	alone	w/BH	alone	w/BH				
GRASSES Annuals	grass size (in.)	rate/A (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	gr. size ⁶ (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)				
Barnyard-grass	2-6	8 S ⁷	2-3	12	2-4	8	10	3	<4	22	3	<4	1-3	4	2-5	5	4-8	0.75	1-4	4	—	
											5	<8	4	24	24	24	2-8	6	8-10			
											<12 ⁸	—	36	—	—	—	—	—	—	—	—	—
Crabgrass	2-6	8 S ⁷	1-2	12	1-4	8	10	3	<6	22	3	<6	1-3	4	2-4*	5	4-8	0.75	1-4	4-5	—	
											5	<8 ⁸	—	36	—	—	—	—	—	—	—	—
Foxtail, giant	2-4	5	2-6	12	2-8	7	10	6	<4	22	6	<4	1-6	4	2-6	5	4-8	0.75	1-4	4	—	
											12	<8	6	24	24	24	2-12	6	8-10			
											<16 ⁸	—	36	—	—	—	—	—	—	—	—	—
Foxtail, green	2-4	7	2-4	12	2-4	8	10	6	<4	22	6	<4	1-3	4	2-6	5	4-8	0.75	2-8	6	8-10	
											12	<8	6	24	24	24	2-8	6	8-10			
											<16 ⁸	—	36	—	—	—	—	—	—	—	—	—
Foxtail, yellow	2-4	7 S ⁷	2-4	12	2-4	8	10	3	<8	22	3	<8	1-3	4	2-6	5	4-8	0.75	2-8	6	8-10	
											4	<16 ⁸	—	36	—	—	—	—	—	—	—	—
Goose-grass	2-6	7	2-4	8	2-4	8	8-12	2	6	22	2	6	16	—	2-4	5	2-6	6	6	6	—	
											3	29	—	—	—	—	—	—	—	—	—	—
Panicum, fall	2-6	7	2-6	12	26	8	10	3	<4	22	3	<4	18	—	2-6	5	4-8	0.75	1-4	4-5	—	
											5	<8	4	24	24	24	2-8	0.19	8-10	2-8	8-10	
											<12 ⁸	—	36	—	—	—	—	—	—	—	—	—

Table 5.53 - Weed Sizes for Postemergence Soybean Herbicides (cont.)

This table lists postemergence soybean herbicides, their rates, and height ranges of weed species that are controlled or suppressed. This table is only a "quick reference"; refer to the herbicide label for additional information on application and timing. Postemergence grass herbicide rates may vary if tank-mixed with broadleaf herbicides due to antagonism. Split applications should be made if target growth stages for broadleaves and grasses do not correspond or if grasses to be managed are difficult-to-control species such as perennials. For split-applications, it is best to apply post-grass herbicides 24 hours before or about 7 days after broadleaf herbicide application.

Herbicides	Assure II/Targa ¹		Fusillade DX ^{1,2}		Fusion ^{1,2}		Liberty		Poast ¹		Pursuit 2L Xtra		Raptor/ Beyond		Glyphosate Select/Clethodim ^{4,5}											
	grass size (in.)	rate/A (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	gr. size ⁶ (in.)	alone w/BH	alone w/BH	alone w/BH	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A (lb ae/A)	grass size (in.)	rate/A (lb ae/A)	grass size (in.)	alone w/BH					
Panicum, Texas	2-4	8	2-8	12	2-8	8	8-12	4	22	8	8	16	-	-	-	-	-	2-6	6	6	2-6	6				
Shattercane	6-12	5	6-12	6	6-12	6	8	6	22	<18	-	24	-	1-8	4	2-8	5	4-8	0.75	4-10	4-10	4	-			
Signalgrass, broadleaf	2-6	10	2-4	12	2-4	8-10	10-12	3	22	8	8	16	-	1-8	4	2-5	5	2-6	6	6	2-6	6	6-18	6	8-10	
Volunteer corn	6-18	5	12-24	6	12	12-24	6	8	10	22	<12	18	-	-	-	2-8	5	4-8	0.75	4-12	4-12	4	-	12-24	6	8-10

Table 5.53 - Weed Sizes for Postemergence Soybean Herbicides (cont.)

Herbicides	Fusion ^{1,2}										Liberty				Poast ¹	Pursuit DG				Raptor/Beyond Xtra				Glyphosate		Select/Clethodim ^{4,5}			
	Assure II/Targa ¹		Fusillade DX ^{1,2}		alone w/BH		alone w/BH		alone w/BH		alone w/BH		alone w/BH		alone w/BH		alone w/BH		alone w/BH		alone w/BH		alone w/BH		alone w/BH				
	grass size (in.)	rate/A (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	gr. size ⁶ (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)	grass size (in.)	rate/A ⁶ (fl oz)			
Bermudagrass																													
1st applic.	≤6	10	4-8	12	4-8	12	22	stolon	24	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	8	
2nd applic.	≤6	7	4-8	8	4-8	8	22	stolon	16	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	3	8		
Johnsongrass (rhizome)																													
1st applic.	10-24	10	8-18	12	8-18	12	-*	20-25	24	6-12*	4	6-12*	5	6-12*	5	<18	1.5	12-24	8	16	0.75-	-	-	-	-	-	-	-	
2nd applic.	6-10	7	6-12	8	6-12	8	-	6-12	24	-	-	6-12	24	<24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Quackgrass																													
1st applic.	6-8	10	S ⁷	6-10	12	6-10	12	-*	36	-	-	6-8	36	-	-	4-8*	5	6-8	1.5	4-8	0.75-	-	-	-	-	-	-	-	
2nd applic.	4-8	7	<10	8	-	10	8	6-8	36	6-8	6-8	6-8	36	4-8*	8	-	-	-	-	-	-	-	-	-	-	-	-	-	
Wirestem muhly																													
1st applic.	4-8*	8	S ⁷	4-12	12	4-12	8	-*	36	-	-	<6	36	-	-	-	-	-	-	-	0.75-	-	-	-	-	-	4-8+	8	16
2nd applic.	4-8*	7	-	4-12	12	4-12	8	-	36	<6	<6	<6	36	4-8	8	-	-	-	-	-	-	-	-	-	-	-	4-8	8	-

* Suppression only; provides <75% control. ≤ means less than or equal to; > means greater than.

¹ May be tank-mixed with certain broadleaf herbicides only, refer to herbicide labels.

² Special reduced rates may be possible if applied early and under certain conditions; refer to label.

³ For use on glyphosate-resistant soybean varieties only. Split applications may be necessary if new weed flushes occur.

⁴ Select/Clethodim can be applied at a special high rate of 8 oz/A for annual grasses and 16 oz/A for perennials. These high rates should be used only for heavy grass pressure or when grasses are at maximum height.

⁵ Select/Clethodim application rates vary when tank-mixed with certain broadleaf herbicides. Average rate ranges are shown above. Refer to label for additional information.

⁶ Refers to rate per acre of herbicide if applied alone or if tank-mixed with broadleaf herbicides ("w/BH"). For Poast, target grass sizes are smaller if tank-mixed with broadleaf herbicides.

⁷ Split applications may be necessary. May not provide adequate control of this species if tank-mixed with a broadleaf herbicide.

⁸ Rescue application only, better control will result if applied alone. (Do not tank-mix Fusion with broadleaf herbicides for rescue treatments).

Table 5.53 - Weed sizes for postemergence soybean herbicides (cont.)

Broadleaves	Burcucumber	Cocklebur	Jimsonweed	Lambsquarters	Morningglory, Annual	Nightshade, Eastern Black	Palmer Amaranth	Waterhemp	Pigweed	Ragweed, Common	Ragweed, Giant	Sida Prickly	Smartweed	Spurred Anoda	Velvetleaf
Herbicide (rate/A)	height range (inches) at application														
Basagran (2 pt)	-	≤10	≤10	≤2*	-	-	-	-	-	≤3	≤6	3	≤10	4	≤6
Caddet (0.9 fl oz)	≤3	-	≤2	≤3*	≤3	≤2	≤4	≤4	≤4	-	-	-	≤2	-	≤36
Classic (0.5 oz)	-	2-6	2-4	-	1-2	-	1-2	1-2	1-2	-	-	-	1-2	-	-
Classic (0.66 oz)	2-3*	2-8	2-5	-	1-3	-	1-3	1-3	1-3	2-3	2-4*	-	1-3	-	2-4
Classic (0.75 oz)	2-6*	2-12	2-6	-	1-4	-	1-4	1-4	1-4	2-4	2-6	-	1-4	-	2-6
Cobra (12.5 fl oz) ¹	4 lvs	6 lvs	4 lvs	-	<4 lvs	6 lvs	6 lvs	6 lvs	6 lvs	6 lvs	4 lvs	3	4 lvs*	2*	4 lvs
Enlist One (2 pt) ²	-	≤6	≤6	≤6	≤6	≤6	≤6	≤6	≤6	≤6	≤6	≤6	≤6	≤6	≤6
FirstRate (0.3 oz)	-	<10	<4	-	<6	-	-	-	-	<10	<10	-	<6	-	<6
Flexstar GT (3.5 pt)	-	≤4	≤4	≤4	≤3	≤4	≤4	≤4	≤4	≤4	≤4	2	≤4	4	≤4
Glyphosate (0.75 lb ae) ³	4-8	4-8	4-8	3-6	3-6	4-8	4-8	4-8	4-8	4-8	4-8	2	3-6	2	4-8
Harmony SG (0.125 oz)	-	2-6*	2-4*	2-4	-	-	2-8	2-8	2-8	-	-	-	2-6	-	2-6
Liberty (32 fl oz)	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Permit Plus (0.75 oz)	≤3	≤9	≤4	≤4	≤3	-	≤6	≤6	≤6	≤9	≤3	-	≤6	-	≤9
Pursuit 2L (4 fl oz)	-	1-8	1-3	1-2*	1-2*	1-3	1-8	1-8	1-8	1-3*	1-3*	-	1-3	1-2	1-3
Raptor/Beyond Xtra (5 fl oz)	-	2-8	2-6	2-5	2-4	2-5	2-8	2-8	2-8	2-5*	2-5	4*	2-5	-	2-8
Reflex (1.25 pt) ¹	-	2 lvs	6 lvs	2 lvs	2 lvs	4 lvs	2-6 lvs	2-6 lvs	2-6 lvs	4 lvs	4 lvs	-*	4 lvs	2 lvs	2 lvs
Resource (6 fl oz) ¹	-	-	-	2-3 lvs*	-	-	≤3 lvs ³	≤3 lvs ³	≤3 lvs ⁴	≤4 lvs	-	3	-	-	≤8 lvs
Storm (1.5 pt)	-	≤6	≤6	≤2*	≤2	≤2	2-3	2-3	2-3	≤3	≤6	2	≤6	2	≤2*
Synchrony ⁵	2-3*	2-8	2-5	2-4	1-3*	-	2-8	2-8	2-8	2-4	2-4*	-	2-8	3*	2-8
Ultra Blazer (1.5 pt)	-	≤2	≤6	≤2	≤2	≤2	≤4	≤4	≤4	≤3	≤3	-	≤6	-	-

Note: See Table 5.3 (generics table) for additional herbicides that contain these active ingredients and Table 5.2 (glyphosate table) for information on glyphosate formulations.

* Suppression only, additional control measures may be necessary.

¹ Labels refer to weed size by number of leaves (lvs).

² For use on 2,4-D-resistant (Enlist E3) soybean varieties only.

³ For use on glyphosate-resistant soybean varieties only.

⁴ Smooth pigweed control only.

⁵ For use on STS, Bolt, or non-STS varieties; use lower rate on non-STS soybeans.

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The following herbicides can be added with postemergence herbicides to improve residual weed control. They will not provide control of emerged weeds, so they should be applied to weed-free soil surface, or apply with products that will provide post-emergence control of weeds present at time of application. Consult labels when tankmixing with any herbicide. Some pesticides or adjuvants used in combination with the following herbicides could increase the chance of soybean injury.

Residual Herbicides Labeled for Postemergence Use

Table 5.54 - Comments on Postemergence Herbicides for Soybeans					
Trade Name	Herbicide Common Name	Site of Action Number	Application (timing on soybean growth stage)	Product/A	lb ai/A
Anthem Maxx 4.3SC	pyroxasulfone + fluthiacet	15 14	preemergence up to third trifoliolate (R6)	2–5.7 fl oz	0.033–0.186 0.002–0.006
<ul style="list-style-type: none"> • Do not exceed a seasonal total of 3.4 fl oz on coarse soils or 5.7 fl oz on all other soils. • Contains fluthiacet (Cadet) and pyroxasulfone (Zidua); see Cadet and Zidua for more information. • Make applications at least 60 days before harvest. 					
Dual Magnum 7.62EC					
Dual II Magnum 7.64EC	S-metolachlor	15	postemergence	1–2 pt	0.95–1.9
<ul style="list-style-type: none"> • Application timing is not specified on label. • Do not exceed a seasonal total of 3.9 pt/A. • Make applications at least 75 days before harvest. • A prepackaged mixture with glyphosate is available as Sequence; application timing is cracking through 3PrdP leaf stage. • A prepackaged mixture with fomesafen (Reflex) is available as Prefix; label mentions early postemergence application timing. Ratio of fomesafen (Reflex) is too low for consistent postemergence control of emerged weeds. • DO NOT exceed 3.71 lb ai/A/year of any S-metolachlor containing product • <i>Water quality advisory.</i> 					
Inversa 3CS	acetochlor	15	EPP or PRE	1.25–2qt	0.94–1.5
<ul style="list-style-type: none"> • Encapsulated acetochlor for enhanced crop safety and residual control of weeds before they germinate. • Can be applied preplant through R2. POST application should be made after soybeans are completely emerged but before soybeans reach growth stage R2. • The optimum timing and rate of application is when soybeans are V2-V3 at 1.5 qts/acre. • Weeds emerged at the time of application are not controlled by this product. • <i>Water quality advisory.</i> 					
Outlook 6EC	dimethenamid	15	cracking stage to 5th trifoliolate (V5)	12–21 fl oz	0.56–0.98
<ul style="list-style-type: none"> • Rates vary with soil type, refer to label. • Limited residual control when applied to coarse-textured soils. • Do not exceed a seasonal total of 24 fl oz. 					
Perpetuo	pyroxasulfone flumiclorac	15 14	emergence to 6th trifoliolate (V6)	6.0–10.0 fl oz	0.108–0.180
<ul style="list-style-type: none"> • Do not apply more than 8 fl oz/ac on coarse soils. • Contains flumiclorac (Resource) and pyroxasulfone (Zidua); see Resource and Zidua for more information. 					

5-178 Weed Control in Field Crops: Soybeans

Table 5.54 - Comments on Postemergence Herbicides for Soybeans

Trade Name	Herbicide Common Name	Site of Action Number	Application (timing on soybean growth stage)	Product/A	lb ai/A
Warrant 3CS	acetochlor	15	emergence to R2	1.25–2 qts	0.94–2.0
<ul style="list-style-type: none"> • Rates vary with soil type and organic matter, refer to label. • Do not exceed 4 qts/A/yr. • Label recommends application at V2 to V3 stage. • A prepackaged mixture with fomesafen (Reflex) is available as Warrant Ultra; ratio of fomesafen (Reflex) is too low for consistent postemergence control of emerged weeds. 					
Zidua 85WDG	pyroxasulfone	15	emergence to 6th	1–3.5 oz wt	0.053–0.186
Zidua SC 4.17SC			trifoliolate	1.75–5.75 fl oz	0.057–0.187
<ul style="list-style-type: none"> • Rates vary with soil type, refer to label. • Can be applied from emergence to the sixth trifoliolate stage. • Do not exceed 2.1 oz wt and 3.5 fl oz per acre per season on coarse-textured soils, 3.0 oz wt and 5.0 fl oz on medium-textured soils, and 3.5 oz wt and 5.75 fl oz on fine-textured soils of Zidua 85WDG and Zidua SC 4.17SC, respectively. 					

The following herbicides are commonly applied postemergence to control emerged weeds. Most of these herbicides require an adjuvant to improve control; refer to proper tables to assist with adjuvant selection.

Postemergence Herbicides

Table 5.54 - Comments on Postemergence Herbicides for Soybean (cont.)

Trade Name	Herbicide Common Name	Site of Action Number	Application	Product/A	Active Ingredient (ai) lb/A
Assure II 0.88E/ Targa	quizalofop	1	postemergence	5–10 fl oz	0.03–0.06
<ul style="list-style-type: none"> • Do not use crop oils manufactured from vegetable oils. • When tank-mixing with a broadleaf herbicide, always read both labels to make sure the right surfactant and concentration are used. • Apply when grasses are within the recommended growth stage specified on the label • Perennial grasses may require a second application for complete control. • Apply to actively growing grasses in 10 to 40 gallons of water per acre using flat fan or hollow cone nozzles. • To avoid antagonism (reduced grass control) from broadleaf herbicides, spray 2-3 days before the broadleaf herbicide or wait 7 days after the broadleaf herbicide application. • Assure II/Targa must be applied at least 80 days before harvest. • A premix with glufosinate (Liberty) is available as Zalo. 					

Table 5.54 - Comments on Postemergence Herbicides for Soybean (cont.)

Trade Name	Herbicide Common Name	Site of Action Number	Application	Product/A	Active Ingredient (ai) lb/A
Basagran 4S	bentazon	6	postemergence	1.5–2.0 pt	0.75–1.0
<ul style="list-style-type: none"> • Application should be made while weeds are small and actively growing and before weeds reach maximum size listed on product label. Basagran will not control pigweed species. • Add crop oil concentrate or nitrogen solution to spray mixture as directed. • Apply in a minimum of 20 gal of water/A and at minimum pressure of 40 psi. • Tank-mixing with Ultra Blazer improves pigweed control. • Apply at least 30 days prior to harvest as forage. • <i>Water quality advisory.</i> 					
Butyrac 200 2L	2,4-DB	4	postemergence	0.7–0.9 pt	0.175–0.22
<ul style="list-style-type: none"> • 2,4-DB is not recommended for use by itself due to limited control and potential for crop injury. Rather 2 oz of 2,4-DB can improve morningglory, cocklebur, and jimsonweed control when tank-mixed with other postemergence herbicides. • Potential for crop injury is increased under hot, dry growing conditions. • If more than 2 oz/A rate is used, apply as directed spray into rows when soybeans are 8 to 12 inches high and cocklebur, morningglory, jimsonweed and pigweed have not exceeded a height of 3 inches. • Top of weed seedling must be sprayed. Use precision directed spray application equipment. Apply with sprayer nozzles mounted on skids or gauge wheels. Do not spray more than one-third of the base of soybean as severe injury may occur. • Apply at least 60 days prior to harvest (forage or grain). 					
Cadet 0.91EC	fluthiacet	14	emergence to full flowering (R2)	0.4–0.9 fl oz	0.0028–0.006
<ul style="list-style-type: none"> • Apply 0.4 to 0.6 fl oz/A with glyphosate (RR-soybean) or glufosinate (LL-soybean); or 0.6 to 0.9 fl oz when applied alone. • Include the necessary spray additives (NIS or COC plus AMS or nitrogen solution). Applications should be made when susceptible broadleaf weeds are small. Cadet is very effective on velvetleaf, but other broadleaf weeds must be small (less than 3 inches) to achieve control/suppression. Tank-mixing with other herbicides will usually be necessary to provide broad-spectrum weed control. • Cadet does not provide residual weed control. • Cadet can cause bronzing or browning of the soybean leaves. • Marvel is prepackaged mixture with Reflex and Cadet; but rate of Reflex is below what is typically recommended and needed for effective weed control. • Apply at least 60 days prior to grain harvest. 					

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Table 5.54 - Comments on Postemergence Herbicides for Soybean (cont.)

Trade Name	Herbicide Common Name	Site of Action Number	Application	Product/A	Active Ingredient (ai) lb/A
Classic 25DF	chlorimuron	2	after 1st trifoliolate (V1)	0.5–0.75 oz wt	0.008–0.012
<ul style="list-style-type: none"> • Application should be made while weeds are small and actively growing. • Always read the label to determine the proper adjuvants. • Observe labeled rotational crop restrictions for all products containing Classic (see Table 5-5). • If the soil pH is greater than 7.0, at Classic rates of 0.5 oz/A or greater, do not plant corn for at least 9 months after application. Use of STS and Bolt varieties will reduce the risk of injury. • Classic plus Harmony SG is available as a prepackaged mixture called Synchrony XP. Synchrony XP can be applied to non-STS soybean varieties at 0.375 oz/A use rate or to STS and Bolt varieties at rates up to 1.125 oz/A. • There is widespread resistance to Classic and other Group 2 herbicides in the region. • Apply at least 60 days prior to harvesting for grain. 					
Cobra 2E	lactofen	14	postemergence	6.0–12.5 fl oz	0.09–0.19
<ul style="list-style-type: none"> • Soybeans should have one to two trifoliolate leaves. • Applications should be made while weeds are small and actively growing. • Use surfactant or crop oil concentrate as directed. • Cobra often causes foliar injury to soybeans. • Use 6–8 fl oz/A for control of four- to six-leaf common ragweed or pigweed. • Apply at least 45 days prior to harvesting for grain or prior to R6 (full seed). 					
Enlist One 3.8SL	2,4-D choline	4		1.5–2 pt	0.71–0.95 ae
Enlist Duo 3.3SL	2,4-D choline + glyphosate	4 9	emergence up to R2	3.5–4.75 pt	0.71–0.95 ae 0.74–1.0 ae
<ul style="list-style-type: none"> • Apply over-the-top to 2,4-D tolerant (Enlist E3) soybean varieties only. • Apply in a broadcast spray volume from 10 to 15 gallons per acre for best results. • Applications should be made while weeds are small (4 inches) and actively growing. • Do not apply more than one preemergence application and no more than two postemergence applications per season. • Make one to two applications with a minimum of 12 days between applications. • Spray droplet size plays an important role in minimizing off-target movement. Nozzles that produce extremely coarse or ultra-coarse droplets while limiting the amount of driftable fine droplets are necessary to limit drift. Comply with guidelines for drift management (see labels for details). • Reduced grass control can occur when tank-mixed with group 1 herbicides as well as glyphosate. • Refer to product label and Enlist.com/TankMix for details on approved adjuvants, drift reduction agents, other tank mixes, drift management, recommended nozzles and pressures, wind speed, boom height, temperature inversions, buffers, susceptible plants, spray equipment cleanout, and other use guidelines that must be followed when using these products. • For all applications, consult label for run-off mitigation measures. • Available online training: https://www.enlist.com/en/enlist-360-training.html. 					

Table 5.54 - Comments on Postemergence Herbicides for Soybean (cont.)

Trade Name	Herbicide Common Name	Site of Action Number	Application	Product/A	Active Ingredient (ai) lb/A
Engenia	dicamba BAMPA Salt	4	N/A	12.8 fl oz for Engenia	0.5 (ae)
XtendiMax	dicamba DGA Salt with VaporGrip			22 fl oz for Xtendimax	0.5 (ae)
<ul style="list-style-type: none"> • These herbicides may not have registration in 2021 and beyond. Carefully read and follow product labels. • As of July 31, 2024 (and at the time of printing this publications), use of Engenia, XtendiMax, and Tavium is prohibited per the District Court of Arizona's order and the EPA's existing stocks order. • Refer to product label and Engeniatankmix.com and xtendimaxapplicationrequirements.com for details. 					
FirstRate 84WDG	cloransulam	2	1 st trifoliolate to R1	0.3–0.6 oz	0.016–0.031
<ul style="list-style-type: none"> • Tank-mix to broaden weed spectrum. • FirstRate may be applied up to 0.6 oz for heavy weed infestations or added residual control. • FirstRate water-dispersible packets are not soluble in liquid fertilizer solutions; premixing in water is required. UAN will improve velvetleaf control. • Two applications of 0.3 oz/A are allowed. Do not exceed 1.05 oz/A per season. • FirstRate is a Group 2 herbicide, and there is wide-spread resistance in the region to this family of herbicides. • Apply at least 65 days prior to harvesting for grain and 14 days prior to harvesting for forage. • <i>Water quality advisory.</i> 					
Flexstar GT 3.5	glyphosate + fomesafen	9 + 14	postemergence	3–4.5 pt	1.0–1.47 (ae) + 0.24–0.35
<ul style="list-style-type: none"> • Prepackaged mixture of glyphosate plus Reflex; refer to comments in those sections for more information. 					
Fusilade DX 2E	fluazifop	1	postemergence	6–12 fl oz	0.09–0.18
Fusion 2.56EC	fluazifop + fenoxaprop	1 + 1	postemergence	6–12 fl oz	0.094–0.188 0.031–0.062
<ul style="list-style-type: none"> • See label for rate and size of weed to be controlled. • Most annual grasses should be treated when 2–4 inches in height. Perennial grasses may require second application to achieve complete control. • To avoid antagonism (reduced grass control) from broadleaf herbicides, spray 2-3 days before the broadleaf herbicide or wait 7 days after the broadleaf herbicide application. • Apply before soybeans begin to bloom. 					

Table 5.54 - Comments on Postemergence Herbicides for Soybean (cont.)

Trade Name	Herbicide Common Name	Site of Action Number	Application	Product/A vary by formulation and acid equivalent ¹	Active Ingredient (ai) lb/A
Glyphosate	glyphosate	9	postemergence		0.75–1.5 (ae)

- Apply over-the-top to glyphosate-resistant (Roundup Ready) soybean varieties only.
- There are many formulations available, but sure to read the label for rates, adjuvants etc.
- Treat in-crop from soybean emergence through full flowering of soybeans.
- If additional weed emergence is anticipated, consider including a herbicide that provides residual control.
- Perennial weeds may require higher rates and repeat applications. Best control may be obtained when perennial weeds are treated in the bud to bloom growth stage.
- Include ammonium sulfate in the tank to improve control of weeds and be sure to read the label to determine if additional adjuvants are required or recommended.
- Observe maximum rates per application and per crop.
- If glyphosate-resistant weeds are present or Palmer amaranth is in the vicinity, include a second, highly effective herbicide to control these species.
- Avoid drift to adjacent crops or other desirable vegetation.

¹Consult specific product label for active ingredient concentration and application rate; various formulations of this herbicide are available (e.g., 1 qt/A glyphosate = 22 fl oz/A WeatherMax).

Harmony SG 50DF	thifensulfuron	2	at least 1st trifoliolate (V1)	0.125 oz wt (1/8 oz)	0.004
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- Harmony SG is a very concentrated formulation. Be sure to use proper application rate otherwise soybean injury may occur.
- Various formulations of Harmony 50SG and generic 75DF thifensulfuron are available, be sure proper rate is applied.
- Apply when weeds are actively growing and before they reach maximum size listed on product label.
- Any crop may be planted within 45 days following Harmony SG application.
- For adequate velvetleaf control, add 1 gallon of liquid nitrogen solution per acre.
- Use of STS or Bolt varieties will reduce the risk of injury.
- Harmony SG plus Classic is available as a pre-packaged mixture called Synchrony XP.
- Harmony SG plus Sandea/Permit is available as a pre-packaged mixture called Permit Plus.
- Synchrony XP can be applied to non-STS soybean varieties at 0.375 oz/A use rate or to STS or Bolt varieties at rates up to 1.125 oz/A rate.
- Harmony SG, generic thifensulfuron products, Permit Plus, and Synchrony XP labels state that the first trifoliolate leaf of the soybean is fully expanded before the application is made.
- Apply Harmony 7 days before harvesting forage green; 30 days before harvesting dried forage; and 60 days before harvesting for grain.
- Harmony is a Group 2 herbicide, and there is wide-spread resistance in the region to this family of herbicides.

Table 5.54 - Comments on Postemergence Herbicides for Soybean (cont.)

Trade Name	Herbicide Common Name	Site of Action Number	Application	Product/A	Active Ingredient (ai) lb/A
Intermoc	S-metolachlor + glufosinate	15 10	postemergence	64 fl oz	1.79
<ul style="list-style-type: none"> • Apply over-the-top to glufosinate-resistant soybean varieties (e.g., LibertyLink) only. • Apply a minimum of 64 fl oz/A to young, actively growing weeds. • Include AMS 2-4 lb/A. • Do not use nitrogen solutions as spray carriers. • Do not apply more than 2 applications per year, and do not apply more than 5 days apart. • Do not apply more than 122 fl oz/A per year. • <i>Water quality advisory.</i> 					
Liberty/Interline/ Scout/Others 2.34L	glufosinate	10	emergence to bloom stage (R1)	32–43 fl oz	0.59–0.79
<ul style="list-style-type: none"> • Apply over-the-top to glufosinate-resistant soybean varieties (e.g., LibertyLink) only. • For best results, plant in narrow rows and apply up to 43 fl oz Liberty about 4 weeks after residual herbicides were applied, when weeds are 2–4 inches tall, and before soybean canopy begins to interfere with spray coverage. • If using sequential applications, apply 10–14 days apart and do not apply more than 87 fl oz/A/season and before soybean bloom stage. • A residual soil-applied product or a sequential POST application may be necessary depending on weed species and severity. • Liberty provides no soil residual activity. • Tank-mixing Liberty with other herbicides including residual products (e.g., Dual, Outlook, Warrant) is allowed. Local university research has not observed increased injury with most herbicide combinations; some stunting and leaf burn was observed when Liberty was tank-mixed with Prefix. • Liberty must be applied with ammonium sulfate at the rate of 3 lb/A. • Use of surfactants or crop oils may increase risk of crop response. • Uniform, thorough spray coverage is necessary to achieve consistent weed control; do not use nozzles that produce large droplets; use at least 15 gal/A, 20 gal/A if dense vegetation is present. • Applications should be made between 2 hours after sunrise and 1 hour before sunset to avoid the possibility of reduced weed control. • Liberty has been observed to antagonize grass control with postemergence grass herbicides. • Apply 70 days before harvesting for grain or forage. • A premix with quizalofop (Assure II) is available as Zalo. 					
Permit Plus 74WDG	halosulfuron + thifensulfuron	2 2	1st trifoliolate to R2 stage	0.75 oz wt	0.031 0.004
<ul style="list-style-type: none"> • Permit Plus is labeled only for STS or Bolt varieties. • Permit Plus can be applied from V1 stage up till 88 days before harvest. • Permit Plus is excellent for yellow nutsedge control. • Can be tank-mixed with glyphosate. • See Harmony entry for more information. • Permit Plus contains two Group 2 herbicides, and there is wide-spread resistance in the region to this family of herbicides. 					

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Table 5.54 - Comments on Postemergence Herbicides for Soybean (cont.)

Trade Name	Herbicide Common Name	Site of Action Number	Application	Product/A	Active Ingredient (ai) lb/A
Poast 1.5E	sethoxydim	1	postemergence	0.75–1.5 pt	0.14–0.28

- Application should be made when grasses are actively growing and within the recommended stage of growth on the Poast label. Perennial grasses may require a second application to achieve complete control.
- Nitrogen fertilizer additives may improve control of some species.
- To avoid antagonism (reduced grass control) from broadleaf herbicides, spray 2-3 days before the broadleaf herbicide or wait 7 days after the broadleaf herbicide application.
- Poast must be applied at least 75 days before harvest.

Pursuit 2S	imazethapyr	2	before bloom (R1)	4 fl oz	0.063
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- A prepackaged mixture with glyphosate is available as Extreme. The amount of glyphosate is lower than the rate commonly used with glyphosate is applied alone.
- Only one application of Pursuit can be made per soybean growing season.
- Extreme can only be applied to soybean varieties designated Roundup Ready.
- Observe rotational restrictions for products containing imazethapyr.
- Pursuit is a Group 2 herbicide, and there is wide-spread resistance in the region to this family of herbicides.
- Apply at least 85 days prior to grain harvest.
- *Water quality advisory.*

Raptor/Beyond Xtra 1S	imazamox	2	before bloom (R1)	4–5 fl oz	0.031–0.039
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- Occasionally, internode shortening and/or temporary yellowing of soybeans may occur, especially if under environmental stress.
- When adequate soil moisture is present, Raptor will provide residual activity of susceptible germinating weeds.
- Apply when weeds are actively growing and before they reach the maximum size listed on product label. Add a nonionic surfactant and fertilizer solution as directed).
- Less persistent than Pursuit, but follow labeled rotational crop restrictions
- Raptor is a Group 2 herbicide, and there is wide-spread resistance in the region to this family of herbicides.
- Apply at least 85 days prior to grain harvest.

Table 5.54 - Comments on Postemergence Herbicides for Soybean (cont.)

Trade Name	Herbicide Common Name	Site of Action Number	Application	Product/A	Active Ingredient (ai) lb/A
Reflex 2E or Flexstar 1.88E	fomesafen	14	postemergence	1.0–1.5 pt	0.25–0.375 or 0.235–0.35

- Do not apply Reflex or Flexstar or other fomesafen containing products more than once every 2 years.
- Follow labeled rotation restrictions (see Table 5.3).
- Flexstar can cause more soybean injury than Reflex.
- Prefix is a premix of Reflex and Dual and must be applied at least 90 days before grain harvest.
- Tankmixing Reflex with glyphosate formulated as a potassium salt can cause compatibility issues; glyphosate formulations as isopropyl or diammonium salts do not have this issue.
- Flexstar GT contains glyphosate plus fomesafen and should be applied only to glyphosate-resistant soybeans.
- Marvel is prepackaged mixture with Reflex and Cadet; but rate of Reflex is below what is typically recommended and needed for effective weed control.
- Prefix is a premix of Reflex and Dual and must be applied at least 90 days before grain harvest; Warrant Ultra is a premix of Reflex with Warrant and must be applied at least 45 days before grain harvest. Both have low ratio of Reflex and is below what is typically recommended for effective control.
- Apply Reflex 45 days prior to grain harvest.
- Do not apply within 14 days of an application of saflufenacil (Kixor or Sharpen).
- *Water quality advisory.*

Resource 0.86EC	flumiclorac	14	postemergence	4–12 fl oz	0.027–0.08
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- Apply to actively growing weeds at growth stages recommended on the label.
- Tank-mixing broadens the weed-control spectrum use higher rates for larger velvetleaf. Resource has activity against several other weeds when they are in the two- to three-leaf stage, including cocklebur, lambsquarters, common ragweed, jimsonweed, pigweed species, and prickly sida, but control declines on larger weeds.
- Apply in a minimum of 10 gal of water/A and a minimum pressure of 30 psi.
- In most cases, use a crop oil concentrate or other additive according to produce label.
- Apply at least 60 days prior to grain harvest.

Select 2E or Select Max 0.97EC/ Shadow 3EC	clethodim	1	postemergence	6–16 fl oz or 6–32 fl oz/ 4–10.67 fl oz	0.094–0.25 or 0.05–0.25/ 0.094–0.25
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- Clethodim is also available as Select Max, which contains a specialized adjuvant system, thus nonionic surfactant plus ammonium sulfate (AMS) is the standard adjuvant recommendation. Also, Select Max does not require additional adjuvants (other than AMS) when tank-mixed with a “loaded” glyphosate product and provides greater flexibility in additive selection when tank-mixed with other products.
- Select 2E should always include crop oil concentrate at 1 qt/A. Add ammonium sulfate at 2.5 lb/A to improve quackgrass control.
- Shadow 3EC should always include crop oil concentrate at 1 qt/A and ammonium sulfate at 2.5 to 4 lb/A or urea ammonium nitrate at 1 to 2 qt/A..
- To avoid antagonism (reduced grass control) from broadleaf herbicides, spray 2-3 days before the broadleaf herbicide or wait 7 days after the broadleaf herbicide application.
- Apply at least 60 days prior to grain harvest.

Table 5.54 - Comments on Postemergence Herbicides for Soybean (cont.)

Trade Name	Herbicide Common Name	Site of Action Number	Application	Product/A	Active Ingredient (ai) lb/A
Storm	bentazon + acifluorfen	6 + 14	postemergence	1–1.5 pt	0.33–0.5 0.167–0.25

- Prepackaged mixture of Basagran plus Ultra Blazer; refer to comments in those sections for more information.
- Apply at least 50 days prior to grain harvest.

Synchrony XP 28.4XP	chlorimuron + thifensulfuron	2 + 2	fully expanded 1 st trifoliolate (V1)	0.375–1.125 oz	0.005–0.015 + 0.0016–0.0045
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- Synchrony XP may be applied postemergence to STS or Bolt soybeans at a use rate of 0.375–1.125 oz/A; and to non-STS soybeans at 0.375 oz/A.
- Synchrony XP may be tank-mixed to improve weed control spectrum.
- Carefully observe crop rotation intervals and note that extended crop rotation intervals apply when Synchrony XP is applied following preemergence applications of other sulfonylurea or imidazolinone herbicides.
- Synchrony contains two Group 2 herbicides, and there is wide-spread resistance in the region to this family of herbicides.
- Apply at least 60 days before harvest.

Ultra Blazer 2S	acifluorfen	14	at least 1 trifoliolate (V1)	0.5–1.5 pt	0.125–0.38
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- Apply in a minimum of 20 gal of water/A and at a minimum pressure of 40 psi.
- Do not apply when weeds or crop are under stress; applications made under these conditions generally will be less satisfactory than those made under optimum conditions.
- Tank-mixing with Basagran improves velvetleaf and common lambsquarters control.
- Apply at least 50 days prior to grain harvest.
- *Water quality advisory.*

¹ Various glyphosate formulations exist; see Table 5.1 (glyphosate formulations for more information).

Table 5.55 - Spray Additives and Rainfastness for “Burndown” or Postemergence Soybean Herbicides

Spray additives, or adjuvants, are products included in the spray tank to improve the performance of herbicides. These include non-ionic surfactants (NIS), crop oil concentrate (COC), methylated or ethylated seed oil (MSO or ESO), or nitrogen solutions. In general, NIS should contain at least 80% active ingredient and COC should contain at least 15% emulsifier. Nitrogen solutions can be 28, 30, or 32% ammonium-based fertilizer solutions; ammonium sulfate (AMS) should be spray-grade dry ammonium sulfate (21-0-0) or other equivalent liquid formulation of AMS (refer to product label for use rate information).

Trade Names	Adjuvant(s)	Rate	Rainfastness (hours)
2,4-D (burndown)	none recommended		1
	or non-ionic surfactant	1 qt/100 gal	
	or crop oil concentrate	1–2 qt/A	
Aim, Cadet, Marvel	non-ionic surfactant	2 pt/100 gal	1
	or crop oil concentrate plus	1 gal/100 gal	
	ammonium sulfate or	2–4 lb/A	
	nitrogen solution (optional)	2–4 gal/100 gal	

Table 5.55 - Spray Additives and Rainfastness for “Burndown” or Postemergence Soybean Herbicides (cont.)

Spray additives, or adjuvants, are products included in the spray tank to improve the performance of herbicides. These include non-ionic surfactants (NIS), crop oil concentrate (COC), methylated or ethylated seed oil (MSO or ESO), or nitrogen solutions. In general, NIS should contain at least 80% active ingredient and COC should contain at least 15% emulsifier. Nitrogen solutions can be 28, 30, or 32% ammonium-based fertilizer solutions; ammonium sulfate (AMS) should be spray-grade dry ammonium sulfate (21-0-0) or other equivalent liquid formulation of AMS (refer to product label for use rate information).

Herbicide	Adjuvant(s)	Rate	Rainfastness (hours)
Assure II/Targa	non-ionic surfactant	1 qt/100 gal	1
	or crop oil concentrate	4 qt/100 gal	
Basagran	crop or vegetable oil concentrate	5 qt/100 gal (2 pt/A maximum)	8
	or nitrogen solution	2–4 qt/A	
	or ammonium sulfate (for velvetleaf)	2.5 lb/A	
Classic	non-ionic surfactant	1 qt/100 gal	1
	or crop oil concentrate	1 gal/100 gal	
	plus nitrogen solution	2–4 pt/A	
	or ammonium sulfate (for velvetleaf)	2–4 lb/A	
Cobra ¹	noni-onic surfactant	1 qt/100 gal	0.5
	or crop oil concentrate	1–2 pt/100 gal	
	plus/or nitrogen solution	4 qt/A	
	or ammonium sulfate	2.5 lb/A	
Elevore (burndown)	crop oil concentrate or	4–8 pt/100 gal	1
	methylated seed oil	4–8 pt/100 gal	
Enlist One	consult https://www.enlist.com/en/herbicides/approved-tank-mix.html		1
Enlist Duo	consult https://www.enlist.com/en/herbicides/approved-tank-mix.html		1
Envive (burndown)	crop oil/modified seed oil	1 gal/100 gal	1
	or nonionic surfactant	1 qt/100 gal	
FirstRate	non-ionic surfactant	1–2 pt/100 gal	2
	plus nitrogen solution	2.5 gal/100 gal	
	or ammonium sulfate	2 lb/A	
	or crop oil concentrate	1.2 gal/100 gal	
	plus nitrogen solution (optional)	2.5 gal/100 gal	
Flexstar	non-ionic surfactant	1–2 qt/100 gal	1
	or crop oil concentrate	2–4 qt/100 gal	
	plus nitrogen solution	1 gal/100 gal (minimum)	
	or ammonium sulfate	4 lb/100 gal (minimum)	
Flexstar GT	ammonium sulfate	8.5–17 lb/100 gal	1
Fusilade	non-ionic surfactant	1–2 qt/100 gal	1
	or crop oil concentrate	2–4 qt/100 gal	
	plus nitrogen solution	1 gal/A	
	or 10–34–0 (optional)	2 pt/A	

Table 5.55 - Spray Additives and Rainfastness for “Burndown” or Postemergence Soybean Herbicides (cont.)

Spray additives, or adjuvants, are products included in the spray tank to improve the performance of herbicides. These include non-ionic surfactants (NIS), crop oil concentrate (COC), methylated or ethylated seed oil (MSO or ESO), or nitrogen solutions. In general, NIS should contain at least 80% active ingredient and COC should contain at least 15% emulsifier. Nitrogen solutions can be 28, 30, or 32% ammonium-based fertilizer solutions; ammonium sulfate (AMS) should be spray-grade dry ammonium sulfate (21-0-0) or other equivalent liquid formulation of AMS (refer to product label for use rate information).

Herbicide	Adjuvant(s)	Rate	Rainfastness (hours)
Fusion	non-ionic surfactant	1–2 qt/100 gal	1
	or crop oil concentrate	2–4 qt/100 gal	
	plus nitrogen solution (optional)	4 gal/100 gal	
Glyphosate	non-ionic surfactant	2 qt/100 gal	1–6
	plus ammonium sulfate (optional)	8.5–17 lb/100 gal	
Gramoxone SL 2.0 or 3.0	non-ionic surfactant	1 qt/100 gal	0.5
	or crop oil concentrate	1 gal/100 gal	
Harmony Extra/ FirstShot/Audit (burndown)	non-ionic surfactant	0.5–2/100 gal	
	or crop oil concentrate	1 gal/100 gal	
	or methylated seed oil	1 gal/100 gal	
	plus ammonium nitrogen fertilizer	2 qt/acre	
Harmony SG ²	non-ionic surfactant	1–2 pt/100 gal	1
	or crop oil concentrate	2 qt/100 gal	
	plus nitrogen solution	4 gal/100 gal	
	or ammonium sulfate (for velvetleaf)	2–4 lb/A	
Liberty/Interline/Scout/ Others	ammonium sulfate	3 lb/A	4
Permit Plus	non-ionic surfactant	1–2 pt/100 gal	4
	or crop oil concentrate	2 qt/100 gal	
	plus nitrogen solution	4 gal/100 gal	
	or ammonium sulfate (for velvetleaf)	2–4 lb/A	
Perpetuo	crop oil concentrate or	1 pt/A	1
	methylated seed oil	1 pt/A	
Poast	crop or vegetable oil concentrate	2 pt/A	1
	or Dash HC	1 pt/A	
	plus nitrogen solution	2–4 qt/A	
	or ammonium sulfate (certain species)	2.5 lb/A	
Prefix	non-ionic surfactant	1 qt/100 gal	1
	DO NOT use crop oil concentrate	–	
Pursuit	non-ionic surfactant	1 qt/100 gal	1
	or crop oil concentrate	2 pt/A	
	or vegetable oil concentrate	1.5–2 pt/A	
	plus nitrogen solution	1–2 qt/A	
	or ammonium sulfate	2.5 lb/A	

Table 5.55 - Spray Additives and Rainfastness for “Burndown” or Postemergence Soybean Herbicides (cont.)

Spray additives, or adjuvants, are products included in the spray tank to improve the performance of herbicides. These include non-ionic surfactants (NIS), crop oil concentrate (COC), methylated or ethylated seed oil (MSO or ESO), or nitrogen solutions. In general, NIS should contain at least 80% active ingredient and COC should contain at least 15% emulsifier. Nitrogen solutions can be 28, 30, or 32% ammonium-based fertilizer solutions; ammonium sulfate (AMS) should be spray-grade dry ammonium sulfate (21-0-0) or other equivalent liquid formulation of AMS (refer to product label for use rate information).

Herbicide	Adjuvant(s)	Rate	Rainfastness (hours)
Raptor/Beyond Xtra	crop oil concentrate	2 pt/A	1
	or vegetable seed oil	1.5–2 pt/A	
	or nonionic surfactant	1 qt/100 gal	
	plus nitrogen solution	1–2 qt/A	
	or ammonium sulfate	2.5 lb/A	
Reflex	non-ionic surfactant	1–2 qt/100 gal	1
	or crop oil concentrate	2–4 qt/100 gal	
	plus nitrogen solution (optional)	4 qt/A	
Resource	crop oil concentrate	2–4 qt/100 gal	1
	plus nitrogen solution (optional)	2–4 qt/A	
Reviton	methylated seed oil	1 gal/100 gal	1
	plus ammonium sulfate	8.5 lb/100 gal	
	or nitrogen solution	2.5 gal/100 gal	
Roundup WeatherMax/ PowerMax	no NIS/COC required		<1
	ammonium sulfate (optional)	8.5–17 lb/100 gal	
Select	crop oil concentrate	2–4 qt/100 gal	1
	plus nitrogen solution (optional)	1–2 qt/A	
Sharpen (burndown)	methylated seed oil	1 gal/100 gal	1
	plus ammonium sulfate	8.5–17 lb/100 gal	
	or nitrogen solution	1.25–2.5 gals/100 gal	
Storm	non-ionic surfactant	1–2 pt/100 gal	8
	or crop oil concentrate	1–2 pt/A	
	or nitrogen solution	2 qt/A	
	or ammonium sulfate (for velvetleaf or pigweed)	2 lb/A	
Synchrony XP	crop oil concentrate	1 gal/100 gal	1
	plus nitrogen solution	2–4 qt/A	
	or 10-34-0	1–2 qt	
	or ammonium sulfate (for velvetleaf)	2–4 lb/A	
Ultra Blazer	non-ionic surfactant	1–2 pt/100 gal	6
	or crop oil concentrate	1–2 pt/100 gal	
	or ammonium sulfate	2.5 lb/A	
	or nitrogen solution (for velvetleaf)	2–4 qt/A	

Table 5.55 - Spray Additives and Rainfastness for “Burndown” or Postemergence Soybean Herbicides (cont.)

Spray additives, or adjuvants, are products included in the spray tank to improve the performance of herbicides. These include non-ionic surfactants (NIS), crop oil concentrate (COC), methylated or ethylated seed oil (MSO or ESO), or nitrogen solutions. In general, NIS should contain at least 80% active ingredient and COC should contain at least 15% emulsifier. Nitrogen solutions can be 28, 30, or 32% ammonium-based fertilizer solutions; ammonium sulfate (AMS) should be spray-grade dry ammonium sulfate (21-0-0) or other equivalent liquid formulation of AMS (refer to product label for use rate information).

Herbicide	Adjuvant(s)	Rate	Rainfastness (hours)
Valor SX/EZ (burndown)	crop oil concentrate	1–2 pt/A	1
	or methylated seed oil	1 gal/100 gal	
	or non-ionic surfactant	1 qt/100 gal	
	plus ammonium sulfate (optional)	8.5–17 lb/100 gal	
Valor XLT (burndown)	crop oil concentrate	1–2 pt/A	1
	or non-ionic surfactant	1 qt/100 gal	
	plus ammonium sulfate (optional)	8.5–17 lb/100 gal	
Warrant Ultra	non-ionic surfactant	1–2 qt/100 gal	1
	or crop oil concentrate	2–4 qt/100 gal	

¹ Adjuvants for use with Cobra depend on relative humidity and weed species.

² Use crop oil concentrate (COC) under drought-stressed conditions.

Table 5.56 - Grain Harvesting Interval and Forage Restrictions for Soybean Herbicides

Trade Name	Forage (ok to feed)	Grain (days to harvest)
2,4-D	no	—*
2,4-DB	60 days	60
Afforia	no	—
Aim, Cadet	no	60
Antares Complete	40 days	—
Anthem Maxx	no	60
Assure II/Targa	no	80
Authority Edge	—	—
Authority Elite	30	—
Authority First/Sonic	no	65
Authority MTZ	no	—
Authority Supreme	—	—
Authority XL	no	—
Basagran	30 days	none
Boundary	40 days	—
BroadAxe XC	30 days	—
Canopy DF/Blend	no	—
Classic	no	60
Cobra	no	45
Command	no	—

Table 5.56 - Grain Harvesting Interval and Forage Restrictions for Soybean Herbicides (cont.)

Herbicide	Forage (ok to feed)	Grain (days to harvest)
Dual II Magnum	no	—
Elevore	—	—
Enlist One/Enlist Duo	56 days	30
Envive	no	—
Fierce/Fierce EZ/Fierce XLT	no	—
FirstRate	14 days	65
Flexstar GT	no	45
Fusilade	no	before bloom
Fusion	no	before bloom
Gangster	no	—
Glyphosate	no	14
Gramoxone (preharvest)	no	application restriction ¹
Harmony SG	7 days (green), 30 days (dried)	60
Intermoc	no	90
Liberty	70 days	70
Lorox	yes	—
Marvel	no	60
Metribuzin	40 days	—
OpTill	no	85
OpTill PRO	no	85
Outlook	no	—
Panther MTZ	no	90
Panther Pro	no	85
Permit Plus	30 days	88
Perpetuo	no	60
Poast/Poast Plus	yes ²	75
Prefix	no	90
Preview 2:1	no	—
Prowl	yes	—
Pursuit	no	85
Python	no	—
Raptor/Beyond Xtra	no	85
Reflex/Flexstar	no	45
Resource	no	60
Reviton	—	—
Roundup (in-crop) ³	14 days	14
Select	no	60
Sequence	no	90

Table 5.56 - Grain Harvesting Interval and Forage Restrictions for Soybean Herbicides (cont.)

Herbicide	Forage (ok to feed)	Grain (days to harvest)
Sharpen	65 days	—
Storm	no	50
Surveil	no	—
Synchrony XP	no	60
Tendovo	45 days	75
Treflan	yes	—
Trivence	no	—
Ultra Blazer	no	50
Valor SX/Valor EZ/Valor XLT	no	—
Warrant/Enversa	no	no
Warrant Ultra	no	45
Zidua	yes	—
Zidua PRO	no	85
Zone Defense	no	—

* — = not addressed on the label.

¹ When at least 65% of the seed pods have reached a mature brown, or when seed moisture is 30% or less.

² Do not feed green forage.

³ Allow 7 days between preharvest application and grain harvest.

Table 5.57 - Comments on Harvest Aids for Soybeans

Treatments are based on broadcast application, not wiper-bar or rope-wick applications.

Trade Name	Common Name	Site of Action		Product/A	lb ai/A
		Number	Timing		
Aim 2EC	carfentrazone	14	At least 3 days before harvest	1.5 fl oz	0.024

- Use as a harvest aid to desiccate a limited number of broadleaf weed species.
- Use a non-ionic surfactant at 2 pt/100 gal spray solution or crop oil concentrate at 1 gal/100 gal spray solution plus ammonium sulfate at 2-4 lb/A or nitrogen solution at 2-4 gal/100 gal spray solution.
- Application shall be made when the crop is mature and the grain has begun to dry down. Do not apply within 3 days of harvest.
- Apply in 10 gal/A water.
- Do not feed treated soybean forage or hay to livestock.
- Include necessary adjuvants and make sure spray coverage is sufficient, otherwise poor control will result.

Table 5.57 - Comments on Harvest Aids for Soybeans (cont.)

Treatments are based on broadcast application, not wiper-bar or rope-wick applications.

Trade Name	Common Name	Site of Action Number	Timing	product/A	lb ai/A
Clarity 4S	dicamba	4	At least 7 days before harvest	8–64 fl oz	0.25–2.0
<ul style="list-style-type: none"> • Apply Clarity to actively growing weeds after soybean pods have reached mature brown color and at least 75% leaf drop has occurred. • Use a non-ionic surfactant at 1 qt/100 gal spray solution or crop oil concentrate at 1 gal/100 gal spray solution plus nitrogen solution at 2-4 qt/A. • Do not feed soybean fodder or hay following a pre-harvest application of Clarity. • <i>Water quality advisory.</i> 					
Defol 5	sodium chlorate		7 to 10 days before harvest	4.8 qts	6.0
<ul style="list-style-type: none"> • Labeled to dry weeds in early maturing soybeans and to facilitate harvest. • Apply to soybeans 7 to 10 days before anticipated harvest, when beans are mature and ready to harvest. • No adjuvant recommended. • Do not graze treated field or feed treated fodder. • Apply in at least 5 gals of water by air, and 20 gals of water with ground application. 					
Glyphosate	glyphosate	9	At least 7 days before harvest	varies with formulation	Up to 0.75
<ul style="list-style-type: none"> • Refer to individual herbicide label to be sure the formulation used is labeled for this type of application. • Apply glyphosate to soybeans after pods have set and lost all green color (80–90% drop of leaves has occurred). • Use a non-ionic surfactant at 2 qt/100 gal spray solution plus ammonium sulfate (optional) at 8.5-17 lb/100 gal spray solution. • Apply glyphosate in 10–20 gallons of water/A to control weeds that may interfere with harvest or to control perennials such as quackgrass or Canada thistle. • Do not graze or harvest the treated crop for livestock feed within 25 days of application. • Do not use on soybeans grown for seed. • Will not control glyphosate-resistant weeds, nor dry down Roundup Ready varieties. • See Table 5.1 (glyphosate table) for more information on glyphosate formulations. 					

Table 5.57 - Comments on Harvest Aids for Soybeans (cont.)

Treatments are based on broadcast application, not wiper-bar or rope-wick applications.

Trade Name	Common Name	Site of Action Number	Timing	product/A	lb ai/A
Gramoxone SL 2.0 Gramoxone SL 3.0	paraquat	22	At least 15 days before grain harvest; at least 3 days before soybean grown for seed harvest	8–16 fl oz 5.4–10.7 fl oz	0.125–0.25

- Gramoxone may be used for drying certain weeds and quickening berry drop of Eastern black nightshade just before soybean harvest.
- Soybean plants must be mature. For indeterminate varieties: 65% or more of the seed pods have reached mature brown color or seed moisture is 30% or less. For determinate varieties: beans are fully developed, half of leaves had dropped, and remaining leaves are yellowing.
- Use a non-ionic surfactant at 1 pt/100 gal spray solution or crop oil concentrate at 1 gal/100 gal spray solution.
- Do not graze or harvest for forage or hay.

Paraquat Use Restrictions

- *Restricted-use pesticide.*
- Only certified applicators, who successfully complete the paraquat-specific training, can mix, load or apply paraquat.
- Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed; registered technicians cannot apply.
- Required training link (<http://usparaquattraining.com>); certified applicators must repeat training every three years.

Sharpen 2.85SC	saflufenacil	14	At least 3 days before harvest	1.0–2.0 fl oz	0.022–0.044
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- Apply after physiological maturity when greater than 50% leaf drop has occurred and remaining leaves are yellow.
- Include methylated seed oil (MSO) at 1 gal/100 gals (1% v/v) plus ammonium sulfate (AMS) at 8.5 to 17 lbs/100 gals or urea ammonium nitrate (UAN) at 1.25 to 2.5 gals/100 gals.
- Do not apply to soybeans grown for seed production.

Table 5.58 - Soybean Herbicide Half-Lives and Their Potential to Injure Fall Cover Crops

This table does not directly address preharvest establishment of cover crops such as interseeding or aerial seeding, which may be more restrictive. Cover crops that are harvested are subject to herbicide residue restrictions, which are not addressed in this table.

Herbicide	Active ingredient	Normal Rate/acre	Half life (days) ¹	Fall cover crops OK to plant	Concern for Fall cover crops	Other
2,4-D Amine 4 (2,4-D LV 4)	2,4-D	1-2 pt	7	All grasses	Wait 30 days before planting sensitive broadleaves	Amine formulations more water soluble and can leach into seed zone
Assure II/Targa	quizalofop	8 oz	60	Most broadleaves	All grasses if less than 120 days or at high rates	Plant anything after 120 days

Table 5.58 - Soybean Herbicide Half-Lives and Their Potential to Injure Fall Cover Crops (cont.)

This table does not directly address preharvest establishment of cover crops such as interseeding or aerial seeding, which may be more restrictive. Cover crops that are harvested are subject to herbicide residue restrictions, which are not addressed in this table.

Herbicide	Active ingredient	Normal Rate/acre	Half life (days) ¹	Fall cover crops OK to plant	Concern for Fall cover crops	Other
Authority 75DF (Authority First, BroadAxe XC, Sonic, Spartan)	sulfentrazone	4 oz	32-302	Cereals and ryegrass	Small seeded legumes, mustards, sorghum ²	Labeled on tobacco, sunflowers, transplanted tomato
Classic (Authority XL, Canopy, Envive, Fierce, Fierce XLT, Synchrony, Trivence, Valor XLT, etc.)	chlorimuron	0.5-2 oz	40	Cereals and ryegrass	Small seeded legumes, mustards, sorghum	More persistent in high pH soils (> 7) and with higher soil applied rates
Dual II Magnum	metolachlor	1.67 pt	15-50	Cereal grains, legumes	Annual ryegrass or other small seeded grasses	Higher rates and later applications more of a potential problem
FirstRate (Authority First, Sonic)	cloransulam	0.3 to 0.6 oz	8-33	Wheat, triticale, rye	Small seeded legumes, mustards, sorghum	The restriction for transplanted tobacco is 10 mo. for 0.3 oz/acre. Sugarbeet and sunflower have a 30 month restriction.
Glyphosate 4 Plus	glyphosate	0.75 to 1.25 lb ae	47 ³	All	None	Glyphosate does not have soil activity at normal use rates
Gramoxone SL 2.0	paraquat	2 pt	1000 ³	All	None	Paraquat does not have soil activity at normal use rates
Harmony SG	thifensulfuron	1/8 oz	12	No restrictions for wheat, barley, and oats	None with 45 day waiting interval	Harmony Extra also contains tribenuron
Liberty 280 SL	glufosinate	22 - 36 fl. oz	7 ³	All	Food or feed residues rather than crop injury may be a concern	Glufosinate does not have soil activity at normal use rates

Table 5.58 - Soybean Herbicide Half-Lives and Their Potential to Injure Fall Cover Crops (cont.)

This table does not directly address preharvest establishment of cover crops such as interseeding or aerial seeding, which may be more restrictive. Cover crops that are harvested are subject to herbicide residue restrictions, which are not addressed in this table.

Herbicide	Active ingredient	Normal Rate/acre	Half life (days) ¹	Fall cover crops OK to plant	Concern for Fall cover crops	Other
Metribuzin 75DF 4L	metribuzin	0.33 lb ai	14-60	Cereal grains and ryegrass	Slight risk for small seeded legumes and mustards	Nonfood/feed winter cover crops allowed
Outlook (Verdict)	dimethenamid	16 fl. oz	20	Most crops should be fine	Food or feed residues rather than crop injury may be a concern	Nonfood/feed winter cover crops should be OK after corn harvest
Prowl H ₂ O	pendimethalin	3 pt	44	Cereal grains	Small seeded legumes and annual ryegrass	We have not seen this herbicide carryover in Mid-Atlantic; nonfood/feed winter cover crops should be OK
Pursuit (Authority Assist, Optill, Zidua Pro)	imazethapyr	4 fl. oz	60-90	Wheat, triticale, rye, alfalfa, clover	Oats, ryegrass, sorghum. Do not plant mustards.	Conduct field bioassay for crops not list
Python WDG	flumetsulam	1 oz	14-120	Cereal grains	Small seeded legumes, mustards, and annual ryegrass	Cover crops and forage grasses are restricted for 9 mo.
Raptor/Beyond Xtra 1S	imazamox	5 fl. oz	20-30	Wheat, triticale, rye, alfalfa, clovers	Slight risk for mustards	Most cash crops allowed 9 mo. following application
Reflex/Flexstar (Warrant Ultra)	fomesafen	1.5 pt	100	Cereal grains	Small-seeded legumes, sorghum. Do not plant mustards.	Since fomesafen is often applied postemergence, soil activity can surprise users
Scepter 70 DG	imazaquin	0.66 pt	60-90	Cereal grains	Small seeded legumes, mustards	Carryover much more of a risk with drought
Select 2EC	clethodim	10 oz	3	All broadleaves	None assuming at least 30 days.	Plant anything after 30 days
Sharpen (Optill, Verdict, Zidua Pro)	saflufenacil	3 fl. oz	7-35	All	None	This product has been reported more persistent in western Canada

Table 5.58 - Soybean Herbicide Half-Lives and Their Potential to Injure Fall Cover Crops (cont.)

This table does not directly address preharvest establishment of cover crops such as interseeding or aerial seeding, which may be more restrictive. Cover crops that are harvested are subject to herbicide residue restrictions, which are not addressed in this table.

Herbicide	Active ingredient	Normal Rate/acre	Half life (days) ¹	Fall cover crops OK to plant	Concern for Fall cover crops	Other
Spartan 4F (Authority First, BroadAxe, Sonic)	sulfentrazone	4 oz	32-302	Cereals and ryegrass	Small-seeded legumes, mustards, sorghum ²	Labeled on tobacco, sunflowers, transplanted tomato
Valor SX (Afforia, Envive, Fierce, Surveil, Trivence, Valor XLT, etc.)	flumioxazin	2.5 oz	12-20	All grasses	Small seeded legumes and mustards	Based on the half-life, all nonfood/feed winter cover crops should be OK
Warrant/Enversa	acetochlor	2 pt	10-20	Most crops should be fine	Food or feed residues rather than crop injury may be a concern	Nonfood/feed winter cover crops are allowed after corn harvest
Zidua (Fierce, Anthem etc.)	pyroxasulfone	2.5 oz	20	Most crops should be fine	Food or feed residues rather than crop injury may be a concern	Nonfood/feed winter cover crops should be OK after corn harvest

¹ The herbicide half-life is defined the time it takes for 50% of the herbicide active ingredient to dissipate. See the Managing Herbicides Section for additional information. The herbicide half-life estimates are derived for the *WSSA Herbicide Handbook* and other scientific literature.

² Common small-seeded legumes include alfalfa, clovers, and hairy vetch.

³ This herbicide does not have soil residual activity at normal application rates.

Small Grains Weed Management

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Integrated Weed Management

A well-planned weed management program for small grains involves using multiple strategies. These strategies include preventive techniques such as monitoring, cultural controls, mechanical or physical controls, biological controls, and chemical control tactics. Preventive techniques start with planting weed-free crop seed or choosing an alternative field or planting date. Regularly monitoring for pests is an important predictive tool. Rotating crops to disrupt weed life cycles and planting adapted varieties are good examples of cultural controls. Mechanical or physical controls may include tillage and mowing. Biological controls may include using insect or disease organisms or even grazing animals in pasture production systems. Finally, chemical controls are an important component of many IPM systems, but their use should be based on sound management decisions. See the introductory chapter of this guide for more information on an IPM system.

A good small-grain stand is highly competitive and may not require herbicides to control weeds. Planting an adapted variety at recommended populations into a weed-free field should serve as the foundation for weed control in small grains. Winter annuals such as chickweed and henbit are becoming more common in small-grain fields.

This guide provides chemical control suggestions based on university research and manufacturer recommendations. Management information for common small grain weed problems is outlined in the following pages. This publication strives for accuracy; however, omissions, inaccuracies, or dated information can occur because of the dynamics of pests and pest management. Seek out additional information from the manufacturer or other reliable sources when making important management decisions. Remember, this guide is not a substitute for the manufacturer's product label.

Fall-planted Small Grains

This chapter pertains to fall planted small grains for the Mid-Atlantic region. Herbicide application timing, expected control levels, and comments are based on fall planting. See below for spring oats.

Fields should be scouted in late fall or early spring to determine if weed populations warrant treatment. Early application while weeds are still small is the key to successful control of weeds in small grains. Apply herbicides only at recommended stages of crop growth in order to avoid crop injury. See Figure 5.1 and Tables 5.3 to 5.5.

Wheat and barley are sensitive to triazine residues; therefore, use a short residual herbicide program in crops preceding small grains. See the corn weed-control section for information on the effect of pH on triazine residues, and for weed-control programs that reduce triazine residues.

Specific Weed Issues:

Downy brome control is listed on Finesse, Outrider, Olympus Flex, and PowerFlex labels. (Refer to label to determine if chess or cheat species will be controlled.) Outrider, PowerFlex, and Olympus Flex provide control of downy brome when applied in the fall and suppression when applied in the spring. Soybeans can be planted 3 months after PowerFlex application. However, be cautious of crop rotation intervals when using Finesse, Outrider, or Olympus Flex. Aside from STS soybeans and IR corn, most other rotational crops cannot be planted for at least 12 to 18 months or more after application depending on the herbicide used.

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Group 2 (ALS) resistant common chickweed populations have been identified in the Mid-Atlantic region since Group 2 herbicides such as Harmony Extra are routinely used in small grains. If Group 2-resistant chickweed is suspected, contact your local county educator to report the incident. Starane Ultra (fluroxypyr) at 0.3 to 0.4 pint per acre up to flag leaf growth stage on wheat, barley, and oats has resulted in good chickweed control in university trials. However, it will not control other key species such as wild garlic, mustards, and henbit. (It will, however, injure/kill underseeded legumes.) Starane Ultra can be tank-mixed with Harmony Extra to broaden the spectrum of control. Valor also provides very effective residual control of common chickweed and can be used in an early preplant burndown program before seeding wheat. Apply up to 2 ounces per acre of Valor (plus other burndown herbicides) at least 7 days before planting wheat (see Table 5-8 for specific comments). Metricor and TriCor (metribuzin) have a 24(c) use label and at 2 to 4 ounces per acre have provided excellent control of Group 2-resistant chickweed in university trials when applied in either fall or spring (see Table 5-6 for specific comments). See Table 5-6 for comments on crop safety with metribuzin and Valor.

Herbicide-resistant annual ryegrass (or Italian ryegrass) in the region is resistant to Group 1 (ACCase) herbicides, which includes Axial and Hoelon. Other populations are resistant to Group 2 (ALS herbicides) such as Osprey, PowerFlex, and Finesse. There is concern about developing populations resistant to both herbicide groups. Valor and Zidua (or Anthem Flex) have fair to good residual control of annual ryegrass but will not control it if emerged seedlings are present at time of application. POST applications of Osprey or PowerFlex or Axial XL will control susceptible populations. Do not rely on these herbicide groups to control annual ryegrass in rotation crops to reduce the risk of developing resistant populations.

Spring Oats: Oats are sensitive to triazine residues; therefore, use a short residual herbicide program when small grains follow in the crop rotation. Read the corn weed-control section for information on the effect of pH on triazine residues, and for weed-control programs that reduce triazine residues.

In addition to comments for other small grains, the following comments regarding herbicide use in small grains pertain:

2,4-D: Use only 0.5 pt/A for oats. Certain varieties, especially ‘Pennuda,’ are more sensitive to 2,4-D than other small grains.

Callisto: For use on oats only (Callisto should not be applied to other small grains). If PRE, apply 6 fl oz/A Callisto prior to oat emergence. If POST, apply 3 fl oz/A Callisto after oat emergence but before weeds reach 5 inches tall. Callisto controls many broadleaf weeds. Callisto may cause temporary injury of the oat crop. Callisto has a 10-month rotation restriction to soybeans and an 18-month rotation restriction to most vegetables.

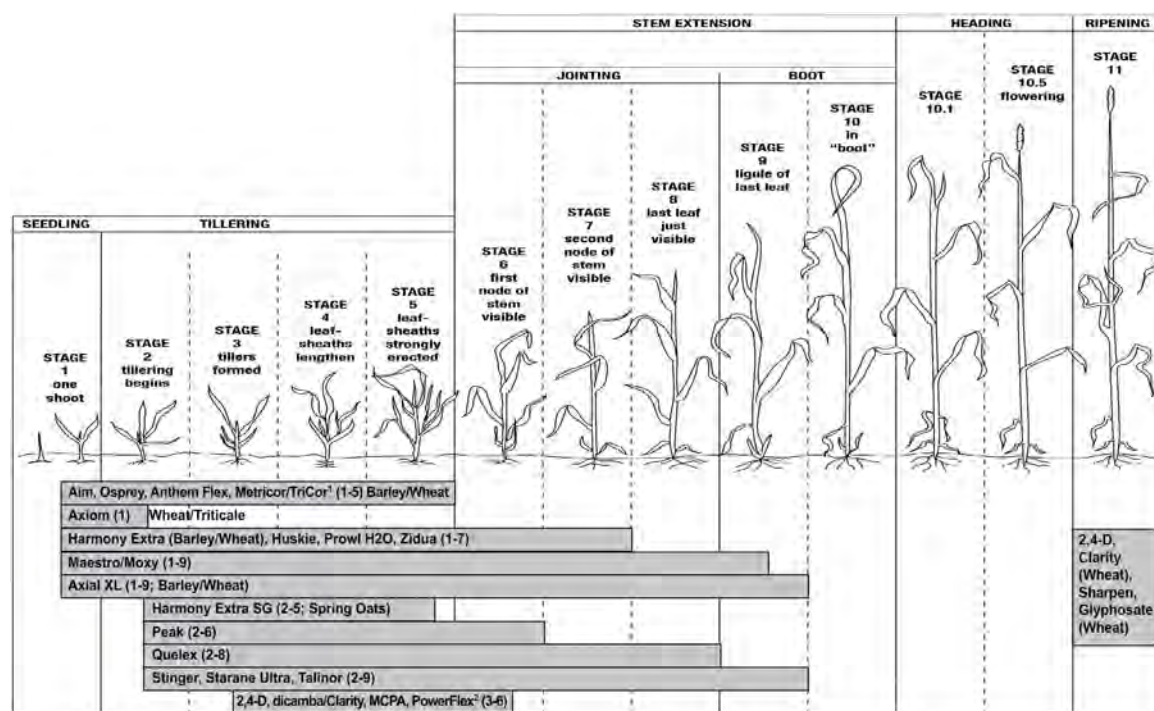
Clarity/dicamba: On spring-seeded oats, apply before five-leaf stage.

Harmony Extra: On spring-seeded oats, apply three-leaf to before jointing (growth stages 2–5). Apply at 0.45 oz to 0.6 oz/a. Do not use on Ogle, Porter, or Premier oat varieties.

Harmony SG: On spring-seeded oats, apply three-leaf to before jointing (growth stages 2–5). Apply at 0.45 oz to 0.6 oz/a. Do not use on Ogle, Porter, or Premier oat varieties.

MCPA amine or ester: Safer on oats underseeded with legumes than 2,4-D (amine formulation only) but use the lower rate (0.25–0.5 pt) and apply in 5–10 gal water/A; legumes should be 2–3 inches tall and cereal should be 8 inches tall to provide canopy to protect legume.

Fig. 5.59 - Growth stages in cereals when herbicides may be applied.



¹Local research has demonstrated that Metricor/TriCor should be applied during “greenup” period in early spring to reduce risk of crop injury.

²Local research has found fall applications of PowerFlex is best timing to reduce risk of crop injury.

Table 5.60 - Small Grain Herbicides and their Restrictions

Trade Name ¹	Common Name	Manufacturer	Site of Action Number	Restricted-Use Pesticide ²	Water Quality Advisory ³	Worker Reentry ⁴ (hours)
2,4-D 4 lb/gal	2,4-D	Several	4	—	—	12–48
Aim 2EC	carfentrazone	FMC	14	—	—	12
Anthem Flex 4SE	pyoxasulfone + carfentrazone	FMC	15, 14	—	yes	12
Axial Bold 0.69L	pinoxaden + fenoxaprop	Syngenta	1, 1	—	—	48
Axial Star 1.15L	pinoxaden + fluroxypyr	Syngenta	1, 4	—	—	48
Axial XL 0.42L	pinoxaden	Syngenta	1	—	—	48
Axiom 68DF	flufenacet + metribuzin	Bayer CropScience	15, 5	—	—	12
Beyond Xtra 1L	imazamox	BASF	2	—	yes	4
Callisto 4SC ⁵	mesotrione	Syngenta	27	—	—	12
Clarity 4S/Banvel 4S	dicamba	BASF	4	—	—	24
Curtail 2.38L	clopyralid + 2,4-D	Corteva	4, 4	—	yes	48
Elevore 0.57L	halauxifen	Corteva	4	—	yes	12
Express 50SG	tribenuron	FMC	2	—	—	12

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Table 5.60 - Small Grain Herbicides and their Restrictions (cont.)

Trade Name ¹	Common Name	Manufacturer	Site of Action Number	Restricted-Use Pesticide ²	Water Quality Advisory ³	Worker Reentry ⁴ (hours)
Finesse Cereal and Fallow 75DF	chlorsulfuron + metsulfuron methyl	FMC	2, 2	—	—	4
Gramoxone SL 2 Gramoxone SL 3	paraquat	Syngenta	22	yes	—	12
Harmony SG 50DF	thifensulfuron	FMC	2	—	—	4
Harmony Extra 50DF/ Audit 1:1/T-Square	thifensulfuron + tribenuron	FMC/UPL	2	—	—	12
Huskie 2.06L	pyrasulfotole + bromoxynil	Bayer CropScience	27, 6	—	yes	24
Huskie Complete 2.4L	pyrasulfotole + bromoxynil + thiencazabone	Bayer CropScience	27, 6, 2	—	yes	24
MCPA 4 lb/gal	MCPA	Several	4	—	—	12–48
Maestro 2EC	bromoxynil	Nufarm	6	—	—	24
Metricor ⁶ 75DF/TriCor ⁶ 75DF	metribuzin	UPL	5	—	yes	12
Moxy 2EC	bromoxynil	WinField United	6	—	—	24
Osprey 4.5WDG	mesosulfuron	Bayer CropScience	2	—	—	4
Outrider 75WDG	sulfosulfuron	Valent	2	—	—	12
Pixxaro 2.43 EC	fluroxypyr + halauxifen	Corteva	4, 4	—	—	12
Peak 57WDG	prosulfuron	Gowan	2	—	yes	12
PowerFlex HL 13WDG	pyroxsulam	Corteva	2	—	—	12
Prowl H ₂ O 3.8CS	pendimethalin	BASF	3	—	—	24
Quelex 20.4WDG	halauxifen + florasulam	Corteva	4, 2	—	yes	12
Reviton 2.83SC	tiafenacil	Helm	14	—	—	12
Rezulant 1.3EC	halauxifen + fluroxypyr + pinoxaden + safener	Corteva	4, 4, 1	—	yes	48
Roundup Powermax 4.5S/Roundup Weather Max 4.5S/ other glyphosates	glyphosate	Bayer CropScience/ others	9	—	—	4–12
Sentrallas 1.55L	thifensulfuron + fluroxypyr	FMC	2, 4	—	—	24
Sharpen 2.85SC	saflufenacil	BASF	14	—	yes	12
Shieldex 400 SC	tolpyralate	Summit Agro	27	—	—	12

Table 5.60 - Small Grain Herbicides and their Restrictions (cont.)

Trade Name ¹	Common Name	Manufacturer	Site of Action Number	Restricted-Use Pesticide ²	Water Quality Advisory ³	Worker Reentry ⁴ (hours)
Starane Flex 0.875L	florasulam + fluroxypyr	Corteva	2, 4	—	—	24
Starane Ultra 2.8L	fluroxypyr	Corteva	4	—	—	24
Stinger 3S	clopyralid	Corteva	4	—	yes	12
Talinor 1.77EC	bicyclopyrone + bromoynil	Syngenta	27, 6	—	yes	24
Tarzac 31.95WG	halauxifen + pyroxsulam	Corteva	4, 2	—	—	12
Tolvera 1.7EC	tolpyralate + bromoxynil	Corteva	27, 6	—	yes	24
Valor SX 51WDG/ Valor EZ 4L	flumioxazin	Valent	14	—	—	12
Zidua 85WDG / Zidua 4.17SC	pyroxasulfone	BASF	15	—	yes	12

¹ Generic alternatives to some of these products are available. See table in the introductory chapter of this guide.

² Only licensed applicators may purchase and apply restricted-use pesticides.

³ These herbicides have an “Environmental Hazard Warning” on their label and have been detected in water supplies from normal agricultural use. Special precautions apply for their use on coarse-textured soils or where water tables are shallow. See the product label for specific restrictions.

⁴ If soil-applied products are injected or incorporated at application time, under certain circumstances the Worker Protection Standard allows workers to enter the treated area if they will have no contact with anything that has been treated. Personal protective equipment is required for early entry to treated areas if contact with treated soil, plants, or water is involved.

⁵ Callisto is only registered for use in spring oats.

⁶ Tricor/Metricor have 24c Local Needs Label for use in specific states. Only approved brands of metribuzin can be used in approved states. Refer to the labels.

Table 5.61 - Herbicides Labeled for Use in Small Grains by Small Grain Species

	Fall Seeded				
	Wheat	Barley	Rye	Triticale	Spring Oats
2,4-D ¹	X	X	X	X ¹	X
Aim	X	X	X	X	X
Anthem Flex	X	X	X	X	X
Audit 1:1	X	X	X	X	X
Axial Star	X	X			
Axial XL, Axial Bold	X	X			
Axiom	X			X	
Callisto					X
Clarity/dicamba	X	X	X	X	X
Curtail	X	X			
Express	X	X	X	X	X
Finesse Cereal and Fallow	X	X		X	
Gramoxone	X	X			
Harmony Extra	X	X		X	X
Harmony SG	X	X		X	X
Huskie	X	X	X	X	
Huskie Complete	X				
MCPA	X	X	X		X
Maestro	X	X	X	X	X
Metricor/TriCor	X	X			
Osprey	X			X	
Outrider	X				
Peak	X	X	X	X	X
Powerflex HL	X			X	
Prowl H2O	X			X	
Quelex	X	X		X	
Roundup	X	X	X	X	X
Sentrallas	X	X			X
Sharpen	X	X	X	X	X
Shieldex	X	X			
Starane Flex	X	X	X	X	X
Starane Ultra	X	X		X	X
Stinger	X	X			X
Talinor	X	X			
Tolvera	X	X			
Valor	X				
Zidua	X				

¹ 2,4-D is manufactured by various companies; labels may vary among manufacturers.

Table 5.62 - Small Grain Herbicide Prepackaged Mixes, or Co-packs, and Equivalents

Trade Name	Components (ai or ae/gal or lb)	Site of Action Number	If You Apply (per acre)	You Have Applied (ai or ae lb / A)	An Equivalent Tank-mix of
Anthem Flex 4SE	3.733 lb pyroxasulfone 0.267 lb carfentrazone	15 14	2.75 fl oz	0.08 lb pyroxasulfone 0.006 lb carfentrazone	2.46 fl oz Zidua 4.17SC 0.4 fl oz Aim 2EC
Audit 1:1 50WDG	0.25 thifensulfuron 0.25 tribenuron	2 2	0.75 oz wt	0.0117 lb thifensulfuron 0.0117 lb tribenuron	0.37 oz Harmony SG 50DF 0.37 oz Express 50DF
Axial Bold 0.69L	0.457 lb pinoxaden 0.228 lb fenoxaprop	1 1	15 fl oz	0.053 lb pinoxaden 0.027 lb fenoxaprop	16.4 fl oz Axial 0.42L 0.44 oz ai fenoxaprop
Axial Star 1.15L	0.42 lb pinoxaden 0.73 fluroxypyr	1 4	16.4 fl oz	0.053 lb pinoxaden 0.094 lb fluroxypyr	16.4 fl oz Axial 0.42L 4.3 fl oz Starane Ultra 2.8L
Axiom 68DF	0.544 lb flufenacet 0.136 lb metribuzin	15 5	6 oz wt	0.2 lb flufenacet 0.05 metribuzin	6.4 oz Define 4SC 1.1 oz Metribuzin 75DF
Curtail 2.4L	0.38 lb clopyralid 2 lb 2,4-D	4 4	1 qt	0.095 lb clopyralid 0.5 lb 2,4-D	4.1 fl oz Stinger 3S 16 fl oz 2,4-D amine 4L
Finesse Cereal and Fallow 75DF	0.625 chlorsulfuron 0.125 metsulfuron	2 2	0.25 oz wt	0.001 chlorsulfuron 0.125 metsulfuron	0.12 oz Glean XP 75DF 1.2 oz Ally XP 60DF
Harmony Extra 50DF	0.333 thifensulfuron 0.167 tribenuron	2 2	0.75 oz wt	0.015 thifensulfuron 0.0078 tribenuron	0.5 oz Harmony SG 50DF 0.25 oz Express 50DF
Huskie 2.06L	0.31 lb pyrasulfotole 1.75 bromoxynil	27 6	13 fl oz	0.031 lb pyrasulfotole 0.178 bromoxynil	0.5 oz ai pyrasulfotole 11.4 fl oz Maestro 2EC
Huskie Complete 2.4L	0.26 lb pyrasulfotole 2.09 bromoxynil 0.042 lb thien carbazone	27 6 2	13.7 fl oz	0.027 lb pyrasulfotole 0.224 lb bromoxynil 0.004 lb thien carbazone	0.44 oz ai pyrasulfotole 14.3 fl oz Maestro 2EC 0.072 oz ai thien carbazone
Pixxaro 2.43EC	0.1 fluroxypyr 2.33 halauxifen	4 4	6 fl oz	0.109 lb fluroxypyr 0.0047 lb halauxifen	5 fl oz Starane Ultra 2.8EC 1.06 fl oz Elevore 0.57SC
Quelex 20.4WDG	0.1 lb halauxifen 0.1 florasulam	4 2	0.75 oz wt	0.005 lb halauxifen 0.005 lb florasulam	1.1 fl oz Elevore 0.57L 0.075 oz ai florasulam
Sentrallas 1.55L	0.25 lb thifensulfuron 1.3 fluroxypyr	2 4	12 fl oz	0.02 lb thifensulfuron 0.1221 lb fluroxypyr	0.5 oz Harmony SG 50DF 5.6 fl oz Starane Ultra 2.8L
Starane Flex 0.875 L	0.042 florasulam 0.833 fluroxypyr	2 4	13.5	0.004 lb florasulam 0.088 lb fluroxypyr	0.07 oz ai florasulam 4 fl oz Starane Ultra 2.8L
Supremacy 42WDG	0.36 fluroxypyr 0.045 thifensulfuron 0.015 tribenuron	4 2 2	5 oz wt	0.113 lb fluroxypyr 0.014 lb thifensulfuron 0.005 lb tribenuron	5.2 fl oz Starane Ultra 2.8L 0.5 oz Harmony SG 50DF 0.16 oz Express 50DF
Tarzec 31.95WG	0.067 lb halauxifen 0.25 lb pyroxulam	4 2	1 oz wt	0.00435 lb halauxifen 0.0156 lb pyroxulam	0.09 fl oz Elevore 0.57SC 1.9 oz wt PowerFlex HL 13.1WG
Tolvera 1.7EC	0.156 lb tolpyralate 1.557 lb bromoxynil	27 6	11 fl oz	0.0134 lb tolpyralate 0.1338 lb bromoxynil	0.5 oz Shieldex 400SC 8.5 oz Maestro 2EC
T-Square 75WG	0.5 thifensulfuron 0.25 tribenuron	2 2	0.5 oz wt	0.015 lb thifensulfuron 0.0078 lb tribenuron	0.5 oz Harmony SG 50DF 0.25 oz Express 50DF

Table 5.63 - Relative Effectiveness of “Burndown” Treatments for No-Till Small Grains

Table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rates and weed size (young weeds) or growth stage. Treatments are rated only for control of vegetation existing at the time of application.

Weed control rating

10 = 95–100% 9 = 85–95% 8 = 75–85% 7 = 65–75% 6 = 55–65%

N = less than 55% or no control L = Labeled but no university data - = no information available

Weed	Trade Name						
	Clarity/ dicamba	Finesse	Gramoxone	Harmony Extra (Fall-Applied)	Roundup/ Glyphosate (Fall-Applied)	Roundup/ Glyphosate (Spring-Applied)	Sharpen
Site of Action Number	4	2, 2	22	2	9	9	14
Chickweed, Common ¹	7	9	8+	9	9	9	6
Clover, Red	9	8	8	6	8+	7	–
Dandelion	7	7+	N	6	8+	6	7
Dogbane, Hemp; Dewberry; Milkweed; etc.	6	N	6	N	8+	6	N
Foxtail spp.	N	N	9	N	9	9	N
Lambsquarters, Common	9	8	8	9	9	9	8
Marestail ²	8	9	7	7	9	9	9+
Mustard spp.	9	8+	8	9	9	9	L
Ragweed, Common ³	9	N	8	6	9	9	8
Rye Cover, Volunteer Small Grains	N	N	9	N	10	10	N
Smartweed	9	6	7	9	7	7	L
Sod, Alfalfa	8	–	N	N	8+	7	N
Sod, Bromegrass or Quackgrass	N	N	6	N	9	7	N
Sod, Orchardgrass or Fescue	N	N	N	N	9	7	N
Thistle, Canada	8	6	6	7	9	7	6
Timothy or Bluegrass	N	N	7	N	10	10	N
Vetch, Hairy	9	–	7	7	8	6	6

¹ Common chickweed biotypes resistant to Group 2 herbicides are found in the region; if you suspect resistant biotypes in your area, do not rely on herbicides from these groups to control resistant biotypes.

² Horseweed biotypes resistant to Group 9 (glyphosate) and Group 2 herbicides are widespread in the region; do not rely on herbicides from these groups to control resistant biotypes.

³ Common ragweed biotypes resistant to Group 9 (glyphosate) and Group 2 herbicides are found in the region; if you suspect resistant biotypes in your area, do not rely on herbicides from these groups to control resistant biotypes.

Table 5.64 - Comments on “Burndown” Herbicides for No-Till Small Grains

See specific product label to determine correct rate for soil type and weed species found in each field.

These treatments may be used in conventional, reduced-till, and no-till systems.

Tables 5.62 and 5.65 list characteristics and efficacy of “burndown” herbicides.

Trade Name ¹	Common Name	Site of Action Number	Application	Product/A	lb ai/A
numerous	dicamba DMA Salt	4	Preplant or preemergence to postemergence	2-4 fl oz	0.06-0.125
Clarity 4S	dicamba DGA Salt			2-4 fl oz	

- The 4 fl oz rate controls small annual broadleaf weeds and there is no waiting period prior to planting at this rate.
- Clarity/dicamba may be used at greater than 4 fl oz prior to planting wheat; however, for each pt/A of dicamba applied, delay crop planting for 20 days.

Finesse 75DF	chloransulam	2	preplant or preemergence to postemergence		0.0078-0.0156
Cereal and Fallow	metsulfuron	2		0.2-0.4 oz	0.0016-0.0031

- Do not apply preplant or preemergence to barley or triticale
- Plant seed at least 1 inch deep to reduce risk of injury.
- Should be tankmixed with another burndown herbicide to broaden spectrum of control.
- Rotation to Bolt or STS soybeans is 4 months; Plenish trait is 6 months.
- Rotation for field corn and all other soybeans is 18 months.
- Include a nonionic surfactant at 0.125 to 0.5% v/v.

Gramoxone SL 2			Preplant,	2-4 pt	0.5-1.0
Gramoxone SL 3	paraquat	22	Preemergence,	1.3-2.6 pt	0.5-1.0

- Apply in 20–60 gal/A for control of emerged annual weeds.
- Add 8–32 oz nonionic surfactant/100 gal of spray.
- Phosphate-containing liquid fertilizer solutions diminish paraquat activity if used as a carrier.
- Use appropriate precautions when handling paraquat to minimize exposure to the herbicide.
- Do not use flood jet tips larger than size 20 or spacing greater than 40 inches.

Paraquat Use Restrictions

- *Restricted-use pesticide.*
- Only certified applicators, who successfully complete the paraquat-specific training, can mix, load or apply paraquat.
- Application of paraquat “under the direct supervision” of a certified applicator is no longer allowed; registered technicians cannot apply.
- Required training link (<http://usparaquattraining.com>); certified applicators must repeat training every three years.

Harmony Extra SG	thifensulfuron +	2	Preplant or preemergence to postemergence	0.45-0.9 oz	0.014-0.028
50DF	tribenuron	2			

- For use on wheat, barley, and oats only.
- Audit 1:1 and T-Square contain similar active ingredients but at different ratios, see label for more use details.
- Apply burndown treatment before or shortly after planting but before small grain emergence.

Roundup 3S/ glyphosate ²	glyphosate	9	Preplant or preemergence	1-3 qt	1.0-3.0 lb ae/A
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- Apply before, during, or after planting but before crop emergence.
- Use the low rate for annual weeds up to 6 inches tall and higher rates for weeds taller than 6 inches.

Table 5.64 - Characteristics of “Burndown” Herbicides for No-Till Small Grains. (cont.)

See specific product label to determine correct rate for soil type and weed species found in each field.

- These treatments may be used in conventional, reduced-till, and no-till systems.
- Tables 5.56 and 5.58 list characteristics and efficacy of “burndown” herbicides.

Herbicide Trade name ¹	Herbicide Common name	Herbicide group # (site of action)	Application	product/A	lb ai/A
Sharpen 2.85SC	saflufenacil	14	Preplant or preemergence	1-2 fl oz	0.022-0.044

- Should be tankmixed with another burndown herbicide to broaden spectrum of control.
- For optimum burndown activity, include methylated seed oil (MSO) plus ammonium sulfate (AMS) at 8.5 to 17 lbs/100 gallons.
- Apply 1 to 2 oz/A for burndown activity. Sequential applications are allowed prior to crop emergence but do not apply more than 4 fl oz/A total per cropping season.

¹ The legitimate use of 2,4-D for burndown in wheat is uncertain. None of the 2,4-D ester or amine labels specify application just prior to wheat seeding or emergence. Some research suggests a minimum delay of 7–10 days after application at rates up to 1 pt/A 2,4-D ester. However, use of 2,4-D burndown in wheat is ambiguous at best and, if injury occurs, liability rests with the consultant or applicator.

² Various formulations of this product are available. See table in the introductory chapter of this guide. Refer to current product label for active ingredient concentration, application rate, and other restrictions.

Table 5.65 - Relative Effectiveness of Fall Planted Small Grain Herbicides for Winter Annuals

Table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rates and weed size or growth stage. Results may differ with variations in weed size, temperature, rainfall, and soil moisture. Crop tolerance rating of VG or E is rarely significant.

Weed control rating	Crop tolerance
10 = 95–100%	E = excellent; almost never any crop injury observed
9 = 85–95%	VG = very good; on rare occasion is crop injury observed
8 = 75–85%	G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., seedling depth, seed slit closure, herbicide rate and application timing, adjuvants)
7 = 65–75%	FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions
6 = 55–65%	F = fair; some crop injury is commonly observed
N = less than 55% or no control	
L = labeled but no university data	
-- = not applicable or no information available	
+ = upper end of rating range	

	Grasses										Broadleaves													
Site of Action Number	Bluegrass, Annual ¹	Bluegrass, Roughstalk	Brome, spp. ²	Oatgrass, Bulbous ⁷	Ryegrass, Annual ²	Buckwheat, Wild	Carrot, Wild	Catchweed Bedstraw	Chickweed, Common ²	Corn, Chamomile	Cornflower	Field Pansy	Groundsel, Common	Henbit/purple Dead Nettle	Horseweed/Marestail ⁸	Knawel	Lettuce, Prickly	Mustard spp.	Pennycress, Field	Shepherdspurse	Speedwell spp. ³	Vetch, Hairy/Annual	Crop Tolerance	
Preplant																								
Finesse	2/2	6	–	6	–	6	6	8	N	9	9	–	–	L	9	8	9	9	8+	8	9	7+	6	FG
Sharpen	14	N	N	N	N	N	N	N	N	L	N	–	N	8	–	L	N	L	L	L	L	–	–	E
Valor	14	6	–	6	N	7	6	N	–	8	–	–	N	L	8	9	N	L	7	8	8	–	–	FG
Delayed Preemergence																								
Axiom	5/15	8+	N	7	–	8+	–	N	–	8+	8+	–	N	–	9	8	9	–	8+	8	6	–	–	FG
Prowl	3	6	–	–	–	8	–	N	–	7+	–	–	N	–	8+	N	N	–	7+	–	7+	N	N	VG
Zidua / Anthem Flex	15	9	–	8	–	8+	–	N	–	7	–	–	N	–	8	8	6	–	–	–	–	–	N	VG
Delayed Preemergence to Early Postemergence																								
Axial	1	N	N	N	N	9 ⁴	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	G
Osprey	2	8+	8+	8	–	9	N	–	N	7	7	N	6	N	7	N	8	N	8	N	N	N	8+	G
Postemergence																								
2,4-D ⁵	4	N	N	N	N	N	6	7	7	6	–	6	N	6	6	8+	N	9	9	9	9	6	8 ⁷	F
Aim	14	N	N	N	N	N	6	N	8	N	–	N	–	N	6	N	6	6	6	8	6	6	6	VG
Clarity/dicamba	4	N	N	N	N	N	8+	6	N	7	–	6	N	7	7	8	7	8	7	7	8	6	9	F
Finesse	2/2	7+	–	6	–	7+	N	8	6	8+	7	–	–	L	8+	7	9	8	8	8	8	7	7	G
Harmony SG	2	N	N	N	N	N	8	N	N	7	–	N	–	9	7	N	–	7	9	9	9	N	6	VG

Table 5.65 - Relative Effectiveness of Fall Planted Small Grain Herbicides for Winter Annuals (cont.)

Site of Action Number	Grasses							Broadleaves														Crop Tolerance		
	Bluegrass, Annual ¹	Bluegrass, Roughstalk	Brome, spp. ²	Oatgrass, Bulbous ⁷	Ryegrass, Annual ²	Buckwheat, Wild	Carrot, Wild	Catchweed Bedstraw	Chickweed, Common ²	Corn Chamomile	Cornflower	Field Parsley	Groundsel, Common	Henbit/Purple Dead Nettle	Horseweed (Marestail)	Knawel	Lettuce, Prickly	Mustard spp.	Pennycress, Field	Shepherdspurse	Speedwell spp. ³		Vetch, Hairy/Annual	
Harmony Extra	2/2	N	N	N	N	8	7+	N	8 ³	-	N	7	9	9	7	8+	8	9	9	9	N	7	VG	
Huskie	6/27	N	N	N	N	L	-	L	7	N	7	N	-	8+	8+	N	-	L	L	L	N	-	VG	
Maestro/Moxy	6	N	N	N	N	9	-	N	6	-	-	-	9	6	7	N	6	9	8	8	N	6	VG	
MCPA	4	N	N	N	N	8	6	N	6	-	-	N	6	6	8+	-	9	9	9	8+	6	7	FG	
Metricor/TriCor	5	8+	6	6+	8	N	-	N	-	9	-	8	N	-	9	N	8+	-	7	L	N	8	6	FG ⁶
Peak	2	N	N	N	N	8	-	N	7	-	-	-	N	6+	8	-	8+	9	9	8	N	9	G	
Powerflex	2	N	7+	8	-	9	6	-	7	8	9+	8	7	N	7	6	9	6	9	9	8	8	9	FG
Quelex	2/4	N	N	N	N	L	-	L	8	L	8	N	-	7	L	8+	6	L	L	L	N	L	VG	
Starane Ultra	4	N	N	N	N	-	-	L	7+	-	8	N	-	8	L	6	-	L	L	-	N	8+	G	
Stinger	4	N	N	N	N	9	-	N	N	-	-	N	9	N	9+	-	9	N	N	N	N	9	FG	

¹ Annual bluegrass control is listed on Osprey Flex label. Fall applications are best.

² See the introduction of this chapter for more detailed information on these weeds.

³ There are several speedwell (Veronica) species, including corn, common, ivy leaf, and others. Depending on the species, their life cycle is either annual or perennial. Many of the commonly used small grain herbicides provide little or no control of speedwell. Finesse has a few annual and perennial speedwells listed on its label and usually provides 80–90 percent control of them. PowerFlex has provided control of certain speedwell species in some university trials. Be cautious of crop rotation intervals if using Finesse. If speedwell is small, Aim provides some control/suppression.

⁴ Will not control group 1 (ACCCase) resistant annual ryegrass biotypes.

⁵ 2,4-D ester provides better control of hairy vetch than 2,4-D amine.

⁶ Crop tolerance with Dimetric Metricor/TriCor is dependent on weather at time of application and variety. Crop tolerance is improved if applications are made in the early spring rather than in the fall or late spring.

⁷ Outrider provides fair to good control (8) of bulbous oatgrass.

⁸ Horseweed biotypes resistant to Group 2 herbicides are widespread in the region; do not rely on herbicides from these groups to control resistant biotypes.

Table 5.66 - Relative Effectiveness of Fall Planted Small Grain Herbicides for Postemergence Perennial Weed Control

Table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rates and weed size or growth stage. Results may differ with variations in weed size, temperature, rainfall, and soil moisture. Crop injury rating of VG or E is rarely significant.

Weed control rating	Crop tolerance
10 = 95–100%	E = excellent; almost never any crop injury observed
9 = 85–95%	VG = very good; on rare occasion is crop injury observed
8 = 75–85%	G = good; seldom is crop injury observed as long as proper management practices are followed (e.g., seedling depth, seed slit closure, herbicide rate and application timing, adjuvants)
7 = 65–75%	FG = fair to good; occasionally crop injury is observed even with proper management practices; injury is often due to herbicide interactions with environmental conditions
6 = 55–65%	F = fair; some crop injury is commonly observed
N = less than 55% or no control	
L = labeled but no university data	
-- = no information available	
+ = upper end of rating range	

	Site of Action Number	Cockle, White	Dandelion	Dock spp.	Garlic or Onion, Wild	Smooth Bedstraw	Thistle, Canada	Crop Tolerance
Postemergence								
2,4-D	4	7+	7+	6+	7	6	7	FG
Aim	14	N	N	N	N	6	N	VG
Clarity/dicamba	4	8	6	7	6	N	7	F
Finesse	2/2	8	7+	8+	8+	N	7	G
Harmony SG	2	–	6	7	9	N	N	VG
Harmony Extra	2/2	–	6	8	9	N	7	VG
Huskie	6/27	L	L-s	L-s	–	L-s	–	VG
MCPA	4	N	8	6+	6	6	7	FG
Maestro	6	6	6	6	N	N	6	G
Metricor/TriCor	5	–	L	N	N	–	N	FG ¹
Peak	2	–	6	8	9	N	6+	VG
Powerflex	2	N	N	N	N	N	N	FG ²
Quelex	2/4	–	L-s	–	–	L	L-s	VG
Starane Ultra	4	–	7	–	–	L	N	VG
Stinger	4	7+	7+	7	N	N	8	FG

¹ Crop tolerance with Dimetric Metricor/TriCor is dependent on weather at time of application and variety. Crop safety is improved if applications are made in the spring rather than in the fall.

² Based on University of Delaware trials, Powerflex applications in the spring can result in significant stunting.

Table 5.67 - Comments on Herbicides for Small Grains

See specific product label to determine correct rate for soil type and weed species found in each field.

- Tables 5.64, 5.65, and 5.66 list characteristics and efficacy of herbicides.
- A good small grain stand is very competitive and normally does not require a herbicide treatment.
- It is important to control all existing vegetation at planting time, prior to no-till production.

Trade Name	Common Name	Site of Action Number	Application	Product/A	lb ai/A
2,4-D amine 4S	2,4-D	4	Full tiller to prejointing (growth stages 3–6)	0.5–2.0 pt	0.25–1.0

- For use on wheat, barley, rye, and oats.
- Use lower rates for small annual weeds.
- Use lower rate (0.25–0.5 pt/A) if underseeded with legume (alfalfa, red or white clover are labeled; vetch and sweet clover will be severely injured).
- Spraying small grains too young or after jointing can result in reduced yields or uneven ripening.
- In general, apply when small grain is 4 to 8 inches tall.
- May be tank-mixed with Harmony Extra SG, Banvel, or Maestro (Buctril).
- No rotation restriction to soybeans; 3 month rotation restriction to vegetables; see Table 5.26.

2,4-D LVE 4E	2,4-D	4	Full tiller to prejointing (growth stages 3–6)	0.5–2.0 pt	0.25–1.0
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- For use on wheat, barley, rye, and oats.
- Use lower rates for annual weeds.
- For wild garlic or onion control, apply 1.5 to 2.0 pt.
- Avoid use if temperatures are expected to exceed 75°F.
- No rotation restriction to soybeans; 3 month rotation restriction to vegetables; see Table 5.26.

Aim 2EC	carfentrazone	14	Up to the jointing stage (growth stages 1–5)	0.5–2 fl oz	0.008–0.016
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- For use on wheat, barley, and oats to control certain broadleaves.
- Apply before weeds are 4 inches tall.
- Aim provides control/suppression of a limited number of weeds species; should be tank-mixed other common small grain herbicides to improve control and increase weed spectrum. Some research has shown that Aim provides suppression of Star-of-Bethlehem and speedwell.
- No rotational restrictions to soybeans or vegetables; see Table 5.24.

Table 5.67 - Comments on Herbicides for Small Grains (cont.)

See specific product label to determine correct rate for soil type and weed species found in each field.

- Tables 5.64, 5.65, and 5.66 list characteristics and efficacy of herbicides.
- A good small grain stand is very competitive and normally does not require a herbicide treatment.
- It is important to control all existing vegetation at planting time, prior to no-till production.

Trade Name	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Anthem Flex – see Zidua					
Axial XL 0.42L	pinoxaden	1	Two-leaf to preboot (growth stages 2–8)	16.4 fl oz	0.053

- For use on wheat or barley only.
- Do not apply within 60 days of harvest. Controls certain grassy weeds such as annual ryegrass, foxtails, barnyardgrass, and wild oat. Apply Axial XL before weeds have more than 5 leaves on the main stem.
- Axial XL does not control downy brome or ACCase-resistant grasses.
- Axial XL will not control broadleaf weeds and should be tank-mixed with other labeled herbicides to enhance weed control spectrum.
- Axial TBC is a premix of pinoxaden (Axial) + florasulam (in Orion) and Axial Star is a combination of pinoxaden (Axial) + fluroxypyr (Starane); both products control annual grasses and broadleaves.
- Rotation to grain crops (including soybeans) is 90 days; to leafy and root crops is 30 days, all other vegetables after 90 days; see Table 5.24.
- Axial Star is a premix containing pinoxaden plus fluroxypyr (Starane Ultra), and Axial Bold is a premix containing pinoxaden plus fenoxaprop.

Axiom 68 DF	flufenacet + metribuzin	5/15	Spiking to 2 leaf (growth stage 1)	4–10 oz	0.133–0.333 0.033–0.083
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- For use on fall-seeded wheat and triticale.
- Plant seeds 1 to 2 inches deep to improve crop safety; use only when wheat is planted with a drill.
- Apply when crop is between full germination and 2-leaf stage; apply before broadleaf weeds reach the 1-leaf stage. Axiom will not control grasses after they have emerged.
- Use rate depends on soil texture; see product label.
- Some crop varieties are more sensitive; see product label.
- No rotation restriction to soybeans. 12 month rotation restriction to vegetables; see Table 5.24.
- *Water Quality Advisory.*

BeyondXtra	imazamox	2	postemergence		
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- For use on Clearfield or Clearfield Plus wheat only.
- Apply early postemergence before broadleaf weeds exceed a height of 3 inches and grasses exceed 4 to 5 leaves.
- Nonionic surfactant and nitrogen based fertilizer must be added to the spray solution for optimal weed control.
- Use a water/liquid fertilizer solution of at least 50% water.
- Weed control may be improved by substituting nonionic surfactant for control, COC, MSO, or HSOC.
- Use of COC, MSO, or HSOC in place of NIS in Clearfield Plus spring wheat may result in crop injury.
- When Beyond Xtra is tank mixed with another herbicide, using COC, MSO, or HSOC in Clearfield Plus spring wheat is only advised when a Beyond Xtra tank mix partner allows use of COC, MSO, or HSOC.

Table 5.67 - Comments on Herbicides for Small Grains (cont.)

See specific product label to determine correct rate for soil type and weed species found in each field.

- Tables 5.64, 5.65, and 5.66 list characteristics and efficacy of herbicides.
- A good small grain stand is very competitive and normally does not require a herbicide treatment.
- It is important to control all existing vegetation at planting time, prior to no-till production.

Trade Name	Common Name	Site of Action Number	Application	Product/A	lb ai/A
dicamba (numerous)	dicamba DMA Salt	4	Full tiller to jointing (growth stages 3–6)	2–4 fl oz	0.06–0.12
Clarity 4S	dicamba DGA Salt			2–4 fl oz	

- For use on fall-seeded barley and wheat only.
- Crop safety and weed control will be similar for all dicamba formulations.
- Spraying small grains after jointing can result in reduced yields or uneven ripening. May be tank-mixed with Maestro or 2,4-D to broaden spectrum of control.
- Do not use if legumes are underseeded.
- No rotation restrictions.

Finesse 75DF Cereal and Fallow	chloransulam metsulfuron	2 2	preemergence to postemergence (after 1-leaf but before boot stage)	0.2–0.4 oz	0.0078–0.0156 0.0016–0.0031
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- Do not apply preplant or preemergence to barley or triticale.
- Plant seed at least 1 inch deep to reduce risk of injury.
- Finesse will not control ALS-resistant weed populations; control of susceptible ryegrass populations can be erratic.
- Rotation to Bolt or STS soybeans is 4 months; Plenish trait is 6 months.
- Rotation for field corn and all other soybeans is 18 months.
- Include a nonionic surfactant at 0.125 to 0.5% v/v.
- Two applications can be used, but do not exceed 0.4 oz per crop.

Table 5.67 - Comments on Herbicides for Small Grains (cont.)

See specific product label to determine correct rate for soil type and weed species found in each field.

- Tables 5.64, 5.65, and 5.66 list characteristics and efficacy of herbicides.
- A good small grain stand is very competitive and normally does not require a herbicide treatment.
- It is important to control all existing vegetation at planting time, prior to no-till production.

Trade Name	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Harmony Extra SG 50DF	thifensulfuron	2	Two-leaf to before visible flag leaf (growth stages 1– 7)	0.45–0.9 oz	0.009–0.018
	+ tribenuron	2			0.005–0.009

- For use on wheat, barley, and oats.
- Do not apply within 45 days of harvest.
- Controls wild garlic and broadleaf weeds. Tank-mix with Express 50SG for improved wild carrot control. Not recommended for cornflower.
- Rates depend on type of weeds and severity.
- Fall applications have been more consistent than spring applications for weed control in regional trials.
- For garlic control use higher rates of Harmony Extra SG plus 2,4-D when garlic is less than 12 inches tall.
- Always premix Harmony Extra SG in water before adding to the spray tank.
- Tank-mix with other herbicides to increase weed control spectrum; improve control of ALS-R common chickweed with Quelex or Starane Ultra.
- Tank-mixing with dicamba or Maestro may result in reduced control of certain broadleaf weeds.
- Do not tank-mix with Malathion.
- Be aware many products contain thifensulfuron plus tribenuron, but often not at the same concentration as Harmony Extra.
- Any crop may be planted 45 days after application; see Table 5.24.

Harmony SG 50DF	thifensulfuron	2	Two-leaf to before visible flag leaf (growth stages 1– 7)	0.45–0.9 oz	0.014–0.028
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- Harmony SG can be used on fall-seeded wheat, barley, triticale, and oats.
- Do not apply within 45 days of harvest.
- Harmony SG controls wild garlic and broadleaf weeds. Not recommended for cornflower or common chickweed.
- The common rate for wheat, barley, and triticale is 0.75 oz/A, but higher or lower rates may be used. Apply 0.45 to 0.6 oz/A to oats.
- Sequential applications may be applied to wheat, barley, and triticale. Do not apply more than exceed 1.5 oz/a per year.
- Tank-mix with other herbicides to increase weed control spectrum; Quelex or Starane Ultra improve control of ALS-R common chickweed.
- Harmony SG also may be used as a preplant burndown application before small grain emergence.
- Any crop may be planted 45 days after application; Table 5.24.

Table 5.67 - Comments on Herbicides for Small Grains (cont.)

See specific product label to determine correct rate for soil type and weed species found in each field.

- Tables 5.64, 5.65, and 5.66 list characteristics and efficacy of herbicides.
- A good small grain stand is very competitive and normally does not require a herbicide treatment.
- It is important to control all existing vegetation at planting time, prior to no-till production.

Trade Name	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Huskie 2.06L	pyrasulfotole + bromoxynil	6 27	First-leaf to flag-leaf emergence (growth stage 1-7)	11-15 oz	0.026-0.036 0.151-0.205

- For use on wheat, barley, rye, and triticale.
- Huskie controls small annual broadleaf weeds.
- Pre-harvest interval is not specified on label.
- In some university trials, Huskie provided control of marestail at the rosette stage when applied in the spring.
- 4 month rotation restriction to soybean; >9 months for vegetables; see Table 5.24.
- *Water quality advisory.*

MCPA amine or ester 4L	MCPA	4	Full tiller to prejoint stage (growth stages 3-6)	0.5-1.0 pt	0.25-0.5
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- For use on wheat, barley, rye, and oats.
- Safer on small grains underseeded with legumes than 2,4-D (amine formulation only) but use the lower rate (0.25-0.5 pt) and apply in 5-10 gal water/A; legumes should be 2-3 inches tall and cereal should be 8 inches tall to provide canopy to protect legume.
- For best results, apply while weeds are small, typically when cereal is 4-8 inches tall.
- No rotation restrictions are indicated.

Maestro 2EC	bromoxynil	6	Emergence to boot stage (growth stages 1-9)	1-2 pt	0.25-0.5
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- For use on fall-seeded wheat, barley, rye and oats.
- May be applied to a small-grain/alfalfa under-seeding.
- Apply before weeds have more than four leaves or are 2 inches tall, or rosettes exceed 1 inch in diameter.
- Use flat fan nozzles and a minimum of 10 gal/A for best results.
- Weak on chickweed and henbit.
- May be tank-mixed with Harmony Extra SG, MCPA, 2,4-D, or Banvel/Clarity.
- 30 day rotation restriction for all crops; see Table 5.24.
- Tolvera is a premix containing tolpyralate and bromoxynil.

Table 5.67 - Comments on Herbicides for Small Grains (cont.)

See specific product label to determine correct rate for soil type and weed species found in each field.

- Tables 5.64, 5.65, and 5.66 list characteristics and efficacy of herbicides.
- A good small grain stand is very competitive and normally does not require a herbicide treatment.
- It is important to control all existing vegetation at planting time, prior to no-till production.

Trade Name	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Metricor 75DF/ TriCor 75DF	metribuzin	5	2-leaf to 4-tiller (growth stages 1–5)	2–4 oz	0.047–0.19

- For use on wheat and barley.
- For control of Group 2 (ALS) resistant common chickweed: Metricor and Tricor are approved for use under 24(c) labels in Delaware, Maryland, Pennsylvania, and Virginia (expires December 2025).
- The typical use rate is 2–4 oz/A (3 oz/A is recommended) either in the fall or spring when the crop is in the 2-leaf to 4-tiller growth stage.
- Rate depends on soil texture; see product label.
- Local research has shown wheat safety is best with an early spring application (at greenup). Potential for injury increases with late spring applications or fall applications.
- Plant wheat at least 1 inch deep.
- Metribuzin can be tank-mixed with other small grain herbicides to broaden control spectrum.
- Certain wheat and barley varieties are sensitive to metribuzin. Refer to the respective label for additional details on varieties and other use restrictions.
- In general, fall-applied herbicide generally provided more consistent common chickweed control, but spring metribuzin treatments were adequate as well.
- For best results, apply metribuzin when chickweed is small (4–6 inches in diameter).
- Metricor may be applied more than once per crop season. Do not apply more than 8 oz/A per year.
- Allow a minimum of 21 days between applications when wheat is actively growing and 45 days if wheat is growing under adverse conditions.
- No rotation restriction to soybean; 4 to 18 months for vegetables; see Table 5.24.
- *Water quality advisory.*

Osprey 4.5 WDG	mesosulfuron	2	Emergence to jointing stage (growth stages 1-5)	4.75 oz	0.013
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- For use in winter wheat and triticale.
- Pre-harvest interval is not specified on label.
- In our region, Osprey will be primarily targeted for control of annual ryegrass, including ACCase-resistant biotypes and downy brome. Can provide control/suppression of annual bluegrass.
- Applications should be made when weeds are young and actively growing at the one-leaf to two-tiller stage.
- To broaden weed control spectrum, Osprey may be tank-mixed with other herbicides including Harmony Extra SG, Harmony SG, MCPA, Maestro (Buctril), and Stinger.
- Do not topdress with nitrogen fertilizer within 14 days following an Osprey application.
- Do not apply more than 4.75 oz/A in a single application, or 4.75 oz/A per year.
- Certain insecticides and fungicides may be tank-mixed.
- Soybeans can be planted after 90 days of application; corn after 3 months; vegetables after 10 months, and alfalfa after 10 months; see Table 5.24.

Table 5.67 - Comments on Herbicides for Small Grains (cont.)

See specific product label to determine correct rate for soil type and weed species found in each field.

- Tables 5.64, 5.65, and 5.66 list characteristics and efficacy of herbicides.
- A good small grain stand is very competitive and normally does not require a herbicide treatment.
- It is important to control all existing vegetation at planting time, prior to no-till production.

Trade Name	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Peak 57WDG	prosulfuron	2	Three-leaf to before visible second node (growth stages 2-6)	0.25–0.5 oz (1 pack/6-12 A)	0.009–0.018 oz

- For use on wheat, barley, oats, rye, and triticale
- Peak controls wild garlic and broadleaf weeds.
- Peak can be tankmixed with glyphosate as a burndown plus residual treatment; can be used prior to planting.
- For best results apply when weeds are small and use the 0.5 oz/A rate if used alone.
- May be tank-mixed with Banvel/Clarity, 2,4-D, MCPA, or Maestro (Buctril) to broaden weed spectrum; however, certain application timing restrictions may apply.
- Do not apply organophosphate (op) insecticide 15 days before or 10 days after Peak application.
- Be cautious of crop rotation restrictions (10 mo. for soybeans and 22 mo. for alfalfa; see label for other cropping restrictions); see Table 5.24.
- *Water quality advisory.*

PowerFlex HL 13WDG	pyroxsulam	2	Three-leaf to jointing (growth stage 6)	2.0 oz	0.016
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- For use on wheat and triticale only.
- Do not apply within 60 days of harvest. Crop stunting and chlorosis is commonly observed with spring applications; and stunted wheat can be observed for weeks after application. Stunting and chlorosis has not been observed with fall applications.
- Do not apply more than 2 oz/A in a single application, or 2 oz/A per year.
- The PowerFlex activity on certain grass and broadleaf weeds, including annual ryegrass, downy brome and annual bluegrass is improved with fall applications.
- Tarzec is a premix containing halauxifen plus pyroxsulam.
- Soybeans can be planted 3 months after application. Vegetables can be planted after 9 to 12 months; see Table 5.24.

Prowl H₂O 3.8SC	pendimethalin	3	First-leaf to before the flag leaf is visible (growth stages 1-7)	1.5–3 pt	0.7–1.4
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- For use on wheat or triticale only.
- Wheat or triticale must be planted 0.5–1 inch deep to avoid crop injury.
- Must be applied prior before weed emergence. Any emerged weeds will not be controlled, so use a tank mix to control them.
- For best results, apply Prowl H₂O once the wheat rows are visible and before weeds have emerged.
- Prowl controls many annual grass and broadleaf weeds.
- No rotation restriction to soybeans or vegetables; see Table 5.24.

Table 5.67 - Comments on Herbicides for Small Grains (cont.)

See specific product label to determine correct rate for soil type and weed species found in each field.

- Tables 5.64, 5.65, and 5.66 list characteristics and efficacy of herbicides.
- A good small grain stand is very competitive and normally does not require a herbicide treatment.
- It is important to control all existing vegetation at planting time, prior to no-till production.

Trade Name	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Quelex 20.4WDG	halauxifen	4	2-leaf to flag leaf emergence (growth stages 2-8)	0.75 oz	0.005
	florasulam	2			0.005

- For use on wheat, barley, or triticale only.
- Best to apply to small, actively growing weeds (2 to 4-leaf stage).
- Quelex is a slow-acting herbicide.
- Quelex provides good control of Group 2 (ALS) resistant common chickweed; Harmony Extra plus Quelex has provided control of ivyleaf speedwell and henbit (better than either herbicide applied alone).
- Do not compost any plant material from the treated area.
- Do not apply within 60 days of crop harvest.
- Rotation is 3 months in Pennsylvania, 45 days in Delaware, Maryland, Virginia to soybeans and 15 months to most vegetables; see Table 5.24.
- *Water quality advisory.*

Sharpen 2.85SC	saflufenacil	14	Preplant or preemergence	1–4 fl oz	0.022–0.088
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- For use on wheat, barley, oats, rye, and triticale.
- Be sure seed row is sufficiently covered with soil to avoid washing and concentrating the herbicide in the seed zone.
- Apply Sharpen for burndown (see Table 5.3) and/or limited residual control of certain annual broadleaf weeds.
- Sharpen does not control grass weeds.
- Do not apply Sharpen if crop has emerged.
- No rotation restriction to soybeans; 1 to 5 months for vegetables, depending on species; see Table 5.24.

Starane Ultra 2.8L	fluroxypyr	4	Two-leaf to early boot (growth stages 2-9)	4.8–6.4 fl oz	0.09–0.13
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- For use on wheat, barley, triticale, and oats.
- Do not apply within 90 days of harvest.
- The Starane Ultra label lists control of bedstraw, chickweed, hemp dogbane, prickly lettuce, ragweed, and velvetleaf and to suppress bindweed, wild buckwheat, mustard species, and others.
- Starane Ultra provides fair to good control of group 2 (ALS) resistant common chickweed. Harmony Extra plus Starane Ultra has provided control of ivyleaf speedwell, henbit, and jagged chickweed (better than either herbicide applied alone).
- Axial Star is a premix containing pinoxaden (Axial) plus fluroxypyr, Starane Flex is a premix containing fluroxypyr plus florasulam, Supremacy is a premix containing thifensulfuron plus tribenuron plus fluroxypyr. Pixaro is a premix containing halauxifen plus fluroxypyr.
- 120 rotation restriction to crops not listed, which includes soybeans. 24(c) labels in Delaware and Virginia permits 90 day rotation to soybeans.

Table 5.67 - Comments on Herbicides for Small Grains (cont.)

See specific product label to determine correct rate for soil type and weed species found in each field.

- Tables 5.64, 5.65, and 5.66 list characteristics and efficacy of herbicides.
- A good small grain stand is very competitive and normally does not require a herbicide treatment.
- It is important to control all existing vegetation at planting time, prior to no-till production.

Trade Name	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Stinger 3S	clopyralid	4	Three-leaf to early boot (growth stages 2-9)	0.25–0.33 pt	0.1–0.125

- For use on wheat, barley, and oats only.
- For best results, apply while weeds are actively growing.
- For Canada thistle, apply when thistle is 1 to 2 feet tall.
- Pre-harvest interval is not specified on label.
- May be tank-mixed with any other small-grain herbicide to increase weed spectrum. (Curtail is a premix of clopyrid and 2,4-D. See product label for details.)
- Do not use plant residues or manure from animals that consumed forage from treated areas for compost or mulch where susceptible plants may be grown the following season.
- 10.5 month rotation restriction to soybeans for soils >2% organic matter; 18 month restriction for soils <2% organic matter. See label as vegetable rotation varies greatly by species; see Table 5.24.
- *Water quality advisory.*

Valor SX 51WDG or Valor EZ 4L	flumioxazin	14	Early-preplant	1.0–2 oz	0.032–0.064
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- For use in wheat only in DE, MD, NJ, PA, and VA.
- Must be applied 7 days prior to planting in no-till or minimum till wheat; 30 days preplant restriction from conventionally tilled wheat.
- When using as a burndown, apply 2 oz/A.
- Wheat must be planted a minimum of 1 inch deep.
- Valor improves control of horseweed and other broadleaf weeds when tank-mixed with other herbicides that broaden control spectrum.
- With sandy soils, stunting and stand loss can occur if seed is not planted at least 1 inch deep and heavy rain occurs shortly after application.
- No rotation restriction to soybeans; more than 4 months for vegetables; see Table 5.24.

Table 5.67 - Comments on Herbicides for Small Grains (cont.)

See specific product label to determine correct rate for soil type and weed species found in each field.

- Tables 5.64, 5.65, and 5.66 list characteristics and efficacy of herbicides.
- A good small grain stand is very competitive and normally does not require a herbicide treatment.
- It is important to control all existing vegetation at planting time, prior to no-till production.

Trade Name	Common Name	Site of Action Number	Application	Product/A	lb ai/A
Zidua 85WDG or Zidua 4.17SC	pyroxasulfone	15	Delayed pre- to early postemergence (4th tiller)	0.7–2.5 oz or 1.25–4 fl oz	0.04–0.13
Anthem Flex 4SE	pyroxasulfone + carfentrazone	15 14	(stages 1-3)	2–4.5 fl oz	0.004–0.01

- For use in wheat only.
- All products can be applied as a delayed preemergence (80% germination with 0.5-inch-long shoot to spiking) to control annual grasses and small-seeded broadleaf weeds. Application before wheat germination, followed by rainfall, can lead to significant stand loss.
- Do not use on broadcast seeded wheat; do not plant wheat deeper than 1.5 inches (but at least 1 one inch deep).
- Do not apply if more than 0.25 inches of rain is expected within 48 hours.
- Crop injury may result under prolonged wet soil conditions.
- Consult label as soil texture influences rate.
- If applied as an early postemergence (spike to 4 tillers) Zidua may be tank-mixed with Clarity, Prowl H₂O, metribuzin, or Axial XL; consult label as soil texture influences rate.
- Zidua alone will not control emerged weeds; Anthem Flex contains carfentrazone (Aim) which will provide control of certain weed species if they are very small at time of application.
- No rotation restriction to soybeans; 18 months for vegetables; see Table 5.24.
- *Water quality advisory.*

Table 5.68 - Spray Additives and Rainfastness for “Burndown” or Postemergence Herbicides in Small Grains

Trade Name	Adjuvant(s) ¹	Rate	Apply in N-carrier (50:50)	Rainfastness (hours)
2,4-D amine 4S/	nonionic surfactant or	1 qt/100 gal	Yes	1
2,4-D LVE 4E	crop oil concentrate	4 qt/100 gal		
Aim	nonionic surfactant or	1 qt/100 gal	Yes	6 to 8
	crop oil concentrate plus	1 gal/100 gal		
	ammonium sulfate or	2-4 lb/A		
	nitrogen solution (optional)	2-4 gal/100 gal		
Anthem Flex ²	non-ionic surfactant	1 qt/100 gal	N/A	1
	or crop oil concentrate	1-2 pt/A		
	or methylated seed oil	1-2 pt/A		
	plus nitrogen solution (optional)	1-2 pt/A		
	or ammonium sulfate (optional)	8.5 lb/100 gal		
Axial XL	none required		Yes	0.5
Axiom	Do not add crop oil concentrate, vegetable, or petroleum oils		No	
Clarity/dicamba	nonionic surfactant or	1 qt/100 gal	Yes	4
	crop oil concentrate plus	1 gal/100 gal		
	nitrogen solution	2-4 qt/A		
Finesse	non-ionic surfactant	0.5-2 qt/100 gal	Yes	6
Harmony Extra	nonionic surfactant	See table below	Yes	several
	nitrogen solution (optional)	2 qt/A		
Harmony SG	nonionic surfactant	See table below	Yes	several
	nitrogen solution (optional)	2 qt/A		
Huskie	ammonium sulfate or	0.5-1 lb/A	Yes	1
	Urea ammonium nitrate	1-2 qt/A		
MCPA	No information		Yes	No information
Maestro	nonionic surfactant or	1 qt/100 gal	Yes	No information
	crop oil concentrate or	1 gal/100 gal		
	nitrogen solution	2-4 gal/100 gal		
Metricor/TriCor	not recommended		not recommended	No information
Osprey	methylated seed oil (MSO) or	2 gal/100 gal	Yes, but no more than 15% of solution	4
	Nonionic surfactant plus	2 pt/100 gal		
	Nitrogen solution	1-2 qt/A		
Peak	nonionic surfactant or	1-2 qt/100 gal	yes	4
	crop oil concentrate	1-4 qt/A	Do not use crop oil with N-carrier	
	nitrogen solution (optional)	2-4 qt/A		

Table 5.68 - Spray Additives and Rainfastness for “Burndown” or Postemergence Herbicides in Small Grains (cont.)

Trade Name	Adjuvant(s) ¹	Rate	Apply in N-carrier (50:50)	Rainfastness (hours)
Powerflex	nonionic surfactant plus	1-2 qt/100 gal	Yes	4
	nitrogen solutions (optional) or	1-2 qt/A		
	crop oil concentrate (nitrogen solutions is not recommended with COC)	1 gal/100 gal		
Quelex	non-ionic surfactant	0.8-2 qt/100 gal	yes ³	4
	or crop oil concentrate	2-4 qt/100 gal		
	or methylated seed oil	2-4 qt/100 gal		
Sharpen	methylated seed oil	1 gal/100 gal	No information	1
	Nitrogen solution	1.25-2.5 gal/100 gals		
Starane Ultra	None recommended		No information	1
Stinger	None recommended		Yes	6
Tolvera	methylated seed oil	2-4 qt/100 gal	Yes	1
	or crop oil concentrate	2-4 qt/100 gal	Yes	1
	or high surfactant oil concentrate	2-4 qt/100 gal	Yes	1
Valor	methylated seed oil	1 qt/A	No information	1
	nitrogen solution	1-2 qt/A		
Zidua	None recommended		No information	N/A

¹ In general, nonionic surfactants should contain at least 80% surface active agent; crop or vegetable oil concentrates should be nonphytotoxic containing at least 15% approved emulsifier; nitrogen solution is ammonium-based fertilizer such as 28%, 30%, or 32% N; and ammonium sulfate should be spray-grade dry ammonium sulfate (21-0-0). You also may use 10-34-0 with some products.

² Anthem Flex label recommends an adjuvant if emerged weeds are present (and are susceptible to carfentrazone [Aim]) at time of application.

³ When applied with liquid nitrogen fertilizer use non-ionic surfactant at no more than 1 qt/100 gal instead of crop oil or methylated seed oil.

5-224 Weed Control in Field Crops: *Small Grains*

Adjuvant recommendations for Harmony SG and Harmony Extra SG.

Carrier	Situation	Rate of NIS/100 gallons
Water	Normal	1 qt
Nitrogen diluted with water (>50% nitrogen)	Normal	0.5-1 pt
Liquid nitrogen fertilizer	Garlic over 8 inches	0.5 pt
Liquid nitrogen fertilizer	Garlic less than 8 inches	None
Liquid nitrogen fertilizer	With 8 fl oz of 2,4-D	None
Water	With 8 fl oz of 2,4-D	1 pt

Table 5.69 - Comments on Herbicides for Harvest Aid in Small Grains

Paraquat/Gramoxone is not labeled as a harvest aid in small grains.

Trade Name	Common Name	Site of Action Number	Product/A	lb ai/A
2,4-D LVE 4E	2,4-D	4	1.0–2.0 pt	0.5–1.0

- For use on wheat, barley, rye, and oats. (Only certain 2,4-D products have all of these small grains listed.)
- Apply when grains are in the hard dough stage.
- 2,4-D is generally not recommended as a harvest aid due to its volatility, and potential damage to the crop during application.
- Avoid use if temperatures are expected to exceed 75°F.
- No adjuvants are recommended.
- 14 day preharvest interval.

Aim 2EC	carfentrazone	14	2 fl oz	0.26 oz
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- Use as a harvest aid to desiccate a limited number of broadleaf weed species
- Application shall be made when the crop is mature and the grain has begun to dry down.
- Ensure spray coverage is sufficient, otherwise poor control will result.
- Methylated seed oil or crop oil concentrate at 1 to 2 gal/100 gal is required; liquid nitrogen fertilizer at 2 to 4 gal/100 gal or ammonium sulfate at 2 to 4 lb/A can be added to the methylated seed oil or crop oil.
- Allow at least 7 days between application and harvest.

dicamba (numerous)	dicamba DMA Salt	4	8 fl oz	0.25
Clarity 4S	dicamba DGA Salt		8 fl oz	

- For use on fall-seeded barley and wheat.
- Do not apply to grain grown for seed.
- Apply when grains are in the hard dough stage.
- Apply with a nonionic surfactant (1 qt/100 gal) or crop oil concentrate or methylated seed oil (1 to 2 qt/100 gal)
- Apply 7 days before harvest.

Table 5.69 - Comments on Herbicides for Harvest Aid in Small Grains (cont.)

Paraquat/Gramoxone is not labeled as a harvest aid in small grains.

Trade Name	Common Name	Site of Action Number	Product/A	lb ai/A
Roundup Powermax 4.5S¹/ Glyphosate¹	glyphosate	9	1–2 pt	0.5–1.0
Sharpen 2.85SC	saflufenacil	14	1–2 fl oz	0.022–0.044

- Do not apply to wheat grown for seed; and feed barley is only barley type labeled.
- Apply to feed barley after the hard dough stage when grain moisture is 20% or less; apply to wheat after the hard dough stage when grain moisture is 30% or less.
- Be cautious of drift.
- See specific glyphosate formulations for adjuvant recommendations.
- Apply at least 7 days before harvest.

- For use on wheat, barley (feed only), and triticale.
- Apply after hard dough stage and grain is less than 30% moisture.
- Ground applications require 10 gallons spray volume per acre; aerial requires 5 gallons.
- No rotation restriction to soybeans; 1 to 5 months for vegetables.
- Apply with methylated seed oil (1 gal/100 gal) plus ammonium sulfate (8.5 lb/100 gal) or urea ammonium nitrate (UAN) (1.25 to 2.5 gal/A).
- Apply at least 3 days before harvest; label recommends 10 days for optimum desiccation effect.
- *Water quality advisory.*

¹ Various formulations of this product are available; see table in the introductory chapter of this guide for various glyphosate products and rates. Refer to current product label for active ingredient concentration, application rate, and other restrictions. Adjust application rate if using Roundup WeatherMax 4.5S (e.g., 1 qt Roundup 4S = 22 fl oz WeatherMAX 4.5S).

Table 5.70 - Grazing and Feeding Restrictions for Small Grain Herbicides and Livestock Use

Herbicide	Days After Treatment Before:					Pre-harvest for Grain (PHI)
	Grazing		Feeding Straw	Withdraw for Meat	Silage	
	Beef	Dairy				
2,4-D ¹	0	14	0	14	— ²	14
2,4-D ¹ (late)	no	no	no	—	—	14
Aim	7	7	7	—	7	7
Anthem Flex	7	7	—	—	—	7
Axial Bold	30	30	30	—	30	70
Axial Star	30	30	30	—	30	60
Axial XL	30	30	60	—	30	60
Axiom	30	30	—	—	—	not specified
Callisto ³	30	30	30	—	30	50
Clarity/dicamba	0	7	37	30	37	7
Finesse	no	no	—	—	—	45
Harmony SG	7	7	yes	—	7/30	45
Harmony Extra	7	7	yes	—	7/30	45
Huskie	25	25	60	—	25	60
MCPA ¹	0	7	0	7	—	not specified
Maestro	30	30	30	30	30	not specified
Metricor/Tricor	14	14	no	—	21	not specified
Osprey	30	30	60	—	30	not specified
Peak	30	30	30	—	40	60
PowerFlex	7	7	28	—	28	60
Prowl H ₂ O	11	11	60	—	11	60
Quelex	7	7	21	—	—	60
Sharpen	30	30	30	—	30	3
Starane Ultra	7	7	40	—	14	120/90 ⁴
Stinger	0	7	no	7	—	not specified
Tolvera	21	21	50	—	21	50
Valor	5 inches in height	5 inches in height	—	—	—	not specified
Zidua	7	7	—	—	—	not specified

¹ 2,4-D and MCPA labels may vary depending on brand name. Consult label for restrictions.

² — = no information available.

³ Callisto is only labeled for use in spring oats only.

⁴ 24c label allows for 90 day plant back to soybeans for Delaware and Virginia only.

Forages, CRP, and Farmstead Weed Management

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Integrated Weed Management

Managing weeds in forages requires a different approach from managing weeds in row crops. Proper management to establish and maintain a dense stand of forage will render it competitive to most common weeds. Managing soil pH, nutrients, grazing or cutting, and insects, as well as using disease-resistant varieties and selective herbicides when necessary, will help the forage stand be competitive. A well-planned pest management program for forage crops involves using multiple strategies. These should include prevention, monitoring, cultural control, mechanical or physical control, biological control, and chemical control tactics. Preventive techniques may start with planting weed-free crop seed or choosing an alternative field or planting date. Regularly monitoring for pests is an important predictive tool. Mechanical or physical controls may include tillage and mowing to disrupt certain pests. Mixed grazing by including small ruminants into the livestock community will help manage brushy weeds in a pasture. Finally, chemical controls are an important component of many integrated pest management (IPM) systems, but their use should be based on sound management decisions. See Chapter 1 of this guide for more information about designing an IPM program.

This guide provides chemical control recommendations based on university research and manufacturer recommendations. Table 5.69 contains general information about herbicides available for use in legume or grass forages including pastures and hayfields.

This publication strives for accuracy; however, omissions, inaccuracies, or outdated information can occur because of the dynamics of pests and pest management. Seek out additional information from the manufacturer or other reliable sources when making important management decisions. Remember, this guide is not a substitute for the manufacturer's product label.

Legumes

If weeds become a problem, they can compete for or interfere with light, nutrients, water, and space, directly influencing yield and forage stand. For instance, winter annuals and perennials such as common or mouseear chickweed, henbit, and purple dead-nettle have been reported to reduce alfalfa stands by more than 30 percent. They emerge in the fall and winter, and develop a thick, lush mat early in the spring that can compete with the first forage cutting. Once they complete their life cycle in early summer, summer annuals, such as foxtails, lambsquarters, and pigweeds, or perennial weeds such as dandelion or dock species can fill in the bare spots and continue to reduce forage yield and quality.

Unlike most grain or fiber crops from which weeds are separated at harvest, weeds often are harvested along with the forage crop, potentially reducing hay quality. Reductions in quality often are in the form of low protein content and feed digestibility. Forage value of weeds may vary from species to species. For example, dandelion is comparable to alfalfa in protein and total digestible nutrients (TDN). Dandelion control may not necessarily improve the quality of hay, but it may be of some value in reducing the time necessary to dry the hay since dandelion dries more slowly than alfalfa. Increased drying time may mean greater harvest losses due to untimely rainfall.

Quality of monocot weeds (grasses) can also be similar to that of the forage. In general, weedy grasses have about 75 percent of the quality of alfalfa. Controlling quackgrass in alfalfa can increase forage protein levels 4 to 7 percent. Weeds with woody stems or flower stalks, such as yellow rocket, white cockle, rough fleabane, curly dock, and broadleaf dock, have lower protein levels (about 50 percent of the quality of alfalfa), so controlling them is even more important.

When weeds are present or persist in spite of good management, herbicides can help improve yield and quality. Weed control

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at establishment or in the seedling year is most critical for maintaining a healthy forage stand. When weeds are controlled during the seedling year, the forage crop seldom requires additional herbicide treatments for at least the first two years of the stand.

Weed management in legume forages can be divided into two phases: control in the establishment or seedling year and control in an established stand.

Control Before and During Establishment

Managing weeds in forages begins long before crop establishment. Certain types of weeds are potentially serious problems for forages, so it is important to eliminate them in advance. In particular, perennial broadleaf and grass weeds such as dandelion, curly dock, Canada thistle, horsenettle, and quackgrass are much easier to manage prior to planting a forage crop. While combating such weeds in the establishment year, prudent use of a genetically modified glyphosate tolerant (Roundup-Ready) alfalfa seed could be of value. Biennial weeds including musk thistle and burdock should be eliminated before establishing forage. If these weeds are not removed before the seeding is made, they commonly persist throughout the life of the forage. The cost of controlling weeds before or at the time of seeding should be considered an investment that will be returned for the life of the stand.

Below are some general rules for managing weeds at establishment or in the seedling year:

- Weeds that emerge with the crop are generally more destructive.
- Maintain the forage relatively weed-free for the first 60 days.
- Weeds that emerge beyond 60 days will not influence that year's forage yield.
- Later-emerging weeds may still influence forage quality.
- Winter-annual weed competition in early spring is most damaging to forages.
- Broadleaf weeds are generally more competitive against legumes than grassy weeds.

Herbicides are needed most often during establishment, and several options exist for managing weeds in pure legume seedings. Weed control is also very important while the forage is young and prone to competition from invading species. In no-till seedings, adequately controlling the existing vegetation, especially perennials, is very important. Burndown herbicides available for use in legume forage seedings are listed in Tables 5.69 and 5.70. Herbicides available for use in legumes are listed in Table 5.71. The effectiveness of various herbicides at or during establishment is included in Table 5.72. Herbicides available for use during the establishment year are included in Table 5.73.

Control in an Established Stand

The best weed control in an established forage stand is achieved by maintaining a dense healthy stand through proper fertilization, cutting management, and insect control. Controlling weeds in established forages is normally of greatest benefit in the first cutting. Weeds generally contribute much less to yield in the second and succeeding harvests. Before using an herbicide in established stands, evaluate the forage to ensure it is worth the cost of the herbicide.

Below are some general rules to follow before using an herbicide in established forage stands:

- Thin or irregular stands do not thicken once weeds are removed. Be sure there are sufficient desirable species to fill in the gaps. A minimum of five alfalfa plants per square foot should be present.
- Weeds tolerant of the herbicide may invade the space left by susceptible species, ultimately creating a new or more severe weed problem.
- Treat only well-established, vigorous stands with herbicides.
- If the forage stand is at least two years old and 25 percent to 30 percent of the plants are weeds, removing them with an herbicide application is of questionable value. Renovation is likely more economical.
- If 50 percent or more of the plants are weeds, it is time to rotate to a different crop, or renovate the existing crop.

If weeds become a problem in established forages, several herbicide options are available (Table 5.73). Chemical control in established forage legumes is often limited to late fall or early spring applications. Many herbicides require the addition of adjuvants for effective control (Table 5.74). Also, many products have harvesting, feeding, or grazing restrictions on their use (Table 5.75).

Grass Forages Including Pastures and Hayfields

Without proper management, broadleaf weeds can directly compete with forage grasses to reduce their nutritional value and longevity. Weeds can replace desirable grass species, filling in gaps or voids and reducing yield and overall quality of the hay or pasture. In addition, certain plants such as poison hemlock, white snakeroot, or black locust have toxic properties that can cause livestock injury or loss under certain circumstances (see poisonous weeds below).

Biennial and perennial weeds are considered especially troublesome by grass hay and pasture producers. Both biennials and perennials produce seed each year, potentially starting new infestations. In addition, perennial weeds such as hemp dogbane, Canada thistle, and multiflora rose reproduce from underground roots or rhizomes. Perennial rooting structures can survive for several years in the soil and are often unaffected by occasional mowing or livestock grazing.

Good cultural practices such as maintaining optimum soil fertility, using a competitive cutting schedule for forages, rotationally grazing pastures, and periodic clipping and/or coring pastures, can help keep the crop competitive with weeds. The most critical time for weed control is during the establishment year. If a no-till seeding is desired, be sure the preplant vegetation is adequately controlled. See Tables 5.68 and 5.69 for the information on burndown herbicides in controlling vegetation prior to planting.

In general, use preplant tillage or herbicides, companion seedings, mowing, and/or a postemergence herbicide to ensure that weeds are not a problem in the seeding year. To reduce weed shading, mow at a height above the grass seedlings when weeds are 8 to 10 inches tall. For warm-season grasses, do not mow after early August.

Certain application methods used in forage crops, including spot spraying and wiper applications, are not commonplace in row crops. With spot spraying, the herbicide is applied to weed-infested areas of the field, typically less than one-tenth of the total area. Spot applications are accomplished using a hand-held sprayer or a spray gun. Refer to the spot treatment section of the herbicide label and apply the recommended concentration on a spray-to-wet basis avoiding spray dripping or runoff (1 gal/1000 ft²) to provide thorough coverage. Most backpack sprayers hold only 1 to 3 gallons of spray solution. Specialized equipment capable of measuring a small volume or weight (i.e.: syringes, gram scales, etc.), are recommended to accurately dispense the desired quantity of herbicide product into small volumes of spray solutions (see Table 5.84). Apply all herbicides at least seven days before crop harvest, or harvest around weed patches, leaving them standing to be treated later. Apply all herbicides at least seven days before a killing frost. Spot treatment may kill desirable vegetation that is contacted by the herbicide. Select an herbicide based on its effectiveness on the target weed, safety to existing desirable vegetation, and grazing, overseeding, or rotational crop intervals.

Wiper applicators (weed wipers) are devices that physically wipe a concentrated solution of herbicide directly onto weeds by taking advantage of sufficient height difference between the weeds and crop canopy. The height difference in pasture can be increased by grazing the forage prior to wiper application and allowing some days for trampled weeds to recover. Sufficient contact from the wiper applicator while preventing contact with the crop controls weeds selectively is the goal. Since only the top several inches of the weeds are contacted with herbicide solution, a translocated herbicide such as dicamba or glyphosate is usually required for effective control. Repeat applications may be required to manage certain perennial weeds. A healthy actively growing crop that can develop a canopy over suppressed weeds is important to the success of wiper applications. There are several types of wiper applicators on the market. Wiper applicators must be designed and operated so that the rope, roller, sponge, or panel remains moist enough to transfer a sufficient amount of herbicide to the weed while not allowing drips to contact the crop. The two most common types are wick and roller applicators. Wick applicators use short braided ropes or appropriate fabric to “wick” the herbicide solution from inside a pipe to the plants that are wiped. With roller applicators, herbicide is manually sprayed intermittently onto a carpet covered roller that is rotated with a motor or a ground-driven shaft. The main advantage of the roller applicator is that more herbicide solution can be maintained on the roller. Compared to wick applicators, roller applicators provide consistent weed control. Bidirectional application is recommended to provide thorough control. Herbicides labeled for wiper application will usually provide specific application instructions on the label. In addition, research trials have indicated that a 5% solution applied in a wiper applicator is somewhat comparable to a broadcast application rate of 1 qt/A.

Controlling woody perennial species (brush) or vines can be very difficult with standard broadcast herbicide applications. Achieving acceptable weed control can require multiple years of intensive and persistent management. Product labels often have specific recommendations concerning herbicide rate, spray volume, seasonal application, retreatment, and growth stage. Recommendations are often species specific, and tank-mixes with other herbicides or alternative application methods may be required. Application methods may include basal bark, cut stump, dormant stem, oil-water emulsions, or high volume foliar applications. Carefully read and follow all herbicide label recommendations.

Management of Fence Rows

Proper weed management in fence lines will make them last longer and function better than where brush is allowed to grow. Weeds can stretch and bend fencing material and also cause electric fences to short-out. Nonselective herbicides like glyphosate (Roundup) can be used to control weeds. But, nonselective herbicides will also kill grasses, reducing grazable area and result in bare ground, which will allow weeds to re-infest the fence line. Bare ground also increases erosion along the fence. Conversely, selective herbicides can be used to control broadleaf weeds and brush while keeping grasses. Some herbicides have soil residual activity, such as tebuthiuron (Spike), prometon (Pramitol), and imazapyr (Arsenal), which will make control last longer than herbicides with no or only limited soil activity, such as 2,4-D, dicamba, and triclopyr (Remedy Ultra). Some herbicides, such as metsulfuron (a component of Chaparral, Cimarron, and other products) and imazapic (Plateau) will suppress tall fescue growth, which can be useful for electric fencing. These herbicides should only be applied every other year or less frequently, to reduce the risk of stand loss or thinning. Make sure to carefully read product labels to understand if the product is nonselective, has residual activity, and weed control spectrum. Also consider what crops are growing on the other side of the fence to avoid off-target injury.

Management of Autumn Olive

Autumn olive (*Elaeagnus umbellata*) is most easily managed through a proactive approach. Once plants become large, they are less easily and affordably controlled. Efficacy of broadcast applications is unknown; individual plant treatment is highly effective. For stems less than one inch in diameter at the base, apply a high volume foliar treatment of Remedy Ultra at 2 QT per 100 gallons of water after autumn olive leaves are fully expanded until prior to fall color. Apply to all foliage until wet but avoid dripping or runoff. For stems 1 to 6 inches in diameter, a basal bark treatment is most effective. Apply Remedy Ultra in bark oil in a 25% herbicide, 75% oil mixture to all sides every stem and exposed roots from the soil line up 12 to 18 inches on the stem. Apply any time of year except during spring. For stems greater than 6 inches in diameter, a cut-stump treatment is most effective. Cut the plant with a chain-saw and apply Remedy Ultra in bark oil in a 25% herbicide, 75% oil mixture less than 10 minutes after cutting. Cut-stump treatment is effective any time of year except during spring. For all treatment types, autumn olive wood is very brittle after death, making removal from fences much easier. Similarly, animals can trample small stems once dead. See Table 5.83 for additional information on timing of application. Mowing does not control autumn olive. For more information on basal bark applications go to <https://plantscience.psu.edu/research/projects/wildland-weed-management/publications/invasive-species-quick sheets/exotic-shrubs>.

Management of Brambles and Multiflora Rose

Brambles (*Rubus spp.*) and multiflora rose (*Rosa multiflora*) can be very difficult and generally requires an herbicide application in two consecutive years for eradication. Goats are an effective option to graze out brambles, but be prepared to graze for 2 to 3 years for complete control. Mowing is a waste of time and money and can lead to decreased herbicide efficacy when conducted up to 1 year preceding application as well as 6 months following application. Triclopyr containing herbicides (Remedy Ultra, PastureGard, and Crossbow) and metsulfuron containing herbicides (metsulfuron, Chaparral, and Cimarron) are most effective and a combination of triclopyr and metsulfuron are recommended. Apply a high volume foliar treatment of Remedy Ultra at 2 QT and metsulfuron 60DF at 1 oz per 100 gallons of water in mid- to late-September. Apply to all foliage until wet but avoid dripping or runoff. See Table 5.85 for additional information on timing of application. A second application is generally required for complete control of brambles. Application of metsulfuron in two consecutive years is not recommended due to tall fescue injury and stand thinning. In the second year, replace metsulfuron with GrazonNext at 7 fl oz/100 gallons of water.

Management of Weedy Grasses in Pasture and Hay

There are no selective postemergence grass herbicides labelled for use in cool-season grass pastures or hayfields. Therefore management practices that provide optimal growing conditions for desirable forages or minimizing bare spots that provide opportunities for weedy grasses could prevent their incidence and invasion. Some of these practices are discussed in earlier sections of this chapter. Scouting pastures to detect aggressive grasses such as Johnsongrass, Japanese stiltgrass, joint-head grass, etc., and taking appropriate steps is recommended to prevent their spread. Perennial grasses such as Johnsongrass may be controlled by applying a glyphosate product as a spot application (to provide 2 lb ae/A) or by applying glyphosate using a weed-wiper (solution strength vary with equipment; ~ 5% strength is required for rotary weed wiper and 1:3 ratio with water required for rope and other types of wipers). Late summer is a good time to apply so that the treated parts of the field can be reseeded in fall. For controlling annual grasses such as Japanese stiltgrass, joint-head grass, foxtails, barnyard grass etc., application of a

preemergence herbicide may be considered. Japanese stiltgrass germinates early, as the forsythias begin to bloom (before peak bloom), and joint-head grass germinates about one week to 10 days later. In established pastures and hayfields, pendimethalin (Prowl H2O) is effective to control most annual weedy grasses when applied prior to weed germination. Higher rates (4 qt/A) are required for Japanese stiltgrass control. Split application is recommended in hayfields (spring application followed by application after first-cut). Quinclorac (Facet L) is also effective to control certain annual grasses such as foxtails.

Find more information here: https://www.pubs.ext.vt.edu/content/pubs_ext_vt_edu/en/SPES/spes-58/SPES-58.html.

Poisonous Weeds

Health effects ranging from none to sickness or occasional death can occur when grazing animals contact or consume toxic plants. To protect animals, it is important to be aware of how toxic plant poisoning occurs commonly. Toxicity is usually derived from certain compounds synthesized by the plant to deter pests, to tolerate extreme soil or other environmental conditions, etc. The toxic potential (the ability to cause detrimental effects) of a given weed on a given day is dependent upon many factors including; the species, age, reproductive status, size, or health of animal consuming it; the plant part, growth stage, condition, and amount of the plant consumed; and the season or environmental conditions when consumed. Discrepancies on poisonous attributes of weeds noted by different sources may be attributed to these variables. Since most of the poisonous substances emit a repulsive odor or are inherently distasteful, the animals typically stay away from plants or plant parts that are poisonous. This is especially true if other more desirable forage species are available. Occasional cases of poisoning, however, do occur when the stand of desirable species is significantly lower than the harmful plants, when extreme weather conditions such as drought occur, with excessive soil fertility, when livestock are contained for extended periods where poisonous plants are prevalent, or when accidental ingestion is followed by lactation and subsequent poisoning of the offspring. Lastly, poisonous weeds are known to affect forage and hay quality as noted above.

With some weeds the toxic compound remains in harvested hay or silage (poison hemlock) while in others it is reduced (hairy vetch) or eliminated (buttercup). Some tree leaves are more toxic after wilting (red maple, wild cherry). Some toxic compounds occur naturally in plants, while others are released by fungi (fungal endophytes) growing in association with a living host forage plant (tall fescue toxicosis, ryegrass staggers, red clover slobbers); by fungi in molded hay or clippings (aflatoxin, botulism, sweet clover poisoning); or by undesirable bacteria in silage (listeriosis). Applications of some herbicides may increase the palatability of certain poisonous plants. Blister beetle poisoning in horses results from consuming a toxin in dead beetles that are baled into alfalfa hay. Certain weeds such as wild garlic or wild onion, while not toxic, may impart a disagreeable flavor to the milk of lactating animals.

About 200 to 300 plant species have been listed as poisonous to animals. While a complete list of poisonous plants is beyond the scope of this publication, a sampling of plant families and species with toxic potential are included here.

- Beech family – oak species
- Boxwood family (**highly toxic**) – boxwood, pachysandra
- Buckwheat family – buckwheat, dock species, rhubarb
- Buttercup family – buttercup species, baneberry, larkspur species
- Heath Family (**highly toxic**) – azalea, rhododendron, mountain laurel
- Legume family – black locust, crown or hairy vetch, golden chain tree, lupine species, pea species, alsike clover, sweet clover, red and white clover
- Lily family – autumn crocus, lily-of-the-valley, star-of-Bethlehem, hyacinth species, skunk cabbage, onion and garlic (both wild and cultivated), tulip, asparagus
- Maple family – red maple
- Nightshade family – nightshade species, jimsonweed, ground cherry, horsenettle, tomato, potato
- Rose family – wild black cherry, chokecherry
- Yew family (**highly toxic**) – English or American Yew
- Other species – black walnut (shavings used as bedding), bleeding heart, bouncing bet, bracken fern, burning bush, cocklebur, dogbane species, foxglove, ground-ivy, horse chestnut species, horsetail, johnsongrass, milkweed species, hemp dogbane, oleander, pigweed (amaranthus species), poison hemlock, pokeweed, privet, ryegrass species, shattercane, St. John's wort, tall fescue, water hemlock species, white snakeroot, and others.

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Toxic weed consumption most often occurs when animals are undernourished, when they are introduced to new grazing areas, when toxic plants are fed directly to them, or when they escape enclosures and feed on toxic plants. It can also occur when the forage provided is not suitable for the species, or is grazed at the wrong growth stage (prussic acid poisoning), while experiencing environmental stress (nitrate poisoning), or during rapid growth with imbalanced fertility (grass tetany). In addition, otherwise suitable feed, hay, or forage can have toxic effects when animals are transitioned to the new source too quickly.

Provide grazing animals with adequate pasture to meet their nutrient and energy requirements, or supplement their diets with a balanced ration, to reduce the chance that they will consume toxic plants. Make gradual transitions to new food sources. Be aware of environmental, seasonal, and fertility conditions that may cause forages to accumulate toxic compounds and test if necessary. Scout for toxic plants (inside and outside the fence), implement good forage and weed management practices, spray for weed control when needed, wait after herbicide treatment until plants are no longer palatable, and remove dangerous plants from your property. Minimize the potential for accidental introductions of toxic plants via downed tree limbs, yard cuttings (especially ornamentals), or others feeding your animals. Provide animals with safe bedding materials.

If you suspect plant poisoning has occurred, call a veterinarian immediately. Remove all animals from the area. Identify the suspected plants. Remove accidentally introduced plant material, or eradicate toxic plant species by hand-weeding, herbicide applications, pasture renovation, or other recommended practices. Monitor the grazing area over time to assure the toxic species has been eradicated. Remove animals from herbicide treated infestations of toxic plant species until dead and unpalatable, as herbicide treatment may increase palatability.

Discussion of toxic ingredients within plants, their specific effects on grazing animals, or toxic dosages (amount required to cause toxicity symptoms) is beyond the scope of this publication. More information can be found in the following sources:

- Burrows, G. E., and R. J. Tyrl, *Handbook of Toxic Plants of North America* (Oxford: Blackwell Publishing, 2006)
- Colorado State University – Veterinary Internal Medicine. <https://poisonousplants.cvmb.colostate.edu/home>
- Cornell University - Animal Science. <https://poisonousplants.ansci.cornell.edu/index.html>
- Knight, A.P., and R.G. Walter. 2001. *A Guide to Plant Poisoning of Animals in North America*. Teton NewMedia, Wyoming, USA.

Table 5.71 - Forage and Pasture Herbicides, their Characteristics, and their Restrictions

Trade Name ¹	Common Name	Manufacturer	Crop	Group # (site of action)	Restricted-Use Pesticide ²	Water Quality Advisory ³	Worker Reentry ⁴ (hours)
2,4-D amine or ester (3.8 lb ae/gal)	2,4-D	Several	grass	4	—	yes	48 or 12
Aim 2EC	carfentrazone	FMC	grass and legume	14	—	—	12
Balan 60DF	benefin	Loveland	legume	3	—	—	12
Beyond Xtra 1AS	imazamox	BASF	legume	2	—	—	4
Butyrac 200 2E	2,4-DB	several	legume	4	—	yes	48
Chaparral 71.6WG	aminopyralid + metsulfuron	Corteva	grass	4, 2	—	yes	48
Chateau 51WDG	flumioxazin	Valent	alfalfa	14	—	—	12
Cimarron Max (co-pack)	metsulfuron + 2,4-D + dicamba	Bayer	grass	2, 4, 4	—	—	48
Cimarron Plus 63WDG	metsulfuron + chlorsulfuron	Bayer	grass	2, 2	—	—	4
Clarity/dicamba 4S	dicamba	BASF/several	grass	4	—	yes	24

Table 5.71 - Forage and Pasture Herbicides, their Characteristics, and their Restrictions (cont.)

Trade Name ¹	Common Name	Manufacturer	Crop	Group # (site of action)	Restricted-Use Pesticide ²	Water Quality Advisory ³	Worker Reentry ⁴ (hours)
Crossbow 3L	2,4-D + triclopyr	several	grass	4, 4	—	yes	until dry
Curtail 2.38L	clopyralid + 2,4-D	Corteva	grass	4, 4	—	yes	48
DuraCor 0.73SC	aminopyralid + florpyrauxifen	Corteva	grass	4, 4	—	yes	48
Engenia	dicamba (BAPMA)	BASF	grass	4	yes	yes	24
Eptam 7E/20G	EPTC	Gowan	legume	8	—	—	12
Escort XP 60DF	metsulfuron	Bayer	grass	2	—	—	4
Facet 1.5L	quinclorac	BASF	grass	4	—	yes	12
Freelexx 3.7 SL	2,4-D (Choline)	Corteva	grass	4	—	yes	48
Gramoxone SL 2.0/3.0	paraquat	Syngenta	legume	22	yes	—	12
GrazonNext HL 3.74E	aminopyralid + 2,4-D	Corteva	grass	4, 4	—	yes	48
Grazon P+D 2.54SL	picloram + 2,4-D	Corteva	grass	4, 4	yes	yes	48
GrazonPD3 3.81SL	picloram + 2,4-D	Corteva	grass	4, 4	yes	yes	48
Huskie 2.06EC ⁵	pyrasulfotole + bromoxynil	Bayer	grass	27, 6	—	yes	24
Imiflex 1AS	imazamox	UPL	legume	2	—	—	4
Kerb 50W	pronamide	Corteva	legume	3	yes	—	24
Maestro 2E	bromoxynil	Nufarm	legume	6	—	—	24
MCPA amine or ester (3.7 lb ae/gal)	MCPA	Several	grass and legume	4	—	yes	48 or 12
Metribuzin 75DF/4L	metribuzin	Several	legume	5	—	yes	12
Metsulfuron 60WG	metsulfuron	Several	grass	2	—	—	4
Milestone 2L	aminopyralid	Corteva	grass	4	—	yes	48
Overdrive 70WDG	dicamba + diflufenzopyr	BASF	grass	4, 4	—	yes	12
PastureGard HL 4SL	triclopyr + fluroxypyr	Corteva	grass	4, 4	—	yes	12
Plateau 2AS	imazapic	BASF	legume and grass	2	—	yes	12
Poast 1.5E	sethoxydim	BASF	legume	15	—	—	12
Prescott 3E	triclopyr + clopyralid	Alligare	grass	4, 4	—	yes	48

5-234 *Weed Control in Field Crops: Forages*

Table 5.71 - Forage and Pasture Herbicides, their Characteristics, and their Restrictions (cont.)

Trade Name ¹	Common Name	Manufacturer	Crop	Group # (site of action)	Restricted-Use Pesticide ²	Water Quality Advisory ³	Worker Reentry ⁴ (hours)
Prowl H ₂ O 3.8CS	pendimethalin	BASF	alfalfa and grass	3	—	—	24
Pursuit 2AS	imazethapyr	BASF	alfalfa/ and grass mix	2	—	yes	4
Raptor 1AS	imazamox	BASF	legume	2	—	—	4
Remedy Ultra 4L	triclopyr	Corteva	grass	4	—	yes	until dry
Roundup 3S/ Roundup WeatherMax 4.5S/ glyphosate ⁶	glyphosate	Bayer/others	grass and legume	9	—	—	4-12
Sandea 75DF/Permit	halosulfuron	Gowan	grass	2	—	yes	12
Satellite HydroCap 3.8CS	pendimethalin	UPL	alfalfa	3	—	—	24
Select Max 1E/ Select 2E	clethodim	Valent	legume	15	—	—	24
Sharpen 2.85SC ⁷	saflufenacil	BASF	grass and alfalfa	14	—	yes	12
Sinbar 80W	terbacil	NovaSource	legume	5	—	yes	12
Spike 20P/80DF	tebuthiuron	Corteva	grass	7	—	yes	—
Starane Ultra 2.8L	fluroxypyr	Corteva	grass	4	—	—	12
Stinger 3S	clopyralid	Corteva	grass	4	—	yes	12
Surmount 1.34E	picloram + fluroxypyr	Corteva	grass	4, 4	yes	yes	12
Tordon 22K 2SL	picloram	Corteva	grass	4	yes	yes	48
Vastlan 4SL	triclopyr	Corteva	grass	4	—	yes	24
Velpar AlfaMax 77.7WG	hexazinone + diuron	NovaSource	alfalfa	5, 7	—	yes	24
Velpar 2L/90DF	hexazinone	NovaSource	legume	5	—	yes	24
Warrant 3L	acetochlor	Bayer	alfalfa	15	—	yes	12
Weedmaster 3.87L	dicamba + 2,4-D	Nufarm	grass	4	—	yes	48
Xtendimax	dicamba (DGA+ VaporGrip)	Bayer	grass	4	yes	yes	24
Yukon 67.5WG	halosulfuron + dicamba	Gowan	grass	2, 4	—	—	24

Table 5.71 - Forage and Pasture Herbicides, their Characteristics, and their Restrictions (cont.)

Trade Name ¹	Common Name	Manufacturer	Crop	Group # (site of action)	Restricted-Use Pesticide ²	Water Quality Advisory ³	Worker Reentry ⁴ (hours)
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¹ Generic or post-patent alternatives to some of these products are available.

² Only licensed applicators may purchase and apply restricted-use pesticides. To become licensed, contact your state's Department of Agriculture.

³ These herbicides have properties that may result in ground or surface water contamination. Do not apply them in areas where soils are permeable or coarse and groundwater is near the surface. Practices should be followed to minimize the potential for dissolved runoff and/or runoff erosion. See the herbicide label for specific restrictions.

⁴ If soil-applied products are injected or incorporated at application time, under certain circumstances the Worker Protection Standard allows workers to enter the treated area if they will have no contact with anything that has been treated. Personal protective equipment is required for early entry to treated areas if contact with treated soil, plants, or water is involved.

⁵ Huskie is recently registered on grass forage; there is little local experience for this use.

⁶ Various formulations available. Refer to product label application rates and other restrictions.

⁷ This use is listed on a supplemental label for use in dormant alfalfa.

Table 5.72 - Relative Effectiveness of "Burndown" Treatments for No-Till Forages

Table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rates and weed size or growth stage. Treatments are rated only for control of vegetation existing at the time of application.

Weed control rating

10 = 95–100% 9 = 85–95% 8 = 75–85% 7 = 65–75% 6 = 55–65% N = less than 55% or no control

Species	Gramoxone	Roundup/glyphosate	
		(Fall-applied)	(Spring-applied)
Alfalfa sod	N	8+	7
Bromegrass or Quackgrass Sod	6	9	9
Chickweed	8+	9	9
Clover, Red	8	8+	7
Dandelion	N	8+	6
Foxtail spp.	9	9	9
Hemp Dogbane, Dewberry, Milkweed, etc.	6	8+	6
Horseweed (Marestail)	7	9	9
Lambsquarters	8	9	9
Mustard spp.	8	9	9
Orchardgrass or Fescue Sod	N	9	7
Ragweed, Common	8	9	9
Rye Cover, Volunteer Small Grains	9	10	10
Smartweed, Annual	7	7	7
Thistle, Canada	6	9	8
Timothy, Bluegrass	7	10	10
Vetch, Hairy	7	8	6

Table 5.73 - Comments on Burndown Herbicides for No-Till Legume Forages

See specific product label to determine correct rate for the weed species found in individual fields.

Trade Name ¹	Common Name	Crop(s)	Product/A	lb ai/A
Gramoxone SL 2S	paraquat	Alfalfa, clovers	2–4 pt	0.5–1.0
<ul style="list-style-type: none"> • Gramoxone SL controls emerged weeds only (no residual activity). • Apply in a minimum of 10 gal/A (ground, 20-60 gal/A preferred) or 5 gal/A (aerial) of water. • Apply before, during, or after planting but before crop emerges. • Phosphate-containing liquid fertilizer carrier solutions diminish Gramoxone activity if used as a carrier. • Gramoxone SL is effective on small annual weeds. • Improved activity on perennial grass sods can be achieved when two applications are made. Graze or mow sod to a height of 3 inches or less and apply 2 pt/A followed in 10 to 14 days by 1.5 pt/A. • Use appropriate precautions when handling Gramoxone to minimize exposure to the herbicide. • Do not use flood jet tips larger than size 20 or spacing greater than 40 inches. • See Table “Adjuvants and rainfast intervals for postemergence herbicides in grass pasture or hay”. • See Table “Grazing, harvest, haying, and slaughter restrictions for grass forage and pasture herbicides”. • <i>Restricted Use Pesticide.</i> 				
Roundup 3S² or Roundup WeatherMax 4.5S²	glyphosate	Alfalfa, clover, and alfalfa or clover-grass mixtures	1.5–4 qt or 1–3 qt	1.0–3.0

- Glyphosate controls emerged weeds only (no residual activity).
- Make ground applications in 10 to 40 gal/A of water. Increase the spray volume within this range as the weed density increases.
- Glyphosate may be applied in clear liquid nitrogen fertilizers and clear liquid complete-analysis fertilizers. Do not use Roundup/glyphosate with suspension-type liquid fertilizers.
- Preplant applications can be made before, during, or after planting but before the crop emerges.
- Glyphosate is effective on annual, biennial, and perennial weeds as well as small grain cover crops.
- Repeated applications may be needed for effective perennial weed control.
- Fall applications are better than spring applications for control of orchardgrass sods and quackgrass.
- Spring applications may be used for control of annual weeds.
- Existing perennial grass stands can be renovated by applying 0.7 to 3.3 qt/A (consult the label for rates for specific species). The existing crop can be grazed or harvested for feed after applications totaling 2 qt/A or less. For applications greater than 2 qt/A, remove livestock before application and wait 8 weeks before grazing or harvest.
- See Table “Adjuvants and rainfast intervals for postemergence herbicides in grass pasture or hay”.
- See Table “Grazing, harvest, haying, and slaughter restrictions for grass forage and pasture herbicides”.

¹ See Table 5.68 for additional formulations or trade names containing these same active ingredients.

² Various formulations of this product are available. Refer to current product label for active ingredient concentration, application rate, and other restrictions.

Table 5.74 - Application Timings for Herbicides Used in Legume Forages

Establishment: Herbicide is applied preplant in no-till establishment to control existing weeds, preplant in existing stands of alfalfa or clover to kill the existing crop and plant a new one (renovation), or preplant incorporated (PPI) or preemergence (PRE) in conventional tillage for residual weed control.

Seedling stand POST: Herbicide is applied postemergence (POST) to seedling alfalfa or clover that has reached a specific growth stage and is actively growing.

Established stand POST: Herbicide is applied POST to alfalfa or clover that has been established for a minimum length of time and is actively growing.

Fall/spring dormant: Herbicide is applied POST to dormant alfalfa or clover legume; may be for seedling legume at a specific growth stage, for legume established for a minimum length of time, or for either. Herbicide rate may be different for seedling or established stands.

Post-cutting: Herbicide is applied to alfalfa or clover between forage or hay cuttings, but within a certain time period after cutting or before the legume achieves a specified level of regrowth.

Spot-spray application: Herbicide is applied only to weed-infested areas of the field; usually with hand-held equipment.

Herbicide	Crop ^a (s)	Establishment	Seedling Stand POST	Established Stand POST	Fall/Spring Dormant (seedling)	Fall/Spring Dormant (established)	Post-Cutting	Spot-Spray or Wiper Applicator
2,4-DB	alfalfa/ clovers		NR ⁵	NR ⁵				
AIM 2EC	alfalfa/ clovers					NR	< 3 inches regrowth	
Balan	alfalfa / clovers	PPI						
Chateau	alfalfa					<6"regrowth	< 6" regrowth	
Eptam	alfalfa / clovers	PPI						
Glyphosate	alfalfa / clovers	preplant renovation						spot spray and wiper
Gramoxone SL	alfalfa / clovers	preplant			< 1 yr	> 1 yr	within 5 days of cut ⁶	spot spray
Kerb	alfalfa / clovers				1-trif ^{1,3}	> 1 season ⁴		
Maestro	alfalfa		4-trif ¹					
MCPA	alfalfa / clovers		2-trif ^{1,7}			> 1 season ⁶		
Metribuzin	alfalfa					> 1 yr		
Poast	alfalfa / clovers		NR ⁵	NR ⁵				spot spray
Prowl H ₂ O/ Satellite HydroCap	alfalfa		2-trif ¹ to 6"		2-trif ¹	after 1 cut	< 6" regrowth	
Pursuit	alfalfa / clovers		2-trif ¹	fall	2-trif ¹	> 1 season	< 3" regrowth	

Table 5.74 - Application Timings for Herbicides Used in Legume Forages (cont.)

Herbicide	Crop ^a (s)	Establishment	Seedling Stand POST	Established Stand POST	Fall/Spring Dormant (seedling)	Fall/Spring Dormant (established)	Post-Cutting	Spot-Spray or Wiper Applicator
Raptor/ Beyond Xtra/Imiflex	alfalfa		2-trif ¹		2-trif ¹	> 1 season	< 3" regrowth	
Roundup PowerMax/ WeatherMax	Round -up ready alfalfa	preplant renovation	emergence to first cut ²	after first cut; 1 appl/cut ²				spot spray and wiper
Select Max	alfalfa		NR ⁵	NR ⁵				spot spray
Sinbar	alfalfa					> 1 yr	< 2" regrowth	
Velpar	alfalfa					> 1 yr ³	< 2" regrowth	
Warrant	alfalfa		4-trif	NR			within 7 days of cut	

¹#-trif = alfalfa trifoliolate leaf stage that must be reached before herbicide application.

²For use on Roundup-Ready alfalfa only; up to 5 days before cutting.

³Spring application.

⁴Fall application before soil freeze-up.

⁵NR = no alfalfa size restriction on label; application based on weed stage.

⁶Application labeled for alfalfa only, not clover.

⁷Application labeled for clover only, not alfalfa.

⁸See herbicide comments table or herbicide label to determine for which clovers herbicide application is labeled.

Table 5.75 - Relative Effectiveness of Herbicides on Weeds and Crop Tolerance in Legume Forages

Table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rates and weed size or growth stage. Results may differ with variations in weed size, temperature, rainfall, soil moisture, soil type, and soil pH. Crop tolerance rating of VG or less is rarely significant.

Weed control rating

10 = 95–100%

9 = 85–95%

8 = 75–85%

7 = 65–75%

6 = 55–65%

N = Less than 55% or no control

	Preemergence								Postemergence								
Trade Name	Balan	Chateau	Eptam	Kerb	Metribuzin	Prowl H2O	Sinbar	Aim	Butyrac / 2,4-DB	Gramoxone	Maestro	Poast	Pursuit	Raptor / Beyond Xtra / Imiflex	Roundup / glyphosate	Select/Clethodim	Velpar
Crop Tolerance¹	VG	F	FG	VG	F	FG	FG	G	G	FG	F	E	G	G	G	E	FG
Site of Action Number	3	14	8	3	5	3	5	14	4	22	6	1	2	2	9	1	5
Winter Annuals																	
Bluegrass, Annual	8+	7+	8+	8+	8	6+	7+	N	N	8+	N	6	6	6	9	7+	8
Brome, Downy	9	N	9	9	9	6	9	N	N	9	N	9	6	N	9	9	9
Chickweed, Common	8	8+	7	8	9	7	9	6	6	9	6	N	8+	8+	9+	N	9
Fleabane, Annual	N	7	N	N	7	N	N	N	7+	7+	N	N	7+	7	9	N	8
Henbit/Deadnettle	6	8+	9	8	9	8	9	7+	6	9	8	N	7	7	8	N	9
Horseweed/Marestail	N	8+	N	N	6	N	7	N	8	6	6	N	N	N	9	N	7
Mustard, Wild	N	7	6	6	9	6	9	8	10	9	8	N	9	9	9	N	9
Pennycress, Field	N	6	6	6	9	6	9	9	9	9	9	N	9	9	9	N	9
Pepperweed spp.	N	7	6	6	9	6	9	8	10	9	8	N	9	9	9	N	9
Radish, Wild	N	7	N	N	7	6	7	8	7	7	6	N	8+	8+	9	N	7
Rocket, Yellow	N	6	N	N	9	6	9	8+	8	8	7	N	8+	8+	9	N	9
Ryegrass, Annual	8+	N	9	8+	7	8	N	N	N	8	N	9	6	6	8	9	7
Shepherds Purse	6	6	7	6	9	6+	9	9	9	9	9	N	8+	9	9	N	9
Summer Annuals																	
Amaranth, Spiny	9	9	9	6	9	9	8+	8	8+	9	8	N	9	9+	9	N	9
Barnyardgrass	9	6	9	8	6	8+	6	N	N	8	N	9	8	8	9+	9	7
Crabgrass	9	6	9	8	6	9	7	N	N	6	N	9	8	8	9	9	7
Foxtails (annual spp.)	9	6	9	8	6	9	7	N	N	9	N	9	8+	8+	9+	9+	7
Goosegrass	9	6	9	8	6	9	7	N	N	9	N	9	8	6	9+	9+	7
Lambsquarters	9	9	9	6	9	9	9	9	8+	8	10	N	7	8+	9	N	9

Table 5.75 - Relative Effectiveness of Herbicides on Weeds and Crop Tolerance in Legume Forages (cont.)

	Preemergence								Postemergence								
	Balan	Chateau	Eptam	Kerb	Metribuzin	Prowl H2O	Sinbar	Aim	Butyrac / 2,4-DB	Gramoxone	Maestro	Poast	Pursuit	Raptor / Beyond Xtra	Roundup / glyphosate	Select	Velpar
Nightshade, Eastern Black	6	8+	9	N	6	N	8+	8	8+	9	9	N	7+	7+	9	N	7
Panicum, Fall	9	6	9	6	6+	9	6+	N	N	9	N	9	8	8+	9+	9	6+
Pigweed spp.	9	9	9	6	9 ²	9	8+	8	8+	9	8	N	9+	9+	9	N	9
Ragweed, Common	N	7	N	N	8	N	8	7	9	9	9	N	7	8	9	N	8+
Smartweed spp.	N	7	N	N	8+	8	8+	8	6	9	9	N	8+	8	9	N	8+
Stiltgrass, Japanese	-	-	-	-	-	8	-	N	N	9	N	9	8+	8+	9	9	-
Velvetleaf	N	7	N	N	8	8+	8	9	9	9	8	N	9	9	9	N	8+
Biennials																	
Carrot, Wild	N	N	N	N	6	N	N	N	6	8	6	N	6	7	7	N	L
Perennials																	
Aster spp.	N	N	N	N	6	N	6	N	6	6	N	N	7	7	8+	N	6
Bedstraw, Smooth	N	N	N	N	N	N	N	6	N	6	N	N	7	7	8	N	N
Bermudagrass	N	N	7	N	N	N	6	N	N	6	N	8	N	N	8	8	N
Bluegrass, Roughstalk	N	N	N	N	N	N	N	N	N	7+	N	8	6+	8	9	8+	8
Cockle, White	N	N	N	N	7	N	7	6	7	6	N	N	6	6	9	N	7
Dandelion	N	7+	N	N	7	N	6	6	7+	N	N	N	7	6	8	N	8
Dock spp.	N	N	N	N	6	N	6	6	6	N	N	N	7	7+	8	N	7
Dogbane, Hemp	N	N	N	N	N	N	6	N	N	6	N	N	N	N	8+	N	6
Fescue, Tall	N	N	N	8	N	N	7	N	N	6	N	6	N	N	9	7	7
Horsenettle	N	N	N	N	6	N	6	N	N	6	N	N	N	N	7	N	6
Johnsongrass	6	N	7	N	N	N	N	N	N	6	N	8	8	8	9	9	N
Milkweed, Common	N	N	N	N	N	N	6	N	N	N	N	N	N	N	7	N	6
Nutsedge, Yellow	N	N	8	N	N	6	N	N	N	N	N	N	7	6	7	N	N
Orchardgrass	N	N	6	7	N	N	6	N	N	6	N	6	N	N	8	7+	7
Plantain spp.	N	N	N	N	7	N	7	6	7	N	N	N	6	6	8	N	7
Quackgrass	N	N	8	8	N	N	6	N	N	6	N	7	6	N	9	8	6
Thistle, Canada	N	N	N	N	N	N	N	N	N	N	N	N	6	6	9	N	N

¹ Crop tolerance ratings are for forage crops listed under each herbicide in Table 5.76.

² Triazine-resistant biotypes exist in the region and are not controlled by metribuzin.

Table 5.76 - Comments on Herbicides for Legume Forages

See specific product label to determine correct rate for the soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Crop(s)	Application Timing	Product/A	lb ai/A
Aim 2EC	carfentrazone	Alfalfa, clover	Seedling-POST Established-POST	1–2 fl oz	0.016
<ul style="list-style-type: none"> • Aim only controls small, emerged weeds (no residual activity). It is not a rescue treatment. • Apply in spring or summer immediately after cutting but before 3 inches of new growth. • A 5 to 8-day or a 10 to 14-day delay in cutting may be observed with applications made to 3 and 6-inch alfalfa, respectively. • Apply when weeds are actively growing and no more than 3 inches in height or rosettes are less than 2 inches across. • Aim may be applied when crop, such as alfalfa, is in dormancy fall through early spring applications. • There are no crop rotation or overseeding restrictions for labeled crops; see label. • <i>Water quality advisory.</i> 					
Balan 60DF	benfenin	Alfalfa, birdsfoot trefoil, red clover, ladino clover, alsike clover	Preplant incorporated	2 lb	1.2
<ul style="list-style-type: none"> • Balan provides approximately one month of soil residual control of many annual grass weeds and some annual broadleaf weeds. • Apply in 5 to 40 gal/A of water or liquid fertilizer to clean, dry soil within three weeks of planting. • Soil incorporation must occur within 8 hours after application. Uniformly incorporate into the top 2 to 3 inches of soil; see product label. • Do not use with companion seedings of small grains or forage grasses. • Forage grasses, small grains, sorghum, and corn can be planted 10 months after application. 					
Butyrac 200 2E (2,4-DB)	2,4-DB	Alfalfa, birdsfoot trefoil, CRP	Seedling-POST Established-POST	1–3 qt	0.5–1.5 ae
<ul style="list-style-type: none"> • Butyrac 200 controls a relatively narrow spectrum of emerged broadleaf weeds, and is particularly effective on morningglory species. • Apply in spring or summer when seedling legumes have two to four trifoliate leaves. • Apply by ground in a minimum of 10 gal/A or by air in 5 to 40 gal/A of water. • Apply when weeds are actively growing and no more than 3 inches in height, or rosettes are less than 2 inches across. • Do not apply if temperatures above 90°F or below 40°F are expected during or shortly after application. • 2,4-DB labels vary concerning overseeding or rotational crop restrictions or do not mention them. Unless specified on the label, most crops can be safely planted 3 months after application under normal environmental conditions. • <i>Water quality advisory.</i> 					

Table 5.76 - Comments on Herbicides for Legume Forages (cont.)

See specific product label to determine correct rate for the soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Crop(s)	Application Timing	Product/A	lb ai/A
Chateau 41.4 EZ			Established-dormant		0.054 -0.108
Chateau 51WDG	flumioxazin	Alfalfa	Between cuttings	2–4 oz	0.064–0.128

- Chateau provides 1 to 2 months of residual control of many annual broadleaf weeds and suppression of some annual grasses as they germinate.
- It will not control weeds that have already emerged at the time of application.
- Apply by ground in 10 to 30 gal/A or by air in 5 to 10 gal/A of water.
- Dormant applications can be made in the fall after the last cutting, during winter dormancy, or anytime in the spring prior to 6 inches of alfalfa regrowth.
- Postcutting applications should be made prior to 6 inches of regrowth or unacceptable crop injury may occur.
- Wait a minimum of 60 days between applications.
- Do not apply with any adjuvant or tank-mix with any products formulated as an emulsifiable concentrate (EC) unless the application follows the last cutting of the season.
- Application with paraquat can be used to burndown winter annuals prior to the winter dormant period.
- Do not apply to mixed alfalfa-grass stands.
- When applied at the 3 to 4 oz/A rate, forage grasses can be planted 6 months after application if soil is tilled or 12 months after application if planted no-tillage; at the 2 oz/A rate it is 4 months (tilled) and 8 months (no-till); see label for more details.

		Alfalfa, birdsfoot trefoil, clovers, lespedeza; not white Dutch clover	Preplant incorporated	3.5–4.5 pt	3.0–4.0
Eptam 7E	EPTC				

- Eptam provides approximately one month of soil residual control of many annual grass weeds, some annual broadleaf weeds, and yellow nutsedge.
- Apply in 10 to 50 gal/A of water or liquid fertilizer to clean, dry soil just before planting and incorporate immediately. Operate equipment to uniformly incorporate into the top 2 to 3 inches of soil. Refer to the product label for specific instructions on soil incorporation equipment and methods.
- Do not use if atrazine was applied within 12 months of planting.
- Do not use on white Dutch clover.
- Do not use on soils with greater than 10% organic matter.
- Forage grasses, small grains, sorghum, and corn can be planted after normal harvest of the legume forage.

Table 5.76 - Comments on Herbicides for Legume Forages (cont.)

See specific product label to determine correct rate for the soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Crop(s)	Application Timing	Product/A	lb ai/A
Extreme 2.17L	imazethapyr + glyphosate	Roundup Ready alfalfa	Seedling-POST	2.2–4.4 pt/A	0.41–0.81
			Established-dormant		
			Established-POST		

- Extreme controls or suppresses many annual and some perennial broadleaf and grass weeds.
- Extreme also provides 1 to 2 months of residual control of many emerging weeds.
- Apply over the top to Roundup Ready alfalfa varieties only.
- Apply to seedling Roundup Ready alfalfa at the second trifoliolate stage or larger.
- Apply to established Roundup Ready alfalfa in the fall, spring, or between cuttings before alfalfa regrowth reaches 3 inches.
- Apply when the majority of weeds are 1 to 3 inches (height or rosette diameter).
- Typical application rate is 3 pt/A.
- Due to breeding constraints, some alfalfa plants may not contain the glyphosate-resistant gene; thus, some seedlings may not survive the application.
- Do not apply more than 3 pt/A Extreme during the last year of the stand, or crop rotation options will be very limited.
- Forage grasses are not listed on the Extreme label in rotational crops section; small grains can be planted 4 months after application; see label.
- If replanting is necessary, do not plant alfalfa for 4 months following an Extreme application.

Gramoxone SL 2S	paraquat	Alfalfa, clover, or trefoil	Seedling-dormant	1–2 pt	0.25–0.5
			Established-dormant	2–3 pt	0.5–0.75
			Between cuttings	1 pt	0.25
			Spot treatment	0.2-0.7 fl oz/gal	0.15%–0.5% solution

- Gramoxone SL controls emerged weeds only (no residual activity).
- Dormant applications provide control of many winter annual weeds, and some seedling biennial and perennial weeds.
- Apply only one dormant application per year by ground in a minimum of 10 gal/A or by air in a minimum of 5 gal/A of water.
- To avoid injury, use only on seedling alfalfa or clover stands that are completely dormant, established clover stands with less than 2 inches of remaining fall regrowth that are completely dormant, or established alfalfa stands with less than 6 inches of remaining fall regrowth or 2 inches of new spring regrowth.
- On seedling alfalfa (first year), 2 between-cutting applications may be made. First-year alfalfa stands and yields may be reduced if alfalfa is allowed to regrow more than 2 inches after cutting and before application.
- On established alfalfa, 3 between-cutting applications may be made. Do not make between-cutting applications more than 5 days after cutting.
- Between-cutting applications are not allowed on other legumes or alfalfa-grass mixtures.
- There are no rotational crop restrictions when applying Gramoxone in legume forages.
- Spot spraying with Gramoxone SL is recommended when only small areas are to be sprayed with labeled applications. Refer to weed rate tables of the herbicide label for the recommended herbicide concentration and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft²) to provide thorough coverage. Do not spray to the point of runoff.
- Always add a nonionic surfactant at 0.5 fl oz/gal (15 ml/gal).
- 0.5 lb paraquat = 2 pt Gramoxone SL2.0 or 1.33 pt Gramoxone SL 3.0.
- *Restricted-use pesticide.*

Table 5.76 - Comments on Herbicides for Legume Forages (cont.)

See specific product label to determine correct rate for the soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Crop(s)	Application Timing	Product/A	lb ai/A
Kerb 50W	pronamide	Alfalfa, birdsfoot trefoil, crown vetch, clovers	Seedling-dormant Established-dormant	1–3 lb	0.5–1.5
<ul style="list-style-type: none"> • Kerb provides 1 to 2 months of residual control or suppression of several annual grass and some broadleaf weeds, and also has postemergence activity on several small annual grass weeds. • Apply by ground in 20 to 50 gal/A of water. Make applications in fall or winter when temperatures fall below 55F but before soil freeze-up. • Kerb may be applied to fall-seeded legumes after they reach the trifoliate leaf stage. • Do not apply to spring-seeded legumes until the following fall or early winter. • Do not use on alfalfa-grass mixtures. • Rainfall or overhead irrigation is required after application to activate the herbicide. • Do not use on soils with greater than 4% organic matter. • Forage grasses, as well as most other crops, can be planted 12 months after application; see label. • <i>Restricted-use pesticide.</i> 					
Maestro 2EC	bromoxynil	Alfalfa and alfalfa/ small grain companion seedings, CRP	Seedling-POST	1.0–1.5 pt	0.25–0.375
<ul style="list-style-type: none"> • Maestro controls emerged weeds only (no residual activity). • Apply in spring or fall to seedling alfalfa with at least 4 trifoliate leaves. • May be applied to a small grain companion seeding up to the boot stage. • Apply by ground in 10 to 20 gal/A or by air in a minimum of 5 gal/A of water or liquid fertilizer. Applications in liquid fertilizer may increase leaf burn to alfalfa. • Weeds should not exceed the four-leaf stage, 2 inches in height, or 1 inch in diameter (whichever comes first). • Maestro application where temperatures are expected to exceed 70°F at or 3 days following application can result in unacceptable crop injury. • Any crop can be planted 30 days after application. • Do not use an adjuvant unless a tank-mix partner requires it. See table 5.79. 					
MCPA amine 4S	MCPA	Alfalfa, clovers, or trefoil with small grain or forage grass companion seedings, CRP	Seedling-POST	0.25–0.5 pt	0.125–0.25
<ul style="list-style-type: none"> • MCPA controls or aids in control of some emerged annual, biennial, or perennial weeds. • Treat after the grain is tillered and legumes are 2–3 inches tall. • Do not use more than 5–10 gal/A of water; higher volumes may result in injury to legumes. • Do not spray when grain is in the boot to dough stage. • Do not use on sweet clover or vetch. • Some MCPA labels allow application to newly seeded clover and grass pastures; treat seedling stands after they have 2 or more true leaves (trifoliate stage). • Follow all label recommendations to reduce the potential for spray drift. • MCPA labels vary concerning overseeding or rotational crop restrictions or do not mention them. Unless specified on the label, most crops can be safely planted 3 months after application under normal environmental conditions. • See Tables 5.79 and 5.80. • <i>Water Quality Advisory.</i> 					

Table 5.76 - Comments on Herbicides for Legume Forages (cont.)

See specific product label to determine correct rate for the soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Crop(s)	Application Timing	Product/A	lb ai/A
Metribuzin 75DF	metribuzin	Alfalfa and alfalfa-grass mixtures	Established-dormant	0.5–1.3 lb	0.38–1.0
<ul style="list-style-type: none"> • Metribuzin provides both postemergence and 1 to 2 months of residual control of several annual broadleaf weeds and a few grasses (Brome species, annual bluegrass, green foxtail, and barnyardgrass). • Apply by ground in 10 to 40 gal/A or by air in a minimum of 2 to 10 gal/A of water or liquid fertilizer. • Apply in fall after alfalfa goes dormant or in the spring before new growth starts. Alfalfa may be severely injured if new growth is present at spring application. • May be applied after dormancy is broken, but before 3 inches of new growth, if impregnated on dry fertilizer. • Apply the appropriate rate from the label when weeds are less than two inches tall or two inches in diameter. • May be used on alfalfa-grass mixtures. Orchardgrass in mixed stands will generally tolerate Metribuzin at rates of up to 0.67 lb/A. Rates of 0.67 to 1.0 lb/A can be used in mixed stands of alfalfa and grass to reduce grass stands and prevent crowding out of alfalfa. • Do not use Metribuzin on sandy soils or serious crop injury can occur. Crop injury can also occur on loamy sand soils. • Forage grasses and corn can be planted 4 months, small grains 8 months, and sorghum 12 months after application. • Tripzin 4 ZC is a premix of pendimethalin + metribuzin labeled for alfalfa. • <i>Water quality advisory.</i> 					
Poast 1.5E	sethoxydim	Alfalfa, clovers, and birdsfoot trefoil	Seedling-POST Established-POST Spot treatment	1.0–2.5 pt 1.0–2.5 pt 1.3–1.9 fl oz/gal	0.19–0.47 0.19–0.47 1%–1.5% v/v solution
<ul style="list-style-type: none"> • Poast controls many annual and perennial grass weeds (emerged weeds only). • Apply to actively growing grasses by ground in 5 to 20 gal/A or by air in a minimum of 5 gal/A of water. • Refer to the herbicide label for the recommended herbicide concentration based on grass species and size (generally less than 8 inches tall) and apply the recommended concentration on a spray-to-wet basis (1 gal/1000 ft²) to provide thorough coverage. • Repeated applications may be needed for complete control of perennial species. • Any crop can be planted 30 days after application. • Spot applications are allowed, but do not make spot treatments in addition to broadcast treatments. Apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft²) to provide thorough coverage. Do not spray to the point of runoff. • Always add a crop oil concentrate at 1.3 fl.oz./gal (38 ml/gal). 					

Table 5.76 - Comments on Herbicides for Legume Forages (cont.)

See specific product label to determine correct rate for the soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Crop(s)	Application Timing	Product/A	lb ai/A
Prowl H₂O / Satellite HydroCap 3.8AS	pendimethalin	Alfalfa	Seedling-POST	0.5–1 qt	0.5–0.95
			Seedling-dormant	0.5–1 qt	0.5–0.95
			Established-dormant	1.1–4.2 qt	1.0–4.0
			Between cuttings	1.1–4.2 qt	1.0–4.0

- Prowl H₂O provides 1 to 2 months of residual control of most annual grasses and some annual broadleaf weeds as they germinate. It will not control any weeds that have already emerged at the time of application.
- Apply by ground in a minimum of 10 gal/A or by air in a minimum of 5 gal/A of water.
- Adequate rainfall or overhead irrigation is required after application to activate Prowl H₂O.
- Apply to seedling alfalfa after the legume has two fully expanded trifoliolate leaves but before it reaches 6 inches in height.
- Established alfalfa is defined by the label as alfalfa planted in the fall or spring which has gone through a first cutting/mowing.
- Apply to established alfalfa before weed emergence. Applications can be made in the fall after the last cutting, during winter dormancy, in the spring, or between cuttings. Applications should be made prior to the alfalfa reaching 6 inches in regrowth.
- Some stunting and yellowing of the alfalfa may occur with postemergence applications.
- Rotational restrictions are based on Prowl rate used, rainfall received, and time of year applied; see label.
- Tripzin 4 ZC is a premix of pendimethalin + metribuzin labeled for alfalfa.

Pursuit 2S	imazethapyr	Alfalfa and alfalfa-grass mixtures, birdsfoot trefoil, clover, CRP	Seedling-POST	3–6 fl oz	0.047–0.094
			Seedling-dormant		
			Established-POST		
			Established-dormant		
			Between cuttings		

- Pursuit controls or suppresses many annual and some perennial broadleaf weeds, as well as several grasses when they are small.
- Pursuit also provides 1 to 2 months of residual control of many emerging weeds.
- Apply by ground in a minimum of 10 gal/A or by air in a minimum of 5 gal/A of water.
- Seedling applications are for pure seeded alfalfa or clover only. Apply when legume has 2 fully expanded trifoliolate leaves or larger.
- Dormant applications can be made in the fall after the last cutting or anytime in the spring prior to 3 inches of alfalfa or clover regrowth.
- Between cutting applications should also be made prior to 3 inches of regrowth.
- Apply when weeds are 1 to 3 inches in height or in the rosette growth stage.
- Do not apply Pursuit to alfalfa-grass mixtures during the establishment year.
- Do not apply more than 4 oz/A to alfalfa or clover in the last year of the stand (crop rotation considerations).
- Forage grasses are not listed on the Pursuit label in rotational crops section; small grains can be planted 4 months after application; see label.
- *Water Quality Advisory.*

Table 5.76 - Comments on Herbicides for Legume Forages (cont.)

See specific product label to determine correct rate for the soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Crop(s)	Application Timing	Product/A	lb ai/A
Raptor 1AS Beyond Xtra 1AS Imiflex 1AS	imazamox	Alfalfa	Seedling-POST Seedling-dormant Established-dormant Between cuttings	4–6 fl oz	0.031–0.047

- Raptor controls or suppresses many annual and some perennial broadleaf weeds, as well as several grasses when they are small.
- Raptor also provides approximately one month of residual control of many emerging weeds.
- Apply by ground in a minimum of 10 gal/A or by air in a minimum of 5 gal/A of water.
- Do not apply Raptor in liquid fertilizer as a carrier.
- Apply when seedling alfalfa has 2 fully expanded trifoliate leaves or larger.
- Seedling alfalfa may experience a temporary reduction in growth.
- Apply when weeds are 1–3 inches in height or rosette width.
- Apply to established alfalfa in the fall, winter, or spring to dormant or semi-dormant alfalfa or between cuttings.
- Any application should be made before significant alfalfa growth or regrowth (3 inches).
- Forage grasses can be planted 18 months, small grains 3-18 months (see label), and sorghum 9 months after application.
- Do not make more than one Raptor/Beyond Xtra application to alfalfa per year; but a sequential Pursuit application may be made after 60 days.
- Beyond Xtra is the new tradename for imazamox and will have the same utility as Raptor.
- Imiflex is another formulation of imazamox for use in alfalfa.

Roundup PowerMax or WeatherMax 5.5L	glyphosate	Roundup Ready alfalfa only	Seedling-POST Established-POST	22–44 fl oz	0.77–1.9
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- Roundup provides broad-spectrum control of existing grass and broadleaf weeds, but has no effect on weeds emerging after application.
- Some species of weeds may require retreatment for complete control, as will species with multiple germination flushes.
- Apply by ground in 3 to 40 gal/A or by air in 3 to 15 gal/A of water.
- Two applications may be made to seedling stands prior to the first cutting. The first application is from emergence up to the 4-trifoliate leaf stage and is necessary to remove the small percentage of glyphosate-susceptible alfalfa plants that are present in the new seeding. The second application is from the 5-trifoliate leaf stage to 5 days before the first cutting.
- After the first cutting, a single application per cutting may be made up to 5 days before cutting.
- In established stands, a single application per cutting may be made up to 5 days before cutting.
- The highest level of control is achieved when annual weeds are less than 4 inches tall.
- For perennial weed problems, glyphosate should be applied during early fall.
- Sequential applications of glyphosate should be at least 7 days apart.
- The combined total for all in-crop applications can not exceed 4.1 qt/A per year. The combined total for all applications (in-crop and establishment) can not exceed 5.3 qt/A per year.
- There are no rotational crop restrictions when applying glyphosate in legume forages.
- The Roundup Ready system in alfalfa is easy to use and very effective on most weeds common to alfalfa plantings. However, herbicide-resistant weeds are selected for by repeated use of the same or similar herbicide over a period of time. Weed species with a very high amount of seed production and a variable genetic pool are more likely to develop resistant populations—for example, horseweed, common lambsquarters, ragweed species, and pigweed species. Therefore, it is recommended that the Roundup Ready system be used during the establishment year when the most benefit can be recognized, and then rotate between Roundup and other herbicides with different modes of action through subsequent seasons.

Table 5.76 - Comments on Herbicides for Legume Forages (cont.)

See specific product label to determine correct rate for the soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Crop(s)	Application Timing	Product/A	lb ai/A
Roundup 3S ² or Roundup WeatherMax 4.5S ²	glyphosate	Alfalfa, clover, and alfalfa or clover-grass mixtures	Spot treatment or Wiper applicator	2% solution or 33–77% solution	

- Make applications with hand-held equipment or wiper applicator.
- Apply only to weed-infested areas of the field, and do not treat more than one tenth of the total area at any one time.
- Refer to weed rate tables of the herbicide label for the recommended herbicide concentration and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft²) to provide thorough coverage. Do not spray to the point of runoff.
- Apply to actively growing susceptible weeds.
- Avoid contact with desirable species as severe injury or death can occur.
- Further application may be made at 30-day intervals if necessary.
- Consult the herbicide label for specific wiper applicator recommendations.
- For best results, do not graze or harvest forage for seven days after application, and make applications at least seven days before a killing frost.
- There are no rotational crop restrictions when applying glyphosate in legume forages.

Roundup 3S or Roundup WeatherMax 4.5S ²	glyphosate	Alfalfa or alfalfa-grass mixtures	Preharvest	32–63 fl oz or 22–44 fl oz	0.77–1.5
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- For use on declining alfalfa stands prior to crop rotation.
- Apply before last cutting in fall or spring to control certain perennials such as quackgrass.
- Can be grazed or harvested in 36 hours. However, harvest should be delayed for 7 to 10 days after application to allow herbicide to have full effect.
- Deep tillage after harvest improves control.
- Fall applications are more effective on perennial grasses relative to spring applications.
- Refer to herbicide label for additional application information and use restrictions.
- There are no rotational crop restrictions when applying glyphosate in legume forages.

Table 5.76 - Comments on Herbicides for Legume Forages (cont.)

See specific product label to determine correct rate for the soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Crop(s)	Application Timing	Product/A	lb ai/A
Select 2EC or Select Max 1EC	clethodim	Alfalfa, birdsfoot trefoil	Seedling-POST	6–16 fl oz	0.09–0.25
				or	or
				12–32 fl oz	0.09–0.25
			Established-POST	6–16 fl oz	0.09–0.25
			or	or	
			Spot treatment	12–32 fl oz	0.09–0.25
				0.33–0.65	0.25%–0.5%
				fl oz/gal	v/v solution

- Select Max controls many annual and perennial grass weeds (emerged weeds only).
- Apply to actively growing grasses by ground in 10 to 40 gal/A or by air in a minimum of 10 gal/A of water.
- Apply to grasses at the size recommended on herbicide label (generally less than 6 inches tall).
- Repeated applications are required for complete control of perennial grasses. Allow a minimum interval of 14 days between repeat applications.
- For annual bluegrass control, apply 6–16 fl oz Select or 12-32 fl oz Select Max before the 4-leaf stage of bluegrass.
- Any crop can be planted 30 days after application.
- Select 2EC and Select Max 1EC require different adjuvants. See table 5.77.
- Spot treatments are allowed but do not exceed a total of 32 fl oz/A per season for Select or 64 fl oz/A per season for Select Max for spot treatments and broadcast treatments combined. Refer to weed rate tables of the herbicide label for the recommended herbicide concentration and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft²) to provide thorough coverage. Do not spray to the point of runoff.
- Always add a crop oil concentrate at 1.3 fl.oz./gal (38 ml/gal).

Sinbar 80WG	terbacil	Alfalfa	Established-dormant Between cuttings	0.75–1.5 lb	0.6–1.2
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- Sinbar provides postemergence control (small weeds) and 1 to 2 months of soil residual control of many annual weeds and some biennial and perennial weeds.
- Use only on alfalfa established for 1 year or more.
- Apply by ground in water with sufficient spray volume for uniform coverage.
- Dormant applications can be made in the fall through winter to dormant alfalfa or in the spring prior to 2 inches of alfalfa regrowth. Spring between cutting applications should also be made prior to 2 inches of regrowth.
- Two applications per year are allowed, but they must be separated by 60 days, and the total amount of Sinbar can not exceed 1.5 lb/A per year.
- Apply before weeds germinate or before they exceed 2 inches in height or width.
- Do not use on alfalfa-grass mixtures.
- Do not use on sand, loamy sand, or gravel soils, or on soils with less than 1% organic matter or serious crop injury can occur.
- No other crops can be planted for two years following an application of Sinbar.
- Do not use any spray adjuvants. See table “Adjuvants and Rainfast Intervals for Postemergence Herbicides in Alfalfa and Clover”.
- See Table 5.77.
- *Water Quality Advisory.*

Table 5.76 - Comments on Herbicides for Legume Forages (cont.)

See specific product label to determine correct rate for the soil type and weed species found in individual fields.

Trade Name ¹	Common Name	Crop(s)	Application Timing	Product/A	lb ai/A
Velpar 2L or 75DF	hexazinone	Alfalfa	Established-dormant Between cuttings	2–6 pt or 0.67–2 lb	0.5–1.5
<ul style="list-style-type: none"> • Velpar provides postemergence control (small weeds) and 1 to 2 months of soil residual control of many annual, biennial, and perennial weeds as well as suppression of some woody species. • Use only on alfalfa established for 1 year or more. • Apply by ground in a minimum of 20 gal/A or by air in a minimum of 5 gal/A of water. • Make a single application after alfalfa becomes dormant and before new growth begins in the spring. Where weeds have emerged, include a surfactant. Weeds should be less than two inches tall or two inches in diameter. • If no dormant application is made, a between cuttings treatment may be made; apply before 2 inches of alfalfa regrowth. Severe injury may result with between cutting applications if significant alfalfa foliage is present at application or air temperature exceeds 90°F. • Do not use an adjuvant with between cutting applications. • Do not use on gravelly or rocky soils, exposed subsoils, or hardpan, sand, or poorly drained soils or serious crop injury can occur. • Unacceptable weed control may occur on soils with greater than 5% organic matter. • When applied at 3 pt/A or less, corn can be planted 12 months after application. • Other crops may be planted 24 months after application. • See Tables 5.77 and 5.78. • <i>Water Quality Advisory.</i> 					
Warrant 3 SL	acetochlor	Alfalfa	Established-dormant Between cuttings	1.25–2 qt	0.94–1.5
<ul style="list-style-type: none"> • Warrant can be applied after alfalfa after emergence to control of several grass and broadleaf weeds prior to their emergence, but will not control weeds that are present at the time of application. • Can be used on newly established and established alfalfa stands. • Do not use this product on alfalfa grown for seed production. • Remove domestic livestock from alfalfa stands before making applications of this product. • Allow a minimum of 20 days between an application and subsequent cutting for forage or hay, or before open grazing of forage and livestock. • Do not exceed a total of 3 applications or a combined total of 4 qt (3 lb ai) per acre per year. • <i>Water Quality Advisory.</i> 					
<p>¹ See Table 5.71 for additional formulations or trade names containing these same active ingredients.</p> <p>² Various formulations of this product are available. Refer to current product label for active ingredient concentration, application rate, and other restrictions. Adjust application rate if using Roundup.</p>					

Table 5.77 - Adjuvants and Rainfastness for Postemergence Herbicides in Legume Forages

Adjuvants are products included in the spray tank to improve the performance of herbicides. These include non-ionic surfactant (NIS), crop oil concentrate (COC), methylated seed oil (MSO) or nitrogen solutions. In general, NIS should contain at least 80% active ingredient, and COC should contain at least 15% emulsifier. Nitrogen solutions can be 28%, 30% or 32% ammonium based fertilizer solutions; ammonium sulfate should be spray grade dry ammonium sulfate (21-0-0). Crop injury can occur with the use of adjuvants. Adding additional adjuvants other than what is labeled can increase the chance or severity of crop injury. Following are recommended adjuvants for broadcast postemergence applications; refer to herbicide labels for adjuvant recommendations with other application types.

Rainfastness is number of hours needed between time of application and rainfall or irrigation to ensure sufficient absorption in the plant.

Trade Name	Adjuvant(s)	Rate	Rainfastness (hours)
Aim 2EC	nonionic surfactant or crop oil concentrate	1 qt/100 gal 0.5-1 gal/100 gal	not specified
Butyrac 200 2L / 2,4-DB 2L	none		not specified
Glyphosate preplant or spot treatment	varies by product, check label	see label	
	ammonium sulfate (optional)	8.5–17 lb/100gal	1–6
Gramoxone 2SL	nonionic surfactant or crop oil concentrate	1 qt/100 gal 1 gal/100 gal	0.5
Kerb 50W	none		not specified
Maestro 2EC	not recommended (see label for instructions when tank-mixing)		1
MCPA 3.7L	none		not specified
Metribuzin 75DF	none		not specified
Poast 1.5EC	crop oil concentrate or	2 pt/A	
	methylated seed oil	1.5 pt/A	
	plus nitrogen solution or	2–4 qt/A or	
	ammonium sulfate (optional)	2.5 lb/A	1
Pursuit 2AS	nonionic surfactant or	1 qt/100 gal	
	crop oil concentrate or	1 gal/100 gal	
	methylated seed oil	1.25 gal/100 gal	
	plus nitrogen solution or	1.25–2.5 gal/100 gal	
	ammonium sulfate (required)	12-15 lb/100 gal	1
Raptor 1AS / Beyond Xtra 1AS / Imiflex 1AS	nonionic surfactant or	1 qt/100 gal	
	crop oil concentrate or	1–2 gal/100 gal	
	methylated seed oil	1–2 gal/100 gal	
	plus nitrogen solution or	2.5 gal/100 gal	
	ammonium sulfate (required)	12–15 lb/100 gal	1
Roundup PowerMax or WeatherMax 5.5L in RR alfalfa	ammonium sulfate (optional)	8.5–17 lb/100 gal	not specified

Table 5.77 - Adjuvants and Rainfastness for Postemergence Herbicides in Legume Forages (cont.)

Trade Name	Adjuvant(s)	Rate	Rainfastness (hours)
Select 2EC	crop oil concentrate	1 gal/100 gal	1
	plus nitrogen solution or	1–2 qt/A	
	ammonium sulfate (optional)	2.5–4 lb/A	
Select Max 1EC	nonionic surfactant or	1 qt/100 gal	1
	crop oil concentrate or	1 gal/100 gal	
	methylated seed oil	1 gal/100 gal	
Sinbar 80WP	do not use		not specified
Velpar 2L	nonionic surfactant on dormant alfalfa		not specified
	none on non-dormant alfalfa	1 qt/100 gal	
Warrant 3L	none		not specified

Table 5.78 - Grazing, Harvest, Haying, and Slaughter Restrictions for Herbicides in Legume Forages

Trade Name	Type	PHI Length	Comments
Aim (carfentrazone)	Grazing (forage) and haying (harvest)	21 days	May be used in established, mixed grass-clover stands as well as established pure forage legume stands
Butyrac (2,4-DB)	Grazing or feeding	60 days	Seedling alfalfa
		30 days	Established alfalfa
Chateau (flumioxazin)	Grazing or harvest	25 days	Established alfalfa; less than 6 inches of regrowth
Gramoxone (paraquat)	Grazing or harvest	60 days	Fall or spring dormant application alfalfa or clover
	Grazing or harvest	30 days	Between-cutting application alfalfa only
Kerb (pronamide)	Grazing or harvest	120 days	Fall or dormant application alfalfa or clover
Maestro (bromoxynil)	Grazing or harvest	30 days	After spring application
		60 days	After fall or winter application
MCPA	Forage or grazing	7 days	Do not forage or graze meat animals within 7 days of slaughter or dairy animals within 7 days of treatment, alfalfa or clover
Metribuzin	Grazing or harvest	28 days	Dormant application
Poast (sethoxydim)	Forage (grazing)	7/20 days	On the label, forage refers to green, undried alfalfa. Poast has 20-day restriction for clover hay only.
	Hay (harvest)	14/20 days	Hay is dried alfalfa. Poast has 20-day restriction for clover hay only.
Prowl H ₂ O (pendimethalin)	Forage or hay harvest	28 days	Apply before 6 inches of alfalfa regrowth. Has a 28-day restriction for 2.1 qt/A or less; 50-day restriction for >2.1 qt/A.
Pursuit (imazethapyr)	Feeding, grazing, or harvest	30 days	Alfalfa or clover, be cautious of rotational crop restrictions.
Raptor / Beyond Xtra / Imiflex (imazamox)	Feeding, grazing, or harvest	NA	Not specified on the label.
Roundup/glyphosate	Grazing or harvest (preplant)	0 days	Alfalfa or clover may be grazed or cut for hay immediately following preplant application.
	RR alfalfa only	5 days	In Roundup Ready alfalfa varieties, apply glyphosate up to 5 days before cutting.
	Grazing or harvest (spot treatment)	3–14 days	Spot treatment on alfalfa or clover depends on glyphosate product used.
Select (clethodim)	Feeding, grazing, or harvest	15 days	Increases when tankmix with 2,4-DB (60 days).
Sharpen (saflufenacil)	Feeding, grazing, or harvest	28 days	
Velpar (hexazinone)	Grazing or feeding	30 days	Plant only corn for 12 months following application of Velpar.
Warrant (acetochlor)	Grazing or feeding	20 days	Post-emergence application

Table 5.79 - Application Timings for Herbicides Used in Grass Pasture, Hay, and CRP Grassland

Use only in these states: If left blank these products are available in Delaware, Maryland, New Jersey, Pennsylvania, Virginia, and West Virginia.

Establishment: Herbicide is applied preplant in no-till establishment to control existing weeds. There are currently no herbicides registered for preplant incorporated (PPI) or preemergence (PRE) applications in grass forage for residual weed control.

Seedling stand POST: Herbicide is applied postemergence (POST) to seedling grass that has reached a specific growth stage and is actively growing, or at a maximum allowable rate.

Established stand POST: Herbicide is applied POST to grass that has been established for a minimum length of time and is actively growing.

Spot-spray application: Herbicide is applied only to weed-infested areas of the field; usually with hand-held equipment. If the herbicide is labeled for seedling or established stands postemergence, then herbicide use rates, application timing, and minimum establishment periods should be observed unless otherwise stated on the label. Grazing, harvest, slaughter, and transfer restrictions still apply for all spot-spray applications.

Grazed Fencerows: Herbicide is applied along a grazed fencerow to control emerged weeds and/or prevent seedling emergence. Use postemergence broadcast rates and timings unless grazed fencerows are specifically mentioned on the label. If the herbicide is labeled for spot applications, and the total area of the fencerows being treated is less than 10% of the total area inside the fencerows, spot application recommendations can be used. Grazing, harvest, slaughter, and transfer restrictions still apply for all applications to grazed fencerows.

Trade Name	Use Only in These States	Establishment	Seedling Stand POST	Established Stand POST	Spot-Spray or Wiper Applicator	Grazed Fencerows
2,4-D amine ¹				L ²	-- ³	yes
2,4-D ester ¹				L	-- ³	yes
Aim			L	L		yes
Arsenal						yes
Chaparral (aminopyralid + metsulfuron)	PA, VA, WV			after tillering ⁵	spot	yes
Clarity			1 pt/A max ⁴	L	spot and wiper	yes
2,4-D + dicamba tank-mix				L		yes
Crossbow (triclopyr + 2,4-D)				after tillering ⁵	spot	yes
DuraCor SC (aminopyralid + florpyrauxifen)		preplant	20 fl oz/A max	after tillering ⁵	spot	yes
Engenia				L	spot and wiper	yes
Facet L				L	spot	yes
Freelexx				L	spot	yes
		preplant				
Glyphosate		renovation			spot and wiper	yes
Gramoxone SL		preplant				no
GrazonNext HL (aminopyralid + 2,4-D)	PA, VA, WV			after tillering ⁵	spot	yes

Table 5.79 - Application Timings for Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Herbicide	Use Only in These States	Establishment	Seedling Stand POST	Established Stand POST	Spot-Spray or Wiper Applicator	Grazed Fencerows
Grazon P+D (picloram + 2,4-D)	VA, WV			after tillering ⁵		yes
GrazonPD3				after tillering ⁵	spot	yes
MCPA			½ pint/A max ⁶	L		yes
Metsulfuron				6-24 months ⁷	spot	yes
Milestone	PA, VA, WV			after tillering ⁵	spot	yes
PastureGard HL (triclopyr + fluroxypyr)				after tillering ⁵	spot	yes
Permit/Sandea				L	spot and wiper	yes
Prowl H2O				6 or more tillers		yes
Remedy Ultra				after tillering ⁵		yes
Sharpen				L		yes
Spike 20P (pelleted) ⁸				L	spot	yes
Stinger				L	spot	yes
Surmount (picloram + fluroxypyr)	VA, WV			after tillering ⁵	spot	yes
Tordon				L	spot	yes
Vastlan				after tillering ⁵	spot	yes
Weedmaster (dicamba + 2,4-D)			2 pt/A max ⁴	L	spot	yes
Xtendimax			22 fl oz/A max ⁴	L	spot	yes
Yukon			L	L	spot	yes

¹ 2,4-D is manufactured by various companies; labels may vary among manufacturers.

² L = allowed on herbicide label with no specific grass size or establishment period restrictions.

³ Most 2,4-D labels do not include spot-spray applications, while some do.

⁴ Labels state that “newly seeded areas” may be severely injured if rates greater than 1 pt/A (Clarity), 2 pt/A (Weedmaster), or 22 fl oz/A (XtendiMax) is applied, but no minimum size or growth stage is given. In practice, these products should not be applied until seedling grasses have attained the 3- to 4-leaf stage, have reached a minimum height of 6 inches, and are healthy and actively growing.

⁵ Grasses should be tillering and have developed a good secondary root system.

⁶ This is labeled for mixed clover/grass stands after 2-trifoliolate clover.

⁷ Six months after establishment for bluegrass, bromegrass, and orchardgrass; 12 months for Timothy; 24 months for fescue.

⁸ Spike is labeled for broadcast applications, but because it can persist for several years in the soil, it is generally only recommended for hand treatment of single plants, multistem clumps, or small stands of woody vegetation in land (including fencerows) dedicated to long-term grass pasture.

Table 5.80 - Herbicides Used in Grass Pasture, Hay, and CRP Grassland, Prepackaged Mixes, or Co-packs, and Equivalents

Trade Name	Components (lb ai/gal or lb ae/gal)	If you apply (per acre)	You have applied (ai or ae)	Site of Action Number	An equivalent tank mixture of
Chaparral 71.6WG	0.6213 lb aminopyralid 0.0945 lb metsulfuron	2.5 oz	0.098 lb aminopyralid 0.015 lb metsulfuron	4 2	6.25 fl oz Milestone 2L 0.4 oz Metsulfuron 60DF
Cimarron Max (co-pack 60DF and 2.87L)	dry: 0.6 lb metsulfuron liquid: 1.87 lb 2,4-D + 1 lb dicamba	dry: 0.4 oz liquid: 1.6 pt	0.015 lb metsulfuron 0.57 lb 2,4-D 0.2 lb dicamba	2 4 4	0.4 oz Metsulfuron 60DF 1.2 pt 2,4-D amine 3.8L 6.4 fl oz Clarity 4S
Cimarron Plus 63WDG	0.48 lb metsulfuron 0.15 lb chlorsulfuron	0.5 oz	0.015 lb metsulfuron 0.0047 chlorsulfuron	2 2	0.4 oz Metsulfuron 60DF 0.1 oz Telar 75DF
Crossbow 3L	2 lb 2,4-D 1 lb triclopyr	4 qt	2 lb 2,4-D 1 lb triclopyr	4 4	2 qt 2,4-D ester 2 pt Remedy Ultra 4L
Curtail 2.38L	0.38 lb clopyralid 2 lb 2,4-D	3 qt	0.285 lb clopyralid 1.5 lb 2,4-D	4 4	12 fl oz Stinger 3L 1.5 qt 2,4-D amine 3.8L
GrazonNext HL 3.74E	0.41 lb aminopyralid 3.33 lb 2,4-D	2.1 pt	0.108 lb aminopyralid 0.9 lb 2,4-D	4 4	6.9 fl oz Milestone 2L 1 qt 2,4-D amine 3.8L
Grazon P+D 2.54SL	0.54 lb picloram 2 lb 2,4-D	4 pt	0.27 lb picloram 1 lb 2,4-D	4 4	1 qt Tordon 2L 1 qt 2,4-D amine 3.8L
GrazonPD3	0.81 lb picloram 3 lb 2,4-D	2 pt	0.203 lb picloram 0.75 lb 2,4-D	4 4	3.24 pt Tordon 2L 1.58 qt 2,4-D amine 3.8L
Huskie 2.06 EC	0.31 lb pyrasulfotole 1.75 lb bromoxynil	15 fl oz	0.036 lb pyrasulfotole 0.2 lb bromoxynil	27 6	0.31 lb pyrasulfotole 13 fl oz Maestro 2EC
PastureGard HL 4SL	3 lb triclopyr 1 lb fluroxypyr	1.5 pt	0.75 lb triclopyr 0.25 lb fluroxypyr	4 4	1.5 pt Remedy Ultra 4L 11 fl oz Vista XRT 2.8L
Prescott 3E	2.25 lb triclopyr 0.75 lb clopyralid	1.5 pt	0.42 lb triclopyr 0.14 lb clopyralid	4 4	0.84 pt Remedy Ultra 4L 0.37 pt Stinger 3S
Surmount 1.34E	0.67 lb picloram 0.67 lb fluroxypyr	3 pt	0.34 lb picloram 0.34 lb fluroxypyr	4 4	1.4 pt Tordon 2L 1 pt Vista XRT 2.8L
Weedmaster 3.87L	1 lb dicamba 2.87 lb 2,4-D	4 pt	0.5 lb dicamba 1.44 lb 2,4-D	4 4	1 pt Clarity 4S 3 pt 2,4-D amine 3.8L
Yukon 67.5WDG	0.125 lb halosulfuron 0.55 lb dicamba	6 oz	0.047 lb halosulfuron 0.206 lb dicamba	2 4	1 oz Permit 75WG 6.6 fl oz Clarity 4S

Table 5.81 - Relative Effectiveness of Herbicides Used in Grass Pasture, Hay, and CRP Grassland

This table compares the relative effectiveness of herbicides on individual weeds. Ratings are based on labeled application rates, weed size or growth stage, and proper timing of application (see Table 5.86). Results may differ with variations in weed size, temperature, rainfall, soil moisture, soil type, and soil pH. Spike 20P also is available for control of problem woody perennials as well as some herbaceous perennials. See a Spike label for additional information. Some products show for which states they are registered under the rate. These products should only be used in the listed states.

Weed control rating

10 = 95–100% 9 = 85–95% 8 = 75–85% 7 = 65–75% 6 = 55–65%

L = Weed is listed as control on herbicide label but local data is limited. N = Less than 55% or no control

- = not applicable or no local data available

Species	2,4-D ¹ 2-3 pt	2,4-D + dicamba ¹ 1 qt + 1 pt	Aim 1-2 oz	Chaparral ¹ 2-3 oz (VA, WV)	Dicamba ¹ 1 pt	Crossbow ¹ 2-4 qt	DuraCor (12 to 20 fl oz/a) (PA, VA, WV)	GrazonNext ¹ HL 1.5-2.6 pt (PA, VA, WV)	Grazon P+D ¹ 3-4 pt (VA, WV)	Metsulfuron 60DF 0.1-0.3oz	Milestone 5-7 oz	Pasture-Gard HL ¹ 1-1.5 pt	Remedy Ultra 2-4 pt	Roundup/glyphosate 1-2 qt (spot treatment)	Stinger 0.66-1.33 pt	Surmount ¹ 1.5-3 pt (VA, WV)
Site of Action Number	4	4	14	4/2	4	4/4	4/4	4/4	4/4	2	4	4/4	4	9	4	4/4
Winter Annuals																
Chamomile, Mayweed	7	10	6	L	8+	8	-	7+	-	10	-	-	-	9	9	-
Chickweed, Common	7	8	6	10	7	9	8+	9	8	10	7	8	7+	10	6	9
Cockle, Corn	8	10	9	L	10	8+	-	-	-	L	-	-	-	10	N	-
Cockle, Cow	8	10	9	9+	10	8+	-	-	-	9	-	-	-	10	N	-
Fleabane spp.	9	10	7	9	8	9+	L	8	9	9	L	-	-	8+	9	-
Henbit/ Deadnettle	6	8+	N	9	7+	9+	9	8	9+	9	8+	8+	7+	9+	-	9
Horseweed (maretail)	9	9	N	9	9	10	9	9	10	9	9+	6	6	9+	9+	9
Mustard, Garlic	N	8	7	8	7	8	-	-	-	8	-	-	8	8	N	-
Mustard spp.	9	10	8+	8	8	10	-	7+	7	8+	N	8	8	10	N	-
Pennycress, Field	9	10	8+	10	8	9+	-	8	10	9	-	L	-	10	N	9+
Pepper Weed spp.	9	10	8+	8	8	9+	L	8	7	10	N	8	8	10	N	-
Shepherdspurse	8+	10	9	10	8	9	-	8	-	10	-	-	-	10	N	-
Yellow Rocket	9	10	9	8+	9	10	-	8	-	9	-	-	-	9	6	-
Summer Annuals																
Amaranth, Spiny	9	10	9	8+	9	9	L	8	7+	8	8	N	N	9	6	9
Cocklebur, Common	9	10	8	10	10	10	9	9	10	8+	L	8+	8+	9	9	9

Table 5.81 - Relative Effectiveness of Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Species	2,4-D ¹ 2-3 pt	2,4-D + dicamba ¹ 1 qt + 1 pt	Aim 1-2 oz	Chaparral ¹ 2-3 oz (VA, WV)	dicamba ¹ 1 pt	Crossbow ¹ 2-4 qt	DuraCor (12 to 20 fl oz/a) (PA, VA, WV)	GrazonNext HL ¹ 1.5-2.6 pt (PA, VA, WV)	Grazon P+D ¹ 3-4 pt (VA, WV)	Metsulfuron 60DF 0.1-0.3oz	Milestone 5-7 oz	Pasture-Gard HL ¹ 1-1.5 pt	Remedy Ultra 2-4 pt	Roundup/glyphosate 1-2 qt (spot treatment)	Stinger 0.66-1.33 pt	Surmount ¹ 1.5-3 pt (VA, WV)
Groundsel, Common	7	7	8	9	6	8	-	7	-	9+	-	-	-	9	9	L
Jimsonweed	8	10	9	8+	10	9	8+	9	7	9	8+	-	-	9	8	7+
Lambsquarters, Common	10	10	9	9+	10	10	10	9	9+	9	9+	9	9	9	6	10
Lettuce, Wild/ Prickly	9+	10	9	10	8+	9	8	9	10	9	9+	9	-	9	9	9
Nightshade, Black	7+	8+	9	8+	8+	8+	-	7	6	8	9	6	-	9	8	L
Perilla mint	7	8	-	-	-	-	8	8	7	-	-	-	-	-	-	-
Pigweed spp.	9	10	9	9	9	9	8+	8	7	10	9	9	8	9	6	9+
Ragweed, Common	9	10	7	9	9	10	9	9	9+	N	9	9	8+	10	9+	9
Ragweed, Giant	8+	10	N	9	9	10	8+	9	9+	N	9	9	8+	10	9+	9
Smartweed spp.	7	9	N	9	8	9	L	9	9	7	8+	N	-	9	8+	9+
Stiltgrass, Japanese ²	N	N	N	N	N	N	7	7	N	N	7	N	N	9	N	N
Velvetleaf	8+	10	9	8	10	9	-	8	8+	8	-	9	-	9	6	9
Biennials																
Burdock, Common	9	10	N	8+	8	9	9	8	9+	7	9	9	9	9	9	8
Carrot, Wild	9	10	N	10	8	9+	10	8	9+	9	N	7	7	9	6	8+
Evening Primrose, Common	9	10	7+	9	8	9+	-	9	-	-	9	-	-	10	-	-
Evening Primrose, Cutleaf	9	10	N	8+	7	8	L	9	9	7+	9	8	8	6	-	-
Hemlock, Poison	7+	9	7+	N	8	9	L	8	8+	N	N	N	N	9	N	8
Mullein, Common	N	6	N	9+	N	N	L	-	7+	8	-	N	N	-	N	7+
Parsnip, Wild	9	10	N	9	9	10	9	8+	8+	7	7	-	-	9	N	-
Teasel	7+	10	8	9	9	8+	9	8+	8+	6	9	9	9	9	9	-
Stiltgrass, Japanese	N	N	N	8	N	N	-	7	-	N	7	-	N	10	N	N
Thistle, Bull	9+	10	N	9+	9	9+	10	9	9	6	9	6	7	9	9+	9
Thistle, Musk	8+	10	N	9+	9	9+	10	9	9	8	9+	6	7	9	9+	8+

Table 5.81 - Relative Effectiveness of Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Species	2,4-D ¹ 2-3 pt	2,4-D + dicamba ¹ 1 qt + 1 pt	Aim 1-2 oz	Chaparral ¹ 2-3 oz (VA, WV)	dicamba ¹ 1 pt	Crossbow ¹ 2-4 qt	DuraCor (12 to 20 fl oz/a) (PA, VA, WV)	GrazonNext HL ¹ 1.5-2.6 pt (PA, VA, WV)	Grazon P+D ¹ 3-4 pt (VA, WV)	Metsulfuron 60DF 0.1-0.3oz	Milestone 5-7 oz	Pasture-Gard HL ¹ 1-1.5 pt	Remedy Ultra 2-4 pt	Roundup/glyphosate 1-2 qt (spot treatment)	Stinger 0.66-1.33 pt	Surmount ¹ 1.5-3 pt (VA, WV)
Thistle, Plumeless	8+	10	N	9+	9	9+	10	9	9	8	9+	6	7	9	9+	8+
Herbaceous Perennials																
Aster spp.	9	10	N	9	8+	9	L	7	8	7	-	-	-	9	9+	-
Bedstraw, Smooth	7	7	6	9	N	8	L	9	7	N	9	L	-	9	7	L
Bindweed, Field	8	8+	6	-	8+	8	-	7	6	N	-	7	7	8	N	8
Bindweed, Hedge	9	10	N	-	9	9	-	8	8+	N	-	7+	8	8	N	8+
Brackenfern	7	7	N	7	N	7+	-	7	-	7	-	-	-	6	-	-
Buttercup spp.	8+	9	7	8+	8	10	10	9	10	9	8+	8	8	9	8	8+
Catsear, Common	7	9	N	9	7+	-	-	9	-	-	9	-	-	8+	-	-
Chickweed, Mouseear	6	8	6	10	7+	8+	9	7	9	10	8	8	8+	9	6	9
Chicory	9	10	7	9	8	9	9	9	9+	7+	9	9	8+	9	9	8+
Clover spp.	7	8+	N	10	8+	8+	9	9+	10	8+	9+	8+	9	10	9	10
Cockle, White	7	9	6	8	8+	9	-	N	-	8	-	L	-	9+	9	L
Daisy spp.	9	10	N	9	8+	9+	L	9	8	6	9	-	-	8+	8+	-
Dandelion	9+	10	6	8+	7	9+	9	9	9	7+	9	8	7+	7	7	9
Dock spp.	8	10	7	9	8	9	9	9	9	8+	9	8	8	9	7+	9
Dogbane, Hemp	6	7	N	N	7	8	-	6	7	N	N	7	7	8	6	8+
Dogfennel	7	7+	N	N	7	7	-	7	7+	6	N	9	8	8	6	9
Garlic or Onion, Wild	8	8+	N	9	7	8	-	6	N	9+	N	N	N	9	N	N
Goldenrod spp.	8	8+	N	8	7	8	N	8	9	8	6	7	7+	9	6	9
Groundcherry spp.	7	7+	7	9	7	8+	-	7	-	-	9	-	-	8	N	-
Hawkweed spp.	8	9	6	L	7+	9	L	8	6	7	L	-	-	9	8	-
Horsenettle	6	7+	N	9	7	8	9	8+	9	7	9	6	6	8	N	8+
Ironweed, Tall	8	9	N	8+	8+	9	9	9	9+	N	8	7	6	9	6	8+
Knapweed, Spotted	7	8	N	8+	7	7	9+	9	9	6	8+	6	6	9	9	8+

Table 5.81 - Relative Effectiveness of Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Species	2,4-D ¹ 2-3 pt	2,4-D + dicamba ¹ 1 qt + 1 pt	Aim 1-2 oz	Chaparral ¹ 2-3 oz (VA, WV)	dicamba ¹ 1 pt	Crossbow ¹ 2-4 qt	DuraCor (12 to 20 fl oz/a) (PA, VA, WV)	GrazonNext HL ¹ 1.5-2.6 pt (PA, VA, WV)	Grazon P+D ¹ 3-4 pt (VA, WV)	Metsulfuron 60DF 0.1-0.3oz	Milestone 5-7 oz	Pasture-Gard HL ¹ 1-1.5 pt	Remedy Ultra 2-4 pt	Roundup/glyphosate 1-2 qt (spot treatment)	Stinger 0.66-1.33 pt	Surmount ¹ 1.5-3 pt (VA, WV)
Knotweed, Japanese	7	7+	6	7+	7+	7	8+	7	N	-	7+	N	6	8	8	L
Lespedeza, Sericea	N	N	N	6	N	7+	-	N	6	6	N	8	8	7	N	7
Milkweed, Common	6	7	N	N	6	7	-	6	7	N	N	6	6+	7+	N	8+
Mugwort	6	7	6	8	7	8	L	8	7	7	8	-	-	7	8+	-
Nettle, Stinging	8	9	6	8	8	9	-	9	9	6	9	9	9	9	7	9
Nightshade, Bitter	7	8+	6	-	7	-	-	7	7	-	-	-	-	9	8	-
Plantain spp.	8	10	7	9	8	9	10	7+	9	9	N	9	8	9	N	8+
Pokeweed, Common	7	7	N	6	7	9	7	8	7+	N	7+	N	N	8	N	8+
Snakeroot, White	8	9	7	-	9	9	9	8	8	N	-	-	-	8	N	-
Sorrel, Red	6	10	8+	8	8+	-	-	-	9	8+	-	6	-	9	8	-
Sowthistle, Perennial	7	9	N	8+	8	8	9	9	9+	7	9	8	8	9	8	-
Star-of- Bethlehem	N	N	8+	-	N	-	-	-	-	-	-	-	-	8	-	-
Thistle, Canada	7	7+	N	9+	7	8	9	9	9	7	9	8	6	8	9	7
Toadflax, Yellow	7	8	8+	-	7+	-	-	7	-	-	-	-	-	8	N	-
Waterhemlock, Spotted	7+	9	N	-	8	9	-	7	-	N	-	-	-	9	N	-
Wingstem	8+	8+	N	9	6	7+	9	9	9	N	9	6	7+	-	6	8+
Woodsorrel, Yellow	7	7+	7	L	7	8	-	8+	-	9	-	-	-	9	8	-
Yarrow, Common	7	9	N	L	9	8+	L	7	-	8	L	L	L	9	7	L
Woody Perennials¹																
Blackberry spp.	6	6+	N	8	6	8	-	N	7+	7	N	7	7+	8	7	8
Dewberry spp.	6	7	N	L	6	7+	-	N	-	8+	-	-	-	7	7	7
Grape, Wild	8	9	N	-	8	9	-	8	-	-	-	L	-	8	N	L
Honeysuckle spp.	7	7+	N	L	N	8+	-	7	8	10	-	L	-	8	N	L
Kudzu	N	6	N	8	6	6	L	8	9	N	8	7	7	-	-	-

Table 5.81 - Relative Effectiveness of Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Species	2,4-D ¹ 2-3 pt	2,4-D + dicamba ¹ 1 qt + 1 pt	Aim 1-2 oz	Chaparral ¹ 2-3 oz (VA, WV)	dicamba ¹ 1 pt	Crossbow ¹ 2-4 qt	DuraCor (12 to 20 fl oz/a) (PA, VA, WV)	GrazonNext HL ¹ 1.5-2.6 pt (PA, VA, WV)	Grazon P+D ¹ 3-4 pt (VA, WV)	Metsulfuron 60DF 0.1-0.3oz	Milestone 5-7 oz	Pasture-Gard HL ¹ 1-1.5 pt	Remedy Ultra 2-4 pt	Roundup/glyphosate 1-2 qt (spot treatment)	Stinger 0.66-1.33 pt	Surmount ¹ 1.5-3 pt (VA, WV)
Locust, Black	7	8+	N	L	8	8	-	L	-	7	L	L	L	8	N	9+
Olive, Autumn	7	8	N	-	7+	8	-	7	-	-	-	-	9	8	N	-
Poison-ivy, Oak	7	8+	N	6	7+	8+	-	7	8+	6	-	L	L	8	N	7
Rose, Multiflora	6	7+	N	8	6	8+	6	7	8+	8+	6	6	8+	8	N	7
Sumac spp.	6	7+	N	-	7	8+	-	L	7	N	-	L	L	8	7	8
Trumpet Creeper	6	7+	N	-	6	8	N	N	7	N	-	-	L	7+	N	7
Virginia Creeper	7	9	N	-	8	8+	-	7	-	-	-	L	L	8	N	-

¹ Herbicide contains multiple active ingredients. See Table 5.80 for prepackaged mixture or co-packs and their constituents.

² Japanese stiltgrass control in grass forages is inconsistent. Prowl H2O or Satellite HydroCap can be applied to established forage grasses in early spring to control germinating Japanese stiltgrass seedlings. Aminopyralid-containing products can provide some residual control when applied in the early spring. Currently there are no labeled, POST herbicides that effectively and selectively control stiltgrass without injuring the desirable forage grasses. Facet L (quinclorac) is labeled in grass forages and has activity on foxtails, crabgrass, barnyardgrass (<2" tall); but it has poor activity on Japanese stiltgrass and kills clover. Acclaim Extra (fenoxaprop) is not labeled in forages. Plateau controls stiltgrass but some cool season forages grasses are sensitive to it (see label for details). Pursuit also controls stiltgrass, but the label is ambiguous about its utility in grass forage settings.

Table 5.82 - Comments on Herbicides Used in Grass Pasture, Hay, and CRP Grassland

The following comments apply to all herbicides, unless otherwise noted below:

- Apply postemergence to actively growing broadleaf weeds. Treat biennials in the rosette stage of growth.
- Higher rates or repeat treatments may be required for less susceptible species, perennial weeds, and woody plants.
- For maximum efficacy, do not mow, graze, hay, or disturb the treated area for 7 days after application. Make applications at least 7 days before a killing frost.
- These herbicides will severely injure alfalfa, clover, and other legumes. Do not use if loss of desirable legume species cannot be tolerated.
- Follow label recommendations to reduce the potential for spray drift or volatility to sensitive plants.

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier
2,4-D LVE 3.8L or 2,4-D amine 3.8L	2,4-D	Established-POST	1.5–3 qt or 1–2 qt	1.4–2.8 ae or 0.95–1.9 ae	yes

- 2,4-D is marketed by various companies with various trade names. Refer to the label provided with the product for specific recommendations and restrictions.
- Make application when grasses are well established, usually 4–5 inches tall with a good root system and tiller development.
- Make applications by ground in a minimum of 10 gal/A or by air in a minimum of 2 gal/A of water or liquid fertilizer.
- Do not make applications when the temperature is expected to exceed 80 degrees that day as drift is more likely to occur.
- Treat susceptible woody perennials in the spring after leaves are fully expanded.
- Ester formulations are slightly more effective (more leaf-absorbed) than amine formulations, but also slightly more volatile.
- 2,4-D labels vary concerning overseeding or rotational crop restrictions. Unless specified on the label, most crops can be safely planted 3 months after application under normal environmental conditions.
- Freelexx is a new choline salt formulation of 2,4-D that has much lower volatility and low odor compared to other 2,4-D formulations. It can be used in grass forage settings.
- *Water Quality Advisory.*

Aim 2EC	carfentrazone	Seedling-POST Established-POST	1–2 fl oz	0.016–0.032	yes
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- For new seedlings apply to grasses that have at least 3-4 leaves.
- Aim is safe to legumes and clovers, but temporary injury may occur.
- Significant crop response may occur, but is temporary.
- Apply in a minimum of 10 gal/A of water or liquid fertilizer. Applying Aim in liquid fertilizer may increase the level of crop response.
- Applications made within 8 hours of rainfall or irrigation or when heavy dew is present may cause significant crop response.
- Aim has a relatively narrow spectrum of weed control and is primarily used for control of winter or summer annual broadleaf weeds up to 4 inches tall (emerged weeds only).
- Aim has activity on Star-of-Bethlehem, dayflower species, and speedwell species. Star-of-Bethlehem may require additional application at least 10 days after the first.
- Three applications per season are allowed, but do not make applications less than 7 days apart.
- There are no rotational crop or overseeding restrictions for labeled crops; see label.

Table 5.82 - Comments on Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier (yes/no)
Arsenal 2AS	imazapyr	Grazed fencerows	1–3 pt or 0.4–1.2 fl oz/ gal	0.25–0.75 or 0.3%–0.9% v/v solution	no
<ul style="list-style-type: none"> • Arsenal is labeled for spot treatment in grass pasture. However, due to its length of residual activity on cool-season grass species, bare spots in the pasture could persist for several months. Therefore, it is only recommended for use along permanent or long-term fencerows. • This use falls under the spot treatment part of the label, so grazed fencerows can be treated so long as the total area to be treated is no more than 10% of the total pasture and fencerow areas combined. • DO NOT apply where Arsenal may contact the roots of desirable trees or other plants. • Arsenal provides postemergence and 3 to 6 months of soil residual control of many annual, biennial, and perennial grass and broadleaf weeds as well as several vine and brush species. • Make applications with hand-held equipment. • Refer to weed rate tables of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft²) to provide thorough coverage. Do not spray to the point of runoff. • Rotational crops can be planted 12 months after application and completion of a successful field bioassay. 					

Table 5.82 - Comments on Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier (yes/no)
Chaparral 71.6WG VA and WV only	aminopyralid + metsulfuron	Established-POST	2–3.3 oz	0.078–0.128 + 0.012–0.019	
		Seed head suppression	2–2.5 oz	0.078–0.098 + 0.012–0.015	
		Spot treatment	0.025–0.033 oz/gal	0.02%–0.026% w/v solution	yes

- Chaparral provides postemergence control and 2 to 3 months of soil residual control of on many annual, biennial, and perennial weed species and suppression of blackberry and multiflora rose **in permanent grass pasture**.
- Apply by ground in a minimum of 10 gal/A or by air in a minimum of 2 gal/A of water or liquid fertilizer.
- High-volume foliar applications for brush control (volume not specified) are allowed; consult herbicide label for details.
- In general, Chaparral may be applied in the spring or early summer, depending on the target weed species, as a broadcast application over grass that was planted at least 4 months prior to the application and growing under favorable conditions for establishment. Grasses should have well-established root systems and be tillering.
- Smooth brome grass may be more sensitive to applications of Chaparral than other perennial grasses, and temporary growth suppression may occur.
- Special precautions are provided on the label for applications to tall fescue to minimize injury and stunting. Make application later in spring after new growth is 5–6 inches tall or in the fall. Do not use more than 2 oz/A of Chaparral and tank-mix with 2,4-D. Use only a non-ionic surfactant (0.5–1 pt/100 gal) when mixing with water; do not use any adjuvant when mixing with liquid fertilizer. Adhere strictly to these precautions, or severe injury may occur. Even when these precautions are followed, some stunting, yellowing, or seed head suppression of fescue may occur.
- Do not use Chaparral on timothy, annual (Italian) ryegrass, or perennial ryegrass, or severe injury will occur.
- With fall applications, do not plant grasses the following spring; do not overseed ryegrass for 4 months after application.
- Do not rotate to any crop within 1 year following treatment, or to any broadleaf crop until an adequately sensitive field bioassay shows that the aminopyralid level in soil will not adversely affect that broadleaf crop. Cereals and corn can be planted 1 year after treatment; most broadleaf crops require at least a 2-year wait until planting.
- The Chaparral label has restrictions concerning the use and management of plant residues (hay, straw, mulch, compost) and manure that may contain aminopyralid residues. These include important restrictions concerning the movement and sale of hay products treated with aminopyralid. Be certain you understand and are able to follow these label restrictions before using this product.
- For tall fescue seed head suppression and broadleaf weed control: Chaparral may be used to reduce the number of seed heads of tall fescue when applied prior to flower emergence. For best results apply 2–2.5 oz/A after initial green-up when grass height is approximately 6 inches. Later applications may still be effective; however, the seed head suppression will be less effective and the number of seed heads could be noticeably higher. Many weed species can be controlled with this application timing in addition to the suppression of seed head development.
- Make spot applications with hand-held equipment. Refer to weed rate tables of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft²) to provide thorough coverage. Do not spray to the point of runoff.
- Spot treatments may be applied at equivalent broadcast rates of up to 6.6 oz/A (0.066 oz/gal), but no more than 50% of the acreage may be treated, and the total amount of Chaparral applied from all applications must not exceed 3.3 oz per acre per year.
- A non-ionic surfactant should be added.
- Repeat treatments may be made, but the total amount of Chaparral applied from all applications must not exceed 3.3 oz per acre per year.
- Chaparral may be impregnated on dry bulk fertilizer and spread. This application method relies on herbicide activity in the soil, and thus, difficult to control perennial weeds are not as well controlled compared to spray applications.
- *Water quality advisory.*

Table 5.82 - Comments on Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier (yes/no)
Clarity 4S	dicamba	Seedling-POST	0.5–1 pt	0.25–0.5 ae	yes
		Established-POST	0.5–2 pt	0.25–1.0 ae	
		Spot treatment	0.2–1.6 fl oz/ gal	0.16%–1.25% v/v solution	
<ul style="list-style-type: none"> • Application to seedling grasses should not exceed 1 pt/A, and grasses should be actively growing, unstressed, and have attained the 3- to 4-leaf stage and 6 inches tall. For higher rates delay application until grasses are well established, usually 4–5 inches tall with a good root system and tiller development. • Apply in a minimum of 10 gal/A of water or liquid fertilizer, or by air in 2 to 40 gal/A of water. • If applied in a liquid nitrogen carrier, foliar burn on the forage can be expected especially if it's sunny and above 80F. It is best to use a 50:50 mixture of water and liquid fertilizer to reduce crop injury. • High-volume foliar applications for brush control (up to 600 gal/A) are allowed; consult herbicide label for details. • Do not make applications when the temperature is expected to exceed 80 degrees that day as drift is more likely to occur. • Forage grasses or small grains can be overseeded after 30 days per pint of dicamba applied. • Legumes and other broadleaf crops may be planted 4 months after application. • Make spot applications with hand-held equipment. Do not treat more than one-tenth of the total area at any one time. • Refer to weed rate tables of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft²) to provide thorough coverage. Do not spray to the point of runoff. • Clarity is also labeled for wiper applications. Consult the herbicide label for specific recommendations. • <i>Water quality advisory.</i> 					
Crossbow 3E	triclopyr + 2,4-D	Established-POST	1–6 qt	0.25–1.5 ae + 0.5–3.0 ae 1.2%–1.6% v/v	yes
		Spot treatment	1.5–2 fl oz/gal	solution	
<ul style="list-style-type: none"> • Crossbow provides postemergence control and 1 to 2 months of soil residual control of many annual, biennial, and perennial weeds as well as many woody plants. • Apply only to grasses with well-established root systems that are tillering. • Apply to actively growing weeds or brush by ground or air (helicopter only) in 10 to 30 gal/A of water or liquid fertilizer. • For best results, treat biennial or winter annual weeds in the rosette stage. • Some hard-to-control perennial weeds and woody species may require retreatment. Use higher rates for less susceptible species. • High-volume foliar applications for brush control (100–200 gal/A) are allowed; consult herbicide label for details. • Follow all label recommendations to reduce the potential for spray drift or volatility to sensitive plants. • Crossbow will severely injure alfalfa, clover, and other legumes. • Forage grasses may be overseeded 21 days after application. Other crops can be planted the next growing season. • Make spot applications with hand-held equipment. • Refer to weed rate tables of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft²) to provide thorough coverage. • For best results, do not graze or harvest for 7 days after application, and make applications at least 7 days before a killing frost. • Do not spray to the point of runoff. • <i>Water quality advisory.</i> 					

Table 5.82 - Comments on Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier (yes/no)
DuraCor 0.73SC (PA, VA, and WV only)	aminopyralid + florpyrauxifen- benzyl	seedling: POST established: POST	12–20 fl oz	0.063–0.104 ae + 0.006–0.0105 ae	
		spot treatment	40 fl oz	1.46 v/v solution	yes
<ul style="list-style-type: none"> Spot treatments may be applied at an equivalent broadcast rate of up to 40 fl oz of DuraCor (0.208 lbs aminopyralid and 0.0209 lbs florpyrauxifen-benzyl) per acre per annual growing season; however, not more than 50% of an acre may be treated at this rate. Repeat treatments may be made, but the total amount of DuraCor applied must not exceed 20 fl oz per acre per year. DuraCor can be applied at 12 fl oz of product per acre in early to mid-spring when weeds are less than 2 inches tall. Applications in this range are most effective when conditions are favorable to plant growth. For longer residual control of susceptible late spring and early summer weed emergence, apply up to 20 fl oz of product per acre. Increasing application rate to the high end of the rate range specified will extend the period of residual control. DuraCor may be impregnated on dry bulk fertilizer and spread. This application method relies on herbicide activity in the soil, and thus, difficult to control perennial weeds are not as well controlled compared to spray applications. 					
Facet L 1.5SL	quinclorac	Established-POST	12–64 fl oz	0.14–0.75 ae	
		Spot treatment	0.55–1.6 fl oz/ gal	0.4%–1.25% v/v solution	no
<ul style="list-style-type: none"> Facet L (formerly Paramount 75WDG) provides postemergence control and 1 to 2 months of soil residual control or suppression of several annual grass weeds, a few annual broadleaf weeds, and field or hedge bindweed. Facet L is the only herbicide labeled for postemergence control of grass weeds in grass forage crops. Labeled grass weeds are barnyardgrass, large crabgrass, giant, green, and yellow foxtails, junglerice, and broadleaf signalgrass. Rates greater than 32 fl oz/A and less than 22 fl oz/A are for leafy spurge control and bindweed maintenance, respectively. For broadleaf control apply 22–32 fl oz/A. For grass control apply at 32 fl oz/A with MSO at 1 % v/v. Use only on labeled established grasses (timothy and reed canarygrass not included) that have developed a good root system and are tillering. Local experience indicates that Facet may cause more injury to orchardgrass than to the other labeled cool-season grasses. Apply to actively growing plants by ground in a minimum of 5 gal/A of water. Aerial applications are not allowed in the Northeast region. For best results apply to labeled grass and broadleaf weeds up to 2 inches tall and prior to grass tiller development. Do not apply Facet when air temperature is more than 90°F. Forage grasses can be overseeded 10 months after application. Legume crops can be planted 24 months after application and completion of a successful field bioassay. For spot applications, do not exceed the maximum per-area rates for broadcast application. Refer to weed rate tables of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft²) to provide thorough coverage. Do not spray to the point of runoff. <i>Water quality advisory.</i> 					

Table 5.82 - Comments on Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier (yes/no)
			1.2–2.1 pt		
		Established-POST		0.062–0.108 +	
			0.5–0.9 fl oz/	0.5–0.9	
GrazonNext HL 3.74E (PA, VA, WV only)	aminopyralid + 2,4-D	Spot treatment	gal	0.4%–0.7% v/v solution	yes

- GrazonNext provides postemergence control and 2 to 3 months of soil residual control of many annual, biennial, and perennial weed species **in permanent grass pasture**.
- In general, it is best to wait 45–60 days after grass planting before applying GrazonNext.
- Smooth brome grass may be more sensitive to applications of GrazonNext than other perennial grasses, and temporary growth suppression may occur.
- Apply by ground in a minimum of 10 gal/A or by air in a minimum of 2 gal/A of water or liquid fertilizer.
- High-volume foliar applications for brush control (volume not specified) are allowed; consult herbicide label for details.
- Grass can be overseeded in the fall after a spring or early summer application.
- Do not rotate to any crop within 1 year following treatment or to any broadleaf crop until an adequately sensitive field bioassay shows that the aminopyralid level in soil will not adversely affect that broadleaf crop. Cereals and corn can be planted 1 year after treatment; most broadleaf crops require at least a 2-year wait until planting.
- The GrazonNext label has restrictions concerning the use and management of plant residues (hay, straw, mulch, compost) and manure that may contain aminopyralid residues. These include important restrictions concerning the movement and sale of hay products treated with aminopyralid. Be certain you understand and are able to follow these label restrictions before using this product.
- Make spot applications with hand-held equipment. Refer to weed rate tables of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft²) to provide thorough coverage. Do not spray to the point of runoff.
- Spot treatments may be applied at equivalent broadcast rates of up to 4.2 pt/A (1.7 fl oz/gal), but no more than 50% of the acreage may be treated, and the total amount of GrazonNext applied from all applications must not exceed 2.1 pints per acre per year.
- A non-ionic surfactant should be added.
- Repeat treatments may be made, but the total amount of GrazonNext applied from all applications must not exceed 2.1 pints per acre per year.
- GrazonNext may be impregnated on dry bulk fertilizer and spread. This application method relies on herbicide activity in the soil, and thus, difficult to control perennial weeds are not as well controlled compared to spray applications
- *Water quality advisory.*

Table 5.82 - Comments on Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier (yes/no)
Grazon P+D 2.54SL (VA, WV only)	picloram + 2,4-D	Established-POST	2–8 pt	0.14–0.54 + 0.5–2.0	yes
<ul style="list-style-type: none"> • Grazon P+D provides postemergence control and 2 to 3 months of soil residual control of many annual, biennial, and perennial weed species in permanent grass pasture. • The distribution of Grazon P+D may be further restricted within Virginia and West Virginia due to the picloram content of the product and sensitivity of certain broadleaf crops. • Apply to grasses that are well established as indicated by tillering, development of secondary root system, and vigorous growth. • Smooth brome grass may be more sensitive to applications of Grazon P+D than other perennial grasses, and temporary growth suppression may occur. • Apply by ground in 10–40 gal/A or by air in a minimum of 2 gal/A of water, an oil-water emulsion, or liquid fertilizer. • High-volume foliar applications for brush control (100 gal/A) are allowed; consult herbicide label for details. • Cool season grasses can be seeded a minimum of 21 days after application (60 days for smooth brome grass). • Do not rotate to food or feed crops on treated land if they are not registered for use with picloram until an adequately sensitive field bioassay or chemical test shows that no detectable picloram is present in soil. • The Grazon P+D label has restrictions concerning the use and management of plant residues (hay, straw, mulch, compost) and manure that may contain picloram residues. Be certain you understand and are able to follow these label restrictions before using this product. • <i>Water quality advisory.</i> • <i>Restricted-use pesticide.</i> 					
GrazonPD3	picloram + 2,4-D	Established-POST	0.67–5 pt	0.07–0.51 + 0.25–1.88	yes
<ul style="list-style-type: none"> • GrazonPD3 provides postemergence control and 2 to 3 months of soil residual control of many annual, biennial, and perennial weed species in permanent grass pasture. • Apply to grasses that are well established as indicated by tillering, development of secondary root system, and vigorous growth. • Smooth brome grass may be more sensitive to applications of GrazonPD3 than other perennial grasses, and temporary growth suppression may occur. • Apply by ground in 10 to 40 gal/A or by air in a minimum of 2 gal/A of water, an oil-water emulsion, or liquid fertilizer. • High-volume foliar applications for brush control (100 gal/A) are allowed; consult herbicide label for details. • Cool-season grasses can be seeded a minimum of 21 days after application (60 days for smooth brome grass). • Do not rotate to food or feed crops on treated land if they are not registered for use with picloram until an adequately sensitive field bioassay or chemical test shows that no detectable picloram is present in soil. • The GrazonPD3 label has restrictions concerning the use and management of plant residues (hay, straw, mulch, compost) and manure that may contain picloram residues. Be certain you understand and are able to follow these label restrictions before using this product. • <i>Water quality advisory.</i> • <i>Restricted-use pesticide.</i> 					

Table 5.82 - Comments on Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier (yes/no)
		Established-POST	0.1–0.4 oz	0.004–0.015	
		Seed head suppression	0.3–0.4 oz	0.011–0.015	
Metsulfuron 60DF	metsulfuron	Spot treatment	0.01 oz/gal	0.008% w/v solution	yes

- Metsulfuron provides both postemergence control and 2 to 3 months of soil residual control of many annual, biennial, and perennial weed species, and suppression of blackberry and multiflora rose **in permanent grass pasture**.
- Apply by ground in a minimum of 10 gal/A or by air in 2 to 5 gal/A of water or liquid fertilizer.
- Postemergence applications are rainfast in 4 hours, after which rainfall or overhead irrigation is required to activate the herbicide in the soil.
- Applications up to 0.4 oz/A may be made to grasses that have been established for a minimum amount of time as follows: bermudagrass (2 months); bluegrass, bromegrass, and orchardgrass (6 months); timothy (12 months); and fescue (24 months).
- Special precautions are provided on the label for applications to fescue or timothy. Apply to fescue in late spring or fall or to timothy in late summer or fall. Either species should be at least 6 inches tall and actively growing. Use the lowest recommended rate of metsulfuron (up to 0.4 oz/A) for the target weeds and tank-mix with 2,4-D for added safety. Use only a non-ionic surfactant at 0.5 pt/100 gal when mixing with water; do not use any adjuvant when mixing with liquid fertilizer. Adhere strictly to these precautions, or severe injury may occur. Even when these precautions are followed, some stunting or yellowing of timothy or fescue may occur.
- Do not use metsulfuron on annual (Italian) or perennial ryegrass, or severe injury will occur.
- Overseeding intervals for grasses are specific to region, soil pH, metsulfuron rate, and grass species. In our region with soils of pH 7.5 or less, the interval range is from 6 to 34 months (see label).
- Metsulfuron is persistent in soil; rotation to most broadleaf crops is 34 months or completion of a successful field bioassay.
- Cimarron Max is a co-pack that contains the active ingredients of metsulfuron and 2,4-D plus dicamba.
- Cimarron Plus is a premix with the active ingredients metsulfuron and chlorsulfuron (Glean or Telar).
- For tall fescue seed head suppression and broadleaf weed control: Metsulfuron may be used to reduce the number of seed heads of tall fescue when applied prior to flower emergence. For best results apply 0.3–0.4 oz/A after initial green-up when grass height is approximately 6 inches. Later applications may still be effective; however, the seed head suppression will be less effective and the number of seed heads could be noticeably higher.
- Spot treatment with metsulfuron is effective for suppression or control of multiflora rose, blackberry, and Canada thistle. Make applications with hand-held equipment. Apply 1 oz/100 gal (0.28 gr/gal) on a spray-to-wet basis (1 gal/1,000 ft²) to provide thorough coverage. Do not spray to the point of runoff, but dense stands of brush may need to be treated from both sides to achieve adequate coverage.
- A non-ionic surfactant at 2–4 pt/100 gal should be added.
- Make applications after plants are fully leafed in the spring up through late summer.

Table 5.82 - Comments on Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier (yes/no)
		Established-POST	3–7 fl oz	0.047–0.109 ae	
Milestone 2E	aminopyralid	Spot treatment	0.13–0.36 fl oz/ gal	0.1%–0.3% v/v solution	yes

- Milestone provides postemergence control and 2 to 3 months of soil residual control of on many annual, biennial, and perennial weed species **in permanent grass pasture**.
- In general, it is best to wait 45–60 days after grass planting before applying Milestone.
- Smooth brome grass may be more sensitive to applications of Milestone than other perennial grasses, and temporary growth suppression may occur.
- Apply by ground in a minimum of 10 gal/A or by air in a minimum of 2 gal/A of water or liquid fertilizer.
- High-volume foliar applications for brush control (volume not specified) are allowed; consult herbicide label for details.
- Grass can be overseeded the fall after a spring treatment.
- Do not rotate to any crop within 1 year following treatment or to any broadleaf crop until an adequately sensitive field bioassay shows that the aminopyralid level in soil will not adversely affect that broadleaf crop. Cereals and corn can be planted 1 year after treatment; most broadleaf crops require at least a 2-year wait until planting.
- The Milestone label has restrictions concerning the use and management of plant residues (hay, straw, mulch, compost) and manure that may contain aminopyralid residues. Follow the label restrictions carefully.
- Make spot applications with hand-held equipment. Refer to weed rate tables of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft²) to provide thorough coverage. Do not spray to the point of runoff.
- Spot treatments may be applied at equivalent broadcast rates of up to 14 fl oz/A (0.32 fl oz/gal), but no more than 50% of the acreage may be treated, and the total amount of Milestone applied from all applications must not exceed 7 fl oz per acre per year.
- A non-ionic surfactant should be added.
- Repeat treatments may be made, but the total amount of Milestone applied from all applications must not exceed 7 fl oz per acre per year.
- *Water quality advisory.*

Table 5.82 - Comments on Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier (yes/no)
PastureGard HL 4L	triclopyr + fluroxypyr	Established-POST	0.75–4 pt 0.2–1.5 fl oz/ gal	0.28–1.5 ae + 0.094–0.5 ae 0.16%–1.2% v/v solution	not recommended
		Spot treatment			
<ul style="list-style-type: none"> • PastureGard provides postemergence control and 1 to 2 months of soil residual control of many annual, biennial, and perennial weeds as well as many woody plants. • Apply to actively growing weeds or brush by ground in a minimum of 5 gal/A or by air in a minimum of 3 gal/A (non-woody broadleaf weeds) or 4 gal/A (woody plants) of water. • For brush control, high-volume foliar applications (50–100 gal/A), basal methods, and cut stump methods are allowed; consult herbicide label for details. • For best results treat blackberry either before first flower or after fruit drop. • Some hard-to-control woody species may require retreatment. • Apply only to grasses with well-established root systems that are tillering. • Forage grasses or small grains can be overseeded 21 days after application. • Other crops can be planted 4 months after application. • For spot treatments apply at rates equivalent to broadcast application rates. Refer to weed rate tables of the herbicide label and apply the recommended per gallon concentration above on a spray-to-wet basis (1 gal/1,000 ft²) to provide thorough coverage. Do not spray to the point of runoff. • <i>Water quality advisory.</i> 					
Permit/Sandea 75WDG	halosulfuron	established: POST	0.67–1.3 oz	0.031–0.063	no
		spot treatment	0.019 oz/gal	0.016% w/v solution	
<ul style="list-style-type: none"> • Sandea provides excellent postemergence control of yellow nutsedge and has both preemergence (3 to 4 weeks soil residual) and/or postemergence activity on several annual broadleaf weeds. • Apply by ground in a minimum of 10 gal/A water or by air in 3–15 gal/A water. • For best results, spray actively growing nutsedge plants at the 3- to 5-leaf stage and susceptible broadleaf plants that are 1 to 3 inches tall. • Heavy nutsedge infestations may require additional applications. • Wait at least 48 hours after application before irrigation. • Yukon is a premix of Sandea and dicamba. • Forage grasses, small grains, sorghum, and corn can be overseeded 2 months after application. • Legume forages can be planted 9 months after application; see label for other broadleaf crops. • Apply Sandea as a postemergence spot treatment only to those areas of emerged nutsedge. Do not exceed a rate of 0.75 oz/A (0.019 oz/gal). Apply on a spray-to-wet basis (1 gal/1,000 sq ft) to provide thorough coverage. Do not spray to the point of runoff. A second postemergence spot application at 0.75 oz/A is allowed where nutsedge has emerged or regrown. Follow the same procedures as first application. The potential for injury to desirable broadleaf and grass plants is increased with a second application. • <i>Water quality advisory.</i> 					

Table 5.82 - Comments on Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier (yes/no)
Prowl H2O/Satellite Hydrocap 3.8AS	pendimethalin	established POST (fall, winter, spring) between cuttings	1.1–4.2 qt	1-4	yes
<ul style="list-style-type: none"> • Prowl H2O will not control any weeds that have already emerged at the time of application. • Provides 1 to 2 months of residual control of most annual grass weeds and a few broadleaf weeds as they germinate (refer to label for weeds controlled). • An early April application may be required to control annual grasses such as foxtails (annual species only), jointhead arthraxon, crabgrass, and others as well as suppression of Japanese stiltgrass • Applications may be made in fall after last cutting/grazing, in winter, spring, or between cuttings (but before weed emergence). • Apply to solid (established) stands of perennial forage grasses with a minimum of 6 tillers. • Apply by ground in a minimum of 10 gal/A or by air in a minimum of 5 gal/A of water or liquid fertilizer. • Adequate rainfall or overhead irrigation is required to activate Prowl H2O. • Multiple applications are allowed, however maximum use rate of Prowl H2O is 4.2 qt/A/year with 30 days between sequential applications. • Adverse environmental conditions or weak stands of grass may cause temporarily injury. • Do not apply to mixed stands with forage legumes other than alfalfa. • Rotational restrictions are based on Prowl rate used, precipitation, and application timing; see label. • Prowl may be impregnated on dry bulk fertilizer and spread. This application method relies on herbicide activity in the soil, and thus, difficult to control perennial weeds are not as well controlled compared to spray applications. 					
Remedy Ultra 4L	triclopyr	Established-POST	0.5-4 pt	0.25–2.0 ae	yes
<ul style="list-style-type: none"> • Remedy Ultra provides postemergence control and 1 to 2 months of soil residual control of many annual, biennial, and perennial weeds as well as many woody plants. • Apply to actively growing weeds or brush by ground in a minimum of 10 gal/A or by air in a minimum of 2 gal/A (non-woody broadleaf weeds) or 4 gal/A (woody plants) of water or liquid fertilizer. • Do not use liquid fertilizer as the carrier when treating woody plants (brush). • For brush control, high-volume foliar applications (100–200 gal/A), basal methods, and cut stump methods are allowed; consult herbicide label for details. • Biennial or winter annual weeds are most susceptible while in the rosette stage. • For best results treat blackberry during or after bloom. • Some hard-to-control woody species may require retreatment. • Apply only to grasses with well-established root systems that are tillering. • Forage grasses can be overseeded 21 days after application. • Other crops can be planted the next season after application. • Vastlan is a new choline salt formulation of triclopyr that has much lower volatility and odor compared to other triclopyr formulations. It can be used in grass forage settings. • <i>Water Quality Advisory.</i> 					

Table 5.82 - Comments on Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier (yes/no)
Roundup 3S or Roundup WeatherMax 4.5S	glyphosate	Spot treatment	2.5 fl oz/gal	2% v/v solution	no
<ul style="list-style-type: none"> • Glyphosate controls emerged weeds only (no residual activity). • Make applications with hand-held equipment or wiper applicators. Avoid contact with desirable vegetation. Consult the herbicide label for specific wiper applicator recommendations. • At rates up to 2 qt/A, any portion up to the entire field may be treated. For rates above 2 qt/A, apply only to weed-infested areas of the field, and do not treat more than one-tenth of the total area at any one time. • Subsequent applications to the same areas can be made at 30-day intervals. • Refer to weed rate tables of the herbicide label for the recommended herbicide concentration. • For spot treatment, apply on a spray-to-wet basis (1 gal/1,000 ft²) to provide thorough coverage. Do not spray to the point of runoff. • There are no overseeding restrictions for spot treatment with glyphosate. 					
Sharpen 2.85SC	saflufenacil	Established- dormant Established-POST	1–2 fl oz	0.022–0.044	yes
<ul style="list-style-type: none"> • Sharpen has a relatively narrow spectrum of weed control and is primarily used for control of winter or summer annual broadleaf weeds up to 6 inches tall. It primarily controls emerged weeds but has some very short (1-2 weeks at the labeled rates) residual activity. • Apply by ground in a minimum of 5 gal/A water or 20 gal/A liquid fertilizer, or by air in a minimum of 3 gal/A water. • Make dormant applications in the fall, during the winter, or in early spring before green-up. • Make in-season applications before weeds reach the maximum size (usually 3-6 inches) listed on the weed table of the label. • Sharpen may cause transitory injury to forage grasses. • There are no replant restrictions for forage grasses, small grains, or sorghum at the 2 fl oz/A rate. • For other crops, rotation restrictions are up to 5 months at the 2 fl oz/A rate; see label. • <i>Water Quality Advisory</i> 					

Table 5.82 - Comments on Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier (yes/no)
		Established-POST	10–20 lb 0.4–0.7 oz/100	2–4	
Spike 20P	tebuthiuron	Individual plant	sq ft	2–4	n/a

- Spike 20P is a pelleted formulation for control of woody plants (trees, shrubs, etc) and vines.
- Apply by hand evenly over the area occupied by individual plants, multistem clumps, or small stands of woody vegetation.
- For multiflora rose control, apply Spike in early spring after ground thaw and before multiflora rose growth.
- Requires rainfall to move herbicide to root zone.
- Make only one application per year.
- Desirable grasses or legumes in the treated area may be injured or killed. Dormant season application is recommended to minimize herbicidal activity on forage grasses.
- For best results, do not disturb treated plants by wood cutting or removal for 2 years after application.
- Poor or erratic results are likely to occur in soils containing more than 5% organic matter or more than 30% clay, and in areas where woody plants are rooted directly in a shallow water table.
- Spike can persist in the soil for several years, and should therefore only be used on land dedicated to long-term grass forage production unless severe herbicide injury to legumes, row crops, shrubs, or trees can be tolerated in treated areas for several years. A field bioassay is required before planting sensitive crops.
- Do not apply Spike 20P in the vicinity of desirable plants. Exposure of even a small part of a plant root system to Spike may cause severe plant injury or death. Treatment setback distance from desirable plants should be one to two times the height or width of adjacent non-target vegetation, whichever is greater. Avoid applications on slopes where surface or ground water flow toward desirable vegetation.
- Do not apply more than 10 lb/A on “vulnerable sites” as described on the herbicide label under “Use Restrictions for Groundwater Protection.” Do not apply in areas where the water table is predominately shallow (5 feet or less), to interior ditch banks, or to ditches used to transport irrigation water or potable water. Do not apply within areas identified by state or local authorities as protected groundwater recharge zones.
- *Water quality advisory.*

		Established-POST	0.66–1.3 pt	0.25–0.50 ae	
Stinger 3S	clopyralid	Spot treatment	0.13–0.5 fl oz/ gal	0.1%–0.4% v/v solution	no

- Stinger provides postemergence control and 1 to 3 months of soil residual control of some annual, biennial, and perennial broadleaf weeds, but is primarily used for Canada thistle control.
- Apply to actively growing weeds by ground in a minimum of 10 gal/A of water. Do not apply by aircraft.
- For Canada thistle, apply in rosette stage or after thistle is at least 4 inches tall, but before the bud stage.
- Multiple treatments are allowed as long as all treatments do not exceed 1.33 pt/A during a growing season.
- Apply only to actively growing well-established grasses that are tillering and have developed secondary roots.
- The Stinger label has restrictions concerning the use and management of plant residues (hay, straw, mulch, compost) and manure that may contain herbicide residues. Follow the label recommendations carefully.
- There are no overseeding restrictions for forage grasses, small grains, or field corn.
- Most broadleaf crops can be planted 10.5–18 months after application; see label.
- Spot treatment with Stinger is primarily for Canada thistle control. Refer to weed rate table of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft²) to provide thorough coverage. Do not spray to the point of runoff.
- *Water quality advisory.*

Table 5.82 - Comments on Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier (yes/no)
Surmount 1.33L (VA, WV only)	picloram + fluroxypyr		3–6 pt		
		Established-POST		0.25–0.5 +	
		Spot treatment	0.6–1.1 fl oz/ gal	0.25–0.5 0.5%–0.85% v/v solution	yes

- Surmount provides postemergence control and 2 to 3 months of soil residual control of many annual, biennial, and perennial weed species **in permanent grass pasture**. It may provide improved control of hemp dogbane, milkweed, dewberry, or sumac species over Grazon P+D.
- The distribution of Surmount may be further restricted within Virginia and West Virginia due to the picloram content of the product and sensitivity of certain broadleaf crops.
- Apply to grasses that are well established as indicated by tillering, development of secondary root system, and vigorous growth.
- Apply by ground in a minimum of 10 gal/A or by air in a minimum of 5 gal/A of water, an oil-water emulsion, or liquid fertilizer.
- High-volume foliar applications for brush control (100 gal/A) are allowed; consult herbicide label for details.
- Cool-season grasses can be seeded a minimum of 21 days after application.
- Do not rotate to any crop within 1 year following treatment other than range or pasture grasses, grasses for hay or silage, barley, oats, rye, or grain sorghum. Thereafter, other crops may be planted after an adequately sensitive field bioassay shows that the risk of crop injury is within acceptable limits.
- The Surmount label has restrictions concerning the use and management of plant residues (hay, straw, mulch, compost) and manure that may contain picloram residues. Be certain you understand and are able to follow these label restrictions before using this product.
- Spot treatment with hand-held sprayers should be applied at a rate equivalent to a broadcast application. Refer to weed rate table of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft²) to provide thorough coverage. Do not spray to the point of runoff.
- Make applications at least 7 days before a killing frost.
- *Water quality advisory.*
- *Restricted-use pesticide.*

Table 5.82 - Comments on Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Trade Name	Common Name	Application Timing	Product/A	lb ai/A	Apply in Liquid Fertilizer as a Carrier (yes/no)
Weedmaster 3.87L	dicamba + 2,4-D	Seedling-POST	0.5–2 pt	0.06–0.25 +	yes
			1–4 pt	0.18–0.72	
		Established-POST	0.4–1.6 fl oz/ gal	0.125–0.5 +	
			Spot treatment	0.36–1.4 0.3%–1.25% v/v solution	

- For broadcast applications, apply by ground in 5–40 gal/A of water or liquid fertilizer or by air in 3–10 gal/A of water.
- For brush control, foliar and basal applications in oil and water emulsions and cut surface applications are allowed; consult herbicide label for details.
- Applications to newly seeded areas should not exceed 2 pt/A and should only be applied to actively growing unstressed grasses that have attained the 3- to 4-leaf stage and have reached a minimum height of 6 inches.
- Multiple applications are allowed on established grasses as long as all treatments do not exceed 8 pt/A during a growing season.
- Do not make applications when the temperature is expected to exceed 80°F that day, as drift is more likely to occur.
- Forage grasses and small grains can be overseeded after 10 days per pint of Weedmaster applied.
- Legumes and other broadleaf crops may be planted 4 months after application.
- Make spot applications with hand-held equipment. Refer to weed rate tables of the herbicide label and apply the recommended concentration on a spray-to-wet basis (1 gal/1,000 ft²) to provide thorough coverage. Do not spray to the point of runoff. Do not make spot treatments in addition to broadcast treatments.
- Weedmaster is effective on many woody species as a spot spray at the higher rates.
- Add a surfactant at 0.5% v/v for improved control.
- *Water quality advisory.*

Table 5.83 - Adjuvants and Rainfastness for Postemergence Herbicides Used in Grass Pasture, Hay, and CRP Grassland

Adjuvants are products included in the spray tank to improve the performance of herbicides. These include non-ionic surfactant (NIS), crop oil concentrate (COC), methylated seed oil (MSO), or nitrogen solutions. In general, NIS should contain at least 80% active ingredient, and COC should contain at least 15% emulsifier. Nitrogen solutions can be 28, 30, or 32% ammonium-based fertilizer solutions; ammonium sulfate should be spray-grade dry ammonium sulfate (21-0-0). Crop injury can occur with the use of adjuvants. Adding additional adjuvants than what is labeled can increase the chance or severity of crop injury. Following are recommended adjuvants for broadcast postemergence applications; refer to herbicide labels for adjuvant recommendations with other application types.

Rainfastness is number of hours needed between time of application and rainfall or irrigation to ensure sufficient absorption in the plant.

Trade Name	Adjuvant(s)	Rate	Apply in Liquid Fertilizer as a Carrier	Rainfastness (hours)
2,4-D amine 3.8L	none recommended ² or	1 qt/100 gal	yes	1
	nonionic surfactant ³ or	1–2 qt/A		
	crop oil concentrate ³			

Table 5.83 - Adjuvants and Rainfastness for Postemergence Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Trade Name	Adjuvant(s)	Rate	Apply in Liquid Fertilizer as a Carrier	Rainfastness (hours)
2,4-D ester 3.8L	none recommended ² or	1 qt/100 gal	yes	1
	nonionic surfactant ³ or crop oil concentrate ³	1–2 qt/A		
Aim 2EC	nonionic surfactant or	1 qt/100 gal	yes	not specified
	crop oil concentrate or	1 gal/100 gal		
	methylated seed oil	1 gal/100 gal		
	plus nitrogen solution or ammonium sulfate (optional)	2–4 gal/100 gal 2–4 lb/A		
Arsenal 2AS	nonionic surfactant or	1 qt/100 gal	N/A	1
	methylated seed oil	1.5–2 pt/A		
Chaparral 71.6WG ¹	crop oil concentrate or	1 gal/100 gal	yes	not specified
	methylated seed oil or	0.5-1 gal/100 gal		
	nonionic surfactant	1 qt/100 gal		
	plus nitrogen solution or ammonium sulfate (optional)	2 qt/A 2 lb/A		
Clarity 4S	nonionic surfactant or	1–2 pt/100 gal	yes	4
	crop oil concentrate	1 qt/A		
	plus nitrogen solution or	2–4 qt/A		
	ammonium sulfate (optional)	2.5 lb/A		
Crossbow 3L	none recommended		yes	not specified
DuraCor 0.73SC	methylated seed oil	1 % v/v	yes	2
	non-ionic surfactant	0.25–0.5 v/v		
Facet 1.5L	crop oil concentrate or	2 pt/A	no	6
	methylated seed oil	1–2 pt/A		
	plus nitrogen solution or	2–4 qt/A		
	ammonium sulfate (optional)	8.5 lb/100 gal		
Glyphosate preplant or spot treatment	varies by product, check label	see label	no	1-6
	ammonium sulfate (optional)	8.5–17 lb/100gal		
Gramoxone SL 2.0	nonionic surfactant or	1 qt/100 gal	yes	0.5
Gramoxone SL 3.0	crop oil concentrate	1 gal/100 gal		
GrazonNext HL 3.74E	nonionic surfactant	1–2 qt/100 gal	yes	not specified
Grazon P+D 2.54SL	nonionic surfactant ²	1 qt/100 gal	yes	not specified
GrazonPD3 3.81SL	nonionic surfactant	1 qt/100 gal	yes	not specified

Table 5.83 - Adjuvants and Rainfastness for Postemergence Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

Trade Name	Adjuvant(s)	Rate	Apply in Liquid Fertilizer as a Carrier	Rainfastness (hours)
MCPA 3.7L	none recommended		yes	not specified
Metsulfuron 60DF	nonionic surfactant or	1–2 qt/100 gal	yes	4
	nonionic surfactant (on fescue)	0.5-1 pt/100 gal		
Milestone 2L	nonionic surfactant	1–2 qt/100 gal	yes	not specified
	nonionic surfactant (on timothy)	0.5 pt/100 gal		
PastureGard HL 4L	nonionic surfactant ⁴ or	1–2 qt/100 gal	not recommended	not specified
	nitrogen solution ⁴	1–2 qt/100 gal		
Permit/Sandea 75DF	non-ionic surfactant	1–2 qt/100 gal	no	4
Prowl H2O 3.8AS	none recommended		yes	not applicable
Remedy Ultra 4L	nonionic surfactant ²	1 qt/100 gal	yes	not specified
Sharpen 2.85SC	methylated seed oil	1 gal/100 gal	yes	1
	plus ammonium sulfate (dormant only)	8.5–17 lb/100 gal		
Stinger 3S	not recommended ⁵		no	6
Surmount 1.33L	nonionic surfactant ³ or	1–2 qt/100 gal	yes	not specified
	nitrogen solution ³	1–2 qt/100 gal		
Weedmaster 3.87L	nonionic surfactant	2–4 pt/100 gal	yes	4
	plus nitrogen solution (optional)	2–4 qt/A		

¹ See fescue precautions on herbicide label for specific adjuvant recommendations.

² An adjuvant is allowed in water dilutions to provide improved wetting of the foliage, but not required.

³ An adjuvant is recommended for control of woody plants only.

⁴ An adjuvant is allowed for improved weed or woody plant control, especially when plants are drought-stressed.

⁵ The label states that the addition of adjuvants is not usually necessary and that “adding a surfactant to the spray mixture may increase effectiveness on weeds but may reduce selectivity to the crop, particularly under situations of plant stress.”

Table 5.84 - Grazing, Harvest, Haying (PHI), and Slaughter Restrictions for Herbicides Used in Grass Pasture, Hay, and CRP Grassland

A – (dash) means interval not specified on the label.

Trade Name	Type of Animal	Interval between Application and Grazing	Interval between Application and Green Harvest ¹	Interval between Application and Haying	Comments
2,4-D amine or	Lactating dairy	7 days	– ²	7 days	Remove meat animals from treated area 3 days before slaughter. 2,4-D labels vary. See specific label of product used.
2,4-D LVE	Other livestock	0	–	7 days	
Aim (carfentrazone)	All	0	0	0	Slaughter restrictions are not mentioned on label.

Table 5.84 - Grazing, Harvest, Haying (PHI), and Slaughter Restrictions for Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

A – (dash) means interval not specified on the label.

Trade Name	Type of Animal	Interval between Application and Grazing	Interval between Application and Green Harvest ¹	Interval between Application and Haying	Comments
Chaparral (aminopyralid + metsulfuron)	All	0	–	0	No slaughter restrictions.
Cimarron Plus (metsulfuron + chlorsulfuron)	All	0	0	0	Be cautious of crop rotation restrictions. See label for details.
Clarity	Lactating dairy	7 days if < 1 pt 21 days if 1-2 pt 40 days if 2-4 pt	–	37 days if < 1 pt 51 days if 1-2 pt 70 days if 2-4 pt	Remove meat animals from treated areas 30 days prior to slaughter.
	Other livestock	0	–	7	
Crossbow (2,4-D + triclopyr)	Lactating dairy	14 days (< 2 gal)	14 days	Next season (dried hay)	Remove meat animals from treated areas or dried hay 3 days prior to slaughter.
	Other livestock	0	0	7 days	
DuraCor SC (aminopyralid + floryprauxifenbenzyl)	All	0 days (allow 14 days for optimal herbicide efficacy)	18 months	14 days	Do not move hay or silage made from grass treated with DuraCor within the preceding 18 months off farm unless allowed by supplemental labeling.
Facet L (quinclorac)	All	0	–	7 days	No slaughter restrictions on the label
GrazonNext HL (aminopyralid + 2,4-D)	All	0	–	7	Do not transfer grazing animals for 3 days from treated areas to areas with Milestone sensitive-species. Do not spread manure to areas where sensitive-species are or will be grown.
Grazon P+D (picloram + 2,4-D)	Lactating dairy	7 days	–	30 days	Remove meat animals from treated area 3 days before slaughter.
	Other livestock	0	–	30 days	
GrazonPD3	Lactating dairy	7 days	–	30 days	Remove meat animals from treated area 3 days before slaughter.
	Other livestock	0	–	30 days	
Metsulfuron	All	0	0	0	Do not seed to other crops for 1 or more years. See label for restrictions.

Table 5.84 - Grazing, Harvest, Haying (PHI), and Slaughter Restrictions for Herbicides Used in Grass Pasture, Hay, and CRP Grassland (cont.)

A – (dash) means interval not specified on the label.

Trade Name	Type of Animal	Interval between Application and Grazing	Interval between Application and Green Harvest ¹	Interval between Application and Haying	Comments
Milestone (aminopyralid)	All	0	0	0	Do not transfer grazing animals for 3 days from treated areas to areas with Milestone-sensitive species. Do not spread manure to areas where sensitive-species are or will be grown.
PastureGard HL (triclopyr + fluroxypyr)	All	0	0	14 days	Remove meat animals from treated areas at least 3 days before slaughter.
Permit/Sandea (halosulfuron)	All	0	37	37	0-day preslaughter interval
Prowl H2O (pendimethalin)	All	0	0	0	Mixed stand alfalfa/cool-season forage grasses may be grazed or harvested for forage or hay 14 or more days after applying Prowl H2O.
Remedy Ultra (triclopyr)	Lactating dairy Other livestock	next season 0	next season 0	14 days	Remove meat animals from treated areas at least 3 days before slaughter.
Roundup/ glyphosate	All	Spot-7 days Renovate- 56 days	Spot-7 days Renovate- 56 days	Spot-7 days Renovate- 56 days	Use as spot treatment. Do not treat more than one-tenth of any acre. Leaves no soil residue.
Sharpen (saflufenacil)	All	0	0	28	No slaughter restrictions on the label.
Spike (tebuthiuron)	All	< 20 lb/A	–	One year	Leaves soil residue up to 2 years.
Stinger (clopyralid)	All	0	0	0	Do not use hay or straw from treated areas for compost or mulch on susceptible broadleaved crops.
Surmount (picloram + fluroxypyr)	Lactating dairy Other livestock	14 0	14 0	14 0	Remove meat animals from treated areas at least 3 days before slaughter.
Weedmaster (dicamba + 2,4-D)	Lactating Dairy Other livestock	7 0	7 7	7 7	Remove meat animals from treated areas 30 days prior to slaughter.

¹ Green harvest includes harvest for silage, green-chop, or haylage.² — = interval not specified on the label.

Table 5.85 - Herbicides labeled for preplant and postemergence uses in native warm-season grasses (NWSGs)¹

	2,4-D + dicamba	atrazine	Chapparall	Cimarron Plus	Crossbow	DuraCor	Facet L	Grazon P+D	GrazonNext HL	Outrider	Plateau	Remedu Ultra	Sharpen	Surmount
preplant														
big bluestem	X		X	X	X	X		X	X	X	X	X	X	X
eastern gamagrass	X	X	X	X	X	X		X	X			X	X	X
Indiangrass	X		X	X	X	X		X	X	X	X	X	X	X
little bluestem	X		X	X	X	X		X	X	X	X	X	X	X
switchgrass	X		X	X	X	X		X	X	X		X	X	X
plant-back restriction for labeled NWSGs	30 days	0 days	6 mo.	6 mo.	30 days	15 days	N/A	21 days ²	3 mo.	14 days	0 days	21 days	0 days	21 days
postemergence														
big bluestem	X	X	X	X	X	X	X	X	X	X	X	X	X	X
eastern gamagrass	X		X	X	X	X	X	X	X		X ³	X	X	X
Indiangrass	X	X	X	X	X	X	X	X	X	X	X	X	X	X
little bluestem	X	X	X	X	X	X	X	X	X	X	X	X	X	X
switchgrass	X	X	X	X	X	X	X	X	X	X		X	X	X
safe growth stage for NWSGs	≥ 5-leaf	≥ 1 year	≥ 5-leaf	≥ 5-leaf	≥ 5-leaf	≥ 5-leaf	≥ 1 year	≥ 5-leaf	≥ 5-leaf	≥ 5-leaf	any time	≥ 5-leaf	≥ 5-leaf	≥ 5-leaf

¹ This table is modified from a publication by Matt Booher, Integrated Conservation Agronomist at Virginia Tech.

² Label states, "after vigorous growth resumes in spring."

³ May cause suppression or thinning of the stand.

Table 5.86 - Herbicides Labeled for Summer Annual Grass Crops

Weed management in summer annual grasses begins with a clean seedbed obtained by either tillage close to planting or preplant herbicides such as glyphosate. Use fields with fewer perennial and annual grass weeds. Successful establishment begins with properly amended soils (pH and fertility) and appropriate seeding rate, depth, and equipment. When moisture is adequate, annual forage grasses emerge and grow quickly and compete well with weeds. There is often no need for additional weed control. Chemical weed control may be warranted when establishment is slow, weed populations are high, potentially toxic weeds are present, or high-quality (weed-free) hay or forage is desired. Herbicide options are limited. 2,4-D and dicamba herbicides are labeled for use in annual grass forages. However, **2,4-D and dicamba herbicides are not recommended in many areas during the hot summer months** due to potential injury to sensitive plants with physical or vapor drift. Pay particular attention to rotational crop restrictions; consult labels for crops not listed. Check labels for weeds controlled. The listed postemergence herbicides typically control only small annual broadleaf weeds, so check labels for maximum weed size or growth stage.

Herbicide	Labeled Annual Grasses	Timing ^{1/} Weed Type	Use Rate per Acre	Crop Stage	Season Maximum Rate	Grazing/ Harvest Interval	Rotation to Grasses (months)	Rotation to Small Grains (months)	Rotation to Alfalfa/ Clover (months)
2,4-D	forage sorghum, sorghum-sudan hybrid	POST/ broadleaf	0.5–2.1 pt	At least 6 leaves and 5 to 10 inches tall	2.1 pt (1 appl.)	30 days	1	After harvest	After harvest
Aim ²	teff, crabgrass	POST / broadleaf	0.5–2.0 fl oz	any	5.9 fl oz (3 appls.)	0	0	0	12/12
Aim ²	millets	POST / broadleaf	0.5–2.0 fl oz	up to jointing	2.0 fl oz	7 days	0	0	12/12
Aim ²	forage sorghum	POST / broadleaf	0.5–1.0 fl oz	up to 6 leaf	1 fl oz	after 6 leaf	0	0	12/12
Atrazine ² 4L	forage sorghum, sor-sudan hybrid	PPI, Pre, POST / broadleaf	3.2–4.0 pt (see label for details)	up to 12 inches	5 pt	PPI/Pre =60 day POST = 45 days	second year	next year to second year ²	second year
Basagran ²	forage sorghum	POST / broadleaf	1.0–2.0 pt	before heading	2 pt	12 days	0	0	0
Callisto ²	pearl millet	Pre / broadleaf	up to 6.0 fl oz	n/a	6.0 fl oz (1 appl.)	n/a	18	4	10/18
dicamba	forage sorghum, sudan-grass	POST/ broadleaf	8–32 fl oz	At least 3 leaves	64 fl oz	7 days	1	0.5-1.5 (see label)	4
Dual II Magnum ^{4,5}	forage sorghum	Pre / grass	1.0 to 1.67 pt ⁵	n/a	1 applic.	n/a	next spring	4.5	4/9
Huskie ²	forage sorghum	POST / broadleaf	12.8–16 fl oz	3-lf but prior to flag leaf or 30 inches.	32 fl oz	7/ 7	1 (9 for timothy)	1 week	4/bioassay

Table 5.86 - Herbicides Labeled for Summer Annual Grass Crops (cont.)

Herbicide	Labeled Annual Grasses	Timing ^{1/} Weed Type	Use Rate per Acre	Crop Stage	Season Maximum Rate	Grazing/ Harvest Interval	Rotation to Grasses (months)	Rotation to Small Grains (months)	Rotation to Alfalfa/ Clover (months)
Maestro 2EC (Buctril) (for 4EC formulation reduce rates by half) ⁴	forage sorghum, sudan-grass, sor-sudan hybrid	POST / broadleaf	1 pt/ 1.5 pt	3-lf but prior to pre-boot/ 4-lf but prior to pre-boot	2 pt	45 days	1	1	1
Permit/Sandea ²	pearl millet	POST / broadleaf & nutsedge	0.5–0.67 oz	2 lf but prior to head	0.67 oz	0/ 0 forage 37 hay	2	2	9
Permit/Sandea ²	sorghum	POST / broadleaf & nutsedge	0.67–1.0 oz	2 lf but prior to head	1.0 oz	30/30	2	2	9
Yukon	sorghum, proso millet	POST/ broadleaf and nutsedge	3–6 oz	3- to 5-leaf	6 oz (1 appl.)	0/0; 30/30	2	2	9

¹ Abbreviations: appl, application; POST, postemergence; PPI, preplant incorporated, PRE, preemergence.

² Check label for adjuvant recommendations.

³ Next year if applied before June 10; second year if applied after June 10.

⁴ No adjuvant recommended.

⁵ Requires the use of Concep-treated seed.

⁶ Coarse soils 1.0 to 1.33 pt; medium soils 1.33 to 1.5 pt; fine soils 1.33 to 1.67 pt.

Table 5.87 - Optimum Time of Year for Foliar Application of Systemic Herbicides to Selected Weeds

These timings are based on adequate soil moisture and climate of the Eastern Shore area. Across the Mid-Atlantic region (north to south or east to west) these timings could vary by 1 to 3 weeks either way. Consult this table for general guidelines but herbicide labels for specific application information.

Winter annual weeds should be treated in late fall to spring. Summer annual weeds should be treated in early to late summer soon after emergence. Biennial weeds should be treated in the fall or early-spring while in the seedling or rosette stages or in the early spring prior to bolting. Herbaceous and woody perennial weeds can vary significantly by species for when best to apply herbicides. In general, apply systemic herbicides to perennials is when the source/sink movement of sugars is towards the underground structures, typically optimized when the perennial is in early bloom stage or in the fall when temperature begin to cool. Applications of these herbicides made in earlier growth stages, when movement is upward from underground structures to shoots and foliage, provides only control of top growth, with essentially no effect on the perennial structures. The addition of mechanical weed control techniques can substantially improve herbicide efficacy on perennials. Mowing or clipping the weed one or more times causes significant reductions in underground food reserves because the plant is forced to produce new top growth. When the weed reaches the early bloom stage following clipping, relatively less of the systemic herbicide is required to produce a lethal concentration in the depleted perennial structure.

	Do not apply									
	Less than optimal but potentially effective depending on your specific geography and weather									
	Optimal timing of application									
Weeds	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	
Winter annual weeds (chickweed, henbit, horseweed, etc.)	█	█								█
Summer annual weeds (fleabane, pigweed, ragweed, perilla mint, etc.)				█	█	█				
Spiny pigweed				█	█	█				
Biennial weeds (burdock, wild carrot, poison hemlock, bull thistle, spotted knapweed, etc.)	█	█								█
Musk thistle										█
Herbaceous Perennials										
Buttercup, ssp., plantains										█
Dandelion	█	█								█
Dock spp.	█	█								█
Dogfennel				█	█	█				
Garlic, Wild	█	█								█
Horsenettle, Carolina										
Dogbane, Hemp						█	█	█		
Milkweed, common						█	█	█		
Pokeweed	█	█								
Star-of-Bethlehem	█	█								
Thistle, Canada				█	█	█				█
Woody Perennials										
Barberry, Japanese				█	█	█				█
Brambles (<i>Rubus</i> spp.)				█	█	█				█
Olive, Autumn				█	█	█				█
Rose, Multiflora				█	█	█	█	█		
Sumac				█	█	█	█	█		

Table 5.88 - Accurate Herbicide Volume and Weight Measurements for Small Volume Applications

Common conversion factors							
Liquid Products	Quart (qt)	Pint (pt)	Cup	Fluid Ounces (fl oz)	Tablespoon (Tbspn)	Teaspoon (tsp)	Milliliter (ml)
1 gallon	4	8	16	128	256	768	3785
1 quart	–	2	4	32	64	192	946
1 pint	–	–	2	16	32	96	473
1 cup	–	–	–	8	16	48	237
1 fl oz	–	–	–	–	2	6	29.57
1 tbsp	–	–	–	–	–	3	14.8
1 tsp	–	–	–	–	–	–	4.9
Dry Products:							
1 pound (lb) = 16 oz-wt = 453.6 grams (gr)							
1 oz wt = 28.35 grams (gr)							

Spot-spray, wiper bar, or other small-area applications often require preparation of a small volume of spray solution. Backpack sprayers usually have a 1- to 3-gallon capacity. Spray concentrations for liquid herbicide formulations can be as low as 0.05 fl oz (1.5 ml) per gallon, and concentrations for dry herbicide formulations as low as 0.01 oz wt (0.28 gr) per gallon. Inaccurate measurement of these very small concentrations can cause large deviations above or below the intended application rate, resulting in possible crop damage, carryover, or poor weed control. For example, when measuring a pint of liquid herbicide, a deviation of 0.5 ml, which is equivalent to 6 drops from a dropper, would result in a negligible increase or decrease of 0.1% from the intended rate. However, the same 6 drop deviation when measuring 1.5 ml of a liquid herbicide would result in an unacceptable rate increase or decrease of 33%.

Most liquid measuring devices intended for use with agricultural products are good for measuring large volumes (pints, quarts, gallons), but they are usually not accurate below a volume of 10 fl oz (296 ml). Two types of measuring devices are available for low volumes that are accurate and easy to use. Graduated cylinders are tall, narrow cylinders with milliliter graduations along the outside of the tube. They are available in durable polypropylene material that can be washed and reused. They are available in sizes ranging from 10 ml (0.34 fl oz) with 0.2-ml increments to 4,000 ml (1.06 gal) with 50-ml increments. Pouring liquid herbicides into small graduated cylinders from large containers can be difficult. Disposable syringes are probably the cleanest and most accurate way to measure small volumes of liquid herbicide. Although they are termed disposable, they can be easily dismantled, washed, and reused several times. Buy syringes without the needles if possible, or remove and dispose of needles before use to avoid possible injury or exposure to the herbicide through a skin puncture. A syringe is essential for measuring volumes of less than 0.17 fl oz (5 ml) and can be purchased in sizes ranging from 3 ml with 0.1-ml increments up to 60 ml with 1-ml increments. A good arrangement of measuring devices to have for medium- to small-volume measurements includes a 250-ml graduated cylinder with 2-ml graduations, and 3-ml, 10-ml, and 60-ml syringes.

For dry products, postal scales measuring to 0.1 oz wt are adequate for weights above 1 oz wt (28.4 gr). A gram scale accurate to 1/100 of a gram (0.01 gr) should be used for measuring weights of less than 1 oz wt. Converting products measured by mass (oz wt or grams) into volume (teaspoons, tablespoons, or milliliters) is not practical because of the variability in the density (weight per given volume) of individual products. If sufficiently accurate weighing devices are not available, dry products requiring low concentrations should not be used for small-volume applications.

Table 5.89 - Herbicides Labeled for Farmstead Use

This table lists several herbicides available for use in farmstead areas. Farmstead areas may include areas around buildings (storage buildings, poultry houses, greenhouses, etc.), non-grazed fencerows, non-irrigation ditch banks, unpaved lanes, or other non-cropped agricultural areas where selective weed control or bare ground is desired. Some herbicide labels allow grazing or haying of treated areas within or around these sites, others do not. Many of these herbicides are toxic to desirable plants when spray particles contact either above-ground plant parts, bare roots, and/or the soil where plant roots have penetrated. Most of these products should not be used on impervious surfaces such as paved or highly compacted areas. Runoff from treated impervious surfaces or transport of treated soils by erosion can severely injure or kill susceptible non-target plants. Do not apply these products directly to water, and exercise caution when using these products near irrigation or domestic water supplies. Many of these products are not recommended for use on highly permeable soils and/or soils with groundwater near the soil surface. Read herbicide labels carefully to determine allowed uses, environmental risks, human risks, desirable plant species tolerance, weed species susceptibility, application types, use rates, adjuvant requirements, and specific grazing or haying restrictions.

Trade Name	Components (ai or ae/gal or lb)	Soil Residual ¹ (yes/no)	Grass Control	Broadleaf Control	Woody Plant and Vine Control	Grazing Restriction (days)	Haying Restriction (days)
2,4-D (various formulations)	(varies) 2,4-D	no	no	yes	few	0–7	7
Arsenal 2AS	2 lb imazapyr	yes	yes	yes	yes	0	7
Cimarron Max CoPack	Part A (dry) 0.6 lb metsulfuron Part B (liquid) 1 lb dicamba 2.87 lb 2,4-D	yes	no	yes	several	0–7	37
Cimarron Plus 63WG	0.48 lb metsulfuron 0.15 lb chlorsulfuron	yes	no	yes	several	0	0
Crossbow 3L	2 lb 2,4-D 1 lb triclopyr	limited	no	yes	several	0–NS ²	14
dicamba	4 lb dicamba	no	no	yes	several	0–40	0–70
Escort / Metsulfuron ³ 60WG	0.6 lb metsulfuron	yes	no	yes	few	0	0
EsplAnade 200SC	1.67 lb indaziflam	yes	yes	yes	no	do not	do not
Glyphosate (various formulations)	(varies) glyphosate	no	yes	yes	several	0–56	0–56
Karmex80DF / Direx 4L	0.8 lb diuron	yes	yes	yes	no	not specified	not specified
PastureGard HL 4L	3 lb triclopyr 1 lb fluroxypyr	limited	no	yes	several	0–NS ²	14
Payload 51WG	0.51 lb flumioxazin	yes	yes	yes	no	do not	do not
Pramitol 25E	2 lb prometon	yes	yes	yes	no	not specified	not specified
Prowl3.3EC	3.3 lb pendimethalin	yes	yes	yes	no	do not	do not
Prowl H2O	3.87 lb pendimethalin	yes	yes	yes	no	see label	see label

Table 5.89 - Herbicides Labeled for Farmstead Use (cont.)

Trade Name	Components (ai or ae/gal or lb)	Soil Residual ¹ (yes/no)	Grass Control	Broadleaf Control	Woody Plant and Vine Control	Grazing Restriction (days)	Haying Restriction (days)
Sahara 70DG	0.078 lb imazapyr 0.62 lb diuron	yes	yes	yes	many	not specified	not specified
Solicam 78.6DF	0.79 lb norflurazon	yes	yes	yes	no	do not	do not
Spike 20P	0.2 lb tebuthiuron	yes	no	yes	many	0	365
Starane Ultra / Vista 2.8L	2.8 lb fluroxypyr	limited	no	yes	no	7	14
Stinger 3L	3 lb clopyralid	limited	no	yes	no	0	0
Velpar 2L or 75DF	2 lb hexazinone	yes	yes	yes	several	60–365	60–365
Weedmaster 3.87L	2.87 lb 2,4-D 1 lb dicamba	no	no	yes	several	0–7	37

¹ Herbicides listed as having limited soil residual activity may, for a short time, provide residual control or suppression of some species, and can injure or kill susceptible desirable plants through soil activity.

² NS=next season after application

³ Not on all metsulfuron labels.

Tobacco

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Soil Texture

Herbicide performance and safety are highly influenced by soil texture and organic matter content. Herbicide rates are usually higher for fine versus coarse soil textures and with increasing percentages of organic matter content. In general, high herbicide rates may be necessary for fine-textured soils with at least 1% to 2% organic matter. Use the low recommended herbicide rate when soil organic matter is less than 1%, regardless of soil texture. Soil textures are described in herbicide recommendations as:

Coarse - Sands; loamy sands; sandy loams

Medium - Sandy clay loams; loams; silt loams; silts

Fine - Clay loam; silty clay loams; clays

Soil Preparation

All weed growth and crop stubble must be thoroughly worked into the soil prior to application of most herbicides used in tobacco fields. The soil should be moist and loose with all clods broken down.

Spray Equipment

ALWAYS clean, check, and calibrate sprayers before use to ensure correct herbicide spray volume and uniform spray pattern. Apply liquid, wettable powder, and dry flowable herbicide formulations in 20 to 40 gallons of water per acre using a standard low-pressure (25 to 50 psi) boom sprayer. Poast must be applied in 5 to 20 gallons of water per acre at 40 to 60 psi using hollow-cone or flat-fan nozzles. Maintain continuous agitation, and never leave a spray mixture in the tank overnight.

Preplant Incorporated (PPI)

Apply herbicides in an even broadcast application before planting. **Avoid spray overlap.** Use boom sprayer equipped with fan-type (8004, etc.), flood-jet (TK4, etc.), or raindrop nozzles. Incorporate herbicide immediately after application (see label) with the following:

1. **Disc** (Combination, tandem, double-disc, disk harrow, or similar equipment) - Set to cut 4 to 6 inches deep and operate in two different directions (at right angles to each other) at 4 to 6 mph. A disc set to cut 4 to 6 inches will incorporate herbicide in the top 1 to 2 inches of soil.

Precautions - Avoid use of a large field disc. Discs should be set no more than 8 inches apart and be no wider than 24 inches in diameter. **A single cultivation does not adequately incorporate herbicides, and may increase crop injury and decrease weed control.** Incorporation with implements set to cut less than 2 inches deep may result in erratic weed control. Using incorporation equipment and tractor speeds not listed on the label may result in poor or erratic weed control and/or crop injury.

2. **PTO-driven equipment** (tillers, cultivators, hoes) - Set to cut 3 to 4 inches deep and operate one time at 4 mph. This type of equipment performs best on coarse soil types. PTO-driven equipment should not be operated at a speed greater than 4 mph.
3. Other equipment can be used, but proper procedures should be followed. Read labels or manufacturer's directions.

Overtop after Transplanting

Herbicides labeled for this use can be sprayed, either in a band or broadcast, onto freshly prepared soil within 7 days of transplanting. Cultivation is required, immediately before or at time of application, if the application is made more than 2 days after transplanting or if significant rain has fallen since transplanting.

1. **Band application** - Apply herbicide in a 14- to 24-inch band over the row using fan-type, even-spray nozzles (8004E, etc.). Refer to label and product information on this type of application. The amount of herbicide required per crop acre is

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reduced with band application and can be determined by the following formula: **Banded product rate/acre = Band width (inches)/Row spacing (inches) x Broadcast product rate.**

- Broadcast** - Apply herbicide in an even broadcast application with a sprayer equipped with fan-type nozzles (8004, etc.).

Layby

Labeled herbicides can be applied as a directed spray to weed-free row middles immediately after the last normal cultivation. Application should be made using commercially available drop nozzles equipped with flood-jet flat (TK2, TK4, etc.) or even flat-fan (8004E, etc.) nozzles in order to spray a 16- to 30-inch band between rows. In fields where the spray boom passes over the same row-middle twice, use nozzles which apply one-half the normal number of gallons per acre to prevent over-application. Use the following formula to determine the amount of product to use with band application: **Product/acre for band treatment = Band width (inches)/Row spacing (inches) x Broadcast rate of product/A.** One-half inch of water is usually necessary within 7 to 10 days after application for herbicide activation.

No-till

Aim (carfentrazone) or Spartan Charge (sulfentrazone + carfentrazone) may be used as a pretransplant burndown treatment. Command 3ME and Devrinol DF may be applied at transplanting. Irrigation or rainfall may be needed to wash Devrinol off mulch and onto the soil surface.

Weeds

A herbicide should be selected based on the most important weeds in each field. The majority of the herbicides used in tobacco will control grasses and a limited number of broadleaf weeds. Herbicide applications to heavier soils may be somewhat less effective than in sandier or "lighter" soils. These differences are indicated in Tables 5.90 and 5.91 below.

Relative Effectiveness of Herbicides for Tobacco

Table 5.90 - Grasses and Nutsedge¹

	Barnyardgrass	Bermudagrass	Broadleaf Signalgrass	Crabgrass	Crowfoot grass	Fall Panicum	Foxtails	Goosegrass	Johnsongrass (seedling)	Johnsongrass (rhizome)	Nutsedge	Texas Panicum
Aim	N	N	N	N	N	N	N	N	N	-	N	N
Command & generics	E	P-F	G-E	G-E	E	G-E	G-E	E	F-G	P	P	G
Devrinol	G	P	G	G-E	E	G	G-E	E	F	P	N-P	-
Poast	G-E	G	E	G	F	G-E	G-E	G	G-E	F	N	E
Prowl & generics	G	P	G	G-E	E	G	G-E	E	G	P	N-P	G
Spartan & generics	F	P	F	F	F	F	F	F	P	P	G-E	F

¹E = 90 to 100% control; G = 75 to 90%; F = 50 to 75%; P = Less than 50%; N = no control. This table gives general ratings of relative herbicidal activity. Activity varies with weather conditions, soil type, and application method. Under non-optimal conditions, activity may be less than indicated.

Table 5.91 - Broadleaf Weeds¹

	Black Nightshade	Carpetweed	Cocklebur	Galinsoga	Jimsonweed	Lambsquarters	Morningglory	Pigweed	Purslane	Prickly sida	Ragweed, Common	Ragweed, Giant	Sicklepod	Smartweed	Velvetleaf
Aim	–	–	G	P	G	G	E	E	G	P	N	N	P	G	–
Command & generics	P	P	F	F-G	F-G	G	P	P	F-G	G-E	F-G	P-F	P	G	G
Devrinol	P	G	N-P	P-F	N-P	F-G	N-P	F-G	G-E	P	F	N-F	P	P	P
Poast	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Prowl & generics	N	G	N-P	P	N-P	G	P	G	G	P	P	N-P	P	P	F
Spartan & generics	G	G	F-G	F-G	G	G-E	G-E	G-E	G	G	P	P	P	G	F

¹E = 90 to 100% control; G = 75 to 90%; F = 50 to 75%; P = Less than 50%; N = no control. This table gives general ratings of relative herbicidal activity. Activity varies with weather conditions, soil type, and application method. Under non-optimal conditions, activity may be less than indicated.

Effect of PPI Applications on Early-season Growth of Tobacco

Preplant herbicides may delay plant growth during the first month after transplanting, but under favorable growing conditions any delay should be minimal and should not effect yield. Herbicide application factors that can enhance root injury include: 1) improper incorporation; 2) incorrect rates for soil texture; 3) poor spray technique or equipment. Applying tobacco herbicides at transplanting and/or after the last cultivation will eliminate possible delays in plant growth from herbicide residues already present in soil prior to transplanting.

Effect of Herbicide on Small Grain Crops

Residues of some tobacco herbicides (Command and Devrinol applied PPI) may affect the growth of small grain crops following tobacco (as indicated on product labels). If the small grain is grown only as a cover crop, the problem may not be serious. The potential for carry-over can be reduced by: 1) using minimum labeled rates of the chemicals; 2) band applications of labeled products at transplanting and/or at layby; 3) early stalk and root destruction; 4) deep plowing before seeding of small grain.

Table 5.92 - Field-grown Tobacco

Weed problem	Soil ¹ Texture	Chemical; lbs Active Ingredient/A	Product; Rate/A	Application ² Method	Remarks
Pigweed, lambsquarters, nightshade, purslane, smartweed, velvetleaf, spurred anoda, carpetweed, cocklebur, cotton, groundcherry, morningglory, common ragweed		carfentrazone	Aim	Burndown, shielded, directed	<u>HRAC Group E</u> . Use a Crop Oil Concentrate (1% v/v). <i>Spray solution will cause extensive burn to broadleaf plants (and tobacco leaves) on contact</i> . Pre-transplant interval = 1 day; pre- harvest interval = 6 days. For directed sprays to flue-cured tobacco (only), direct nozzles toward the base of tobacco plants, at least 3 to 4 inches above the soil, to spray <i>beneath</i> the plant canopy. Read precautionary statements.
		0.012-0.024	0.5-1.0 oz		
			Aim EC or Aim EW		
		0.013-0.023	0.8-1.5 fl oz.		
Barnyardgrass, broadleaf signalgrass, crabgrass, field sandbur (suppression), foxtails, seedling johnsongrass, lambsquarters, fall panicum, velvetleaf, jimsonweed, prickly sida, purslane, spurred anoda, venice mallow, common ragweed, smartweed, cocklebur (suppression), shattercane		clomazone	Command 3ME	PPI, OT	<u>HRAC Group F4</u> . Use the higher rate for heavy weed pressure or heavy soils. Best results are obtained when the product is incorporated no more than 1 inch deep. Transplants should be planted so that roots are below the treated area. OT applications must be made within 7 days of transplanting. Read precautionary statements.
			Willowood Clomazone 3ME		
	Coarse	0.75	2.0 pt		
	Fine	1.0	2.7 pt		
Barnyardgrass, carpetweed, crabgrass, fall panicum, foxtails, goosegrass, johnsongrass from seed, lambsquarters, pigweed, common purslane, ragweed (suppression), rye- grass. Check label for uncommon weeds.		napropamide	Devrinol 2EC or Devrinol 2-XT	PPI only	<u>HRAC Group K3</u> . Incorporate the same day as applied. Small grain injury may result from PPI application. Use high rate for burley in southwest Virginia. Read precautionary statements.
	Coarse	1.0	2.0 qt		
	Medium	1.0-1.5	2.0-3.0 qt		
	Fine	2.0	4.0 qt		
				Devrinol 50DF or Devrinol DF-XT	
	Coarse	1.0	2.0 lb		
	Medium	1.0-1.5	2.0-3.0 lb		
	Fine	2.0	4.0 lb		

Table 5.92 - Field-grown Tobacco (cont.)

Weed problem	Soil ¹ Texture	Chemical; lbs Active Ingredient/A	Product; Rate/A	Application ² Method	Remarks	
Grass weeds and Volunteer small grain	All types	sethoxydim	Poast	post-emergence	HRAC Group A. Apply to actively growing grasses at 40-60 psi in 5-20 gal/A through hollow cone or flat-fan nozzles. May be banded or applied broadcast. Do not apply more than 4 pt/A/season. Read precautionary statements.	
	Single use:	0.28	1.5 pt + 2.0 pt oil concentrate			
	Sequential use:	0.19	1.0 pt + 2.0 pt oil concentrate			
Annual spurge, barnyardgrass, carpetweed, crabgrass, crowfootgrass, Florida pusley, foxtails, goosegrass, johnsongrass from seed, lambsquarters, panicums, pigweed, purslane, signalgrass. Check label for uncommon weeds.		pendimethalin	Prowl 3.3EC		HRAC Group K1. Use on transplanted tobacco. Apply up to 60 days prior to transplanting; incorporate within 7 days after application. Use highest rate of Acumen specified for each soil type. May also be applied in a band in row middles at layby. Read precautionary statements.	
	Coarse	0.74-0.99	1.8-2.4 pt	PPI only		
	Medium	0.74-1.24	1.8-3.0 pt			
	Fine	0.99-1.24	2.4-3.0 pt			
	Coarse	0.50-0.74	1.2-1.8 pt	Layby only		
	Medium	0.74-0.99	1.8-2.4 pt			
	Fine	0.74-0.99	1.8-2.4 pt			
			Acumen Satellite 3.3			
	Coarse		2.4 pt	PPI only		
	Medium		2.4 pt			
	Fine		3.0 pt			
	Coarse		1.8 pt	Layby only		
	Medium		2.4 pt			
	Fine		2.4 pt			
			Prowl H ₂ O Satellite HydroCap			
Coarse	0.95	2.0 pt	PPI only			
Medium	0.95-1.19	2.0-2.5 pt				
Fine	1.19	2.5 pt				
Coarse	0.71	1.5 pt	Layby			
Medium	0.95	2.0 pt				
Fine	0.95	2.0 pt				

Table 5.92 - Field-grown Tobacco (cont.)

Weed problem	Soil ¹ Texture	Chemical; lbs Active Ingredient/A	Product; Rate/A	Application ² Method	Remarks			
Hairy galinsoga, goosegrass, groundcherry, jimsonweed, lambsquarters, morning-glory (except pitted), wild mustard, nightshade, nutsedge, orchardgrass, fall panicum, pigweed, prickly sida, broadleaf signalgrass, Pennsylvania smartweed. Suppresses: most grasses, foxtail, cocklebur, sparges. Check label for uncommon weeds.	<u>Coarse</u> <1.5%OM 1.5-3%OM >3%OM	0.14-0.19	4.5-6.0 fl.oz.	After bedding, before transplanting	HRAC Group 14. Apply to soil surface after field has been prepared for planting. Apply within 14 days of transplanting. Where raised beds are used, apply after beds are knocked down for planting. If soil must be worked after application, do not disturb soil below a 2 inch depth. Do not apply at or after transplanting. Maximum rates for Shutdown are 11.8 fl.oz./A for all soil textures. Read precautionary statements.			
		0.19-0.25	6.0-8.0 fl.oz.					
		0.25-0.32	8.0-10.1 fl.oz.					
	<u>Medium</u> <1.5%OM 1.5-3%OM >3%OM	0.19-0.25	6.0-8.0 fl.oz.					
		0.25-0.32	8.0-10.1 fl.oz.					
		0.32-0.38	10.1-12.0 fl.oz.					
	<u>Fine</u> <1.5%OM 1.5-3%OM >3%OM	0.25	8.0 fl.oz.					
		0.32	10.1 fl.oz.					
		0.38	12.0 fl.oz.					
	Pre-Emergent: Same as Spartan 4F. Check label for uncommon weeds, as well as weed control spectrum for Post-Emergent, Pre- Plant Burndown applications.	<u>Coarse</u> <1.5%OM 1.5-3%OM >3%OM	0.14-0.19 + 0.016-0.021			5.6-7.6 fl.oz.	Burndown, preplant surface application, PPI	HRAC Group 14. May be surface applied or preplant incorporated (less than 2 inches) from 14 days to 12 hours before transplanting. Beds must be knocked down before applying the product. If not incorporated, timely cultivation after transplanting is required for acceptable weed control. Tobacco may be re-planted in treated soil, but do not retreat or re-bed field. Read precautionary statements.
			0.19-0.25 + 0.021-0.028			7.6-10.2 fl.oz.		
			0.25-0.32 + 0.028-0.035			10.2-12.8 fl.oz.		
<u>Medium</u> <1.5%OM 1.5-3%OM >3%OM		0.19-0.25 + 0.021-0.028	7.6-10.2 fl.oz.					
		0.25-0.32 + 0.028-0.035	10.2-12.8 fl.oz.					
		0.32-0.38 + 0.035-0.042	12.8-15.2 fl.oz.					
<u>Fine</u> <1.5%OM 1.5-3%OM >3%OM		0.25 + 0.028	10.2 fl.oz.					
		0.32 + 0.035	12.8 fl.oz.					
		0.38 + 0.042	15.2 fl.oz.					

¹ When the soil type has less than 1% organic matter, use the rate for the coarse soil texture recommendations. **Coarse** - Sands; loamy sands; sandy loams. **Medium** - Sandy clay loams; loams; silt loams. **Fine** - Clay loam, silty clay loam; clays.

² PPI - Preplant incorporated. Delay in growth may result under adverse weather conditions and/or when poor application practices have been used. OT - Overtop after transplanting as a band or broadcast applications. Layby - Application of herbicide to row-middle after last cultivation. Burndown, shielded, directed - broadcast spray before transplanting (burndown), or shielded/hooded spray to row-middles only (shielded), or spray directed toward row-middles and surface of row beds after sequential harvesting of flue-cured tobacco has removed sufficient leaves that the spray will not contact remaining crop leaves (directed).

Precautionary and Restriction Statements

Read all directions, cautions, precautions, and special precautions on each product label.

Aim EC, EW (carfentrazone)

As a contact burndown herbicide for broadleaf weeds, Aim may be applied (1) to kill cover crops prior to no-till transplanting, (2) as a shielded or hooded spray to row middles before layby, or (3) as a directed spray following first harvest of flue-cured tobacco. Spray solution will cause extensive burn to broadleaf plants (and tobacco leaves) on contact. Don't spray when conditions favor drift, such as wind above 10 mph. Don't apply more than 2 oz of Aim or 3 fl oz. of Aim EC or EW per acre per season.

Command 3ME and Caravel (clomazone)

Apply only as specified on the label. Command and Caravel may be tank-mixed with other EPA-registered tobacco herbicides and can be impregnated on dry bulk fertilizer. Bottom leaves of tobacco plants in treated soil may whiten or yellow temporarily, but the crop should grow out of this with no adverse effect on yield or quality. Avoid spraying Command or Caravel within 300 feet of susceptible and desirable plant species, as spray drift can cause foliar whitening or yellowing of some plants. Do not apply Command or Caravel within 1,200 feet of residences, towns, subdivisions, or commercial vegetable or fruit nurseries or greenhouses. Small grains should not be planted in the fall or following spring after product use.

Devrinol 50DF, DF-XT, 2EC, 2-XT (napropamide)

Do not apply more than a total of 2 lb of active ingredient per acre in any one season. After harvest or prior to planting succeeding crops, a deep moldboard or disk plowing operation must be carried out. Do not seed to alfalfa, small grain, sorghum, or corn for 12 months after applying a napropamide herbicide. Injury to rotational crops is lessened by band versus broadcast application. When Devrinol is applied after transplanting or at layby, rainfall or overhead irrigation following application improves weed control.

Poast (sethoxydim)

When mixing Poast, fill sprayer 1/2-2/3 full of water. Add oil concentrate (preferably highly refined vegetable oil) first, with agitation. Add Poast last with remaining volume of water, also with agitation. Agitation must be maintained during application. Do not apply Poast (1) at rates above 1.5 pt/A in the field; (2) to exceed 4 pt/A/season; (3) when grasses are under stress; (4) if rainfall is expected within 1 hour; (5) with any other pesticide, additive, or fertilizer except as specified on the Poast label; (6) through any type of irrigation system; (7) within 42 days of harvest.

Prowl 3.3EC, Satellite 3.3, Prowl H₂O, Satellite HydroCap and Acumen (pendimethalin)

Applied according to directions and under normal growing conditions, pendimethalin should not harm transplanted tobacco, but can temporarily retard growth under stressful conditions (cold/wet or hot/dry weather). *Layby applications should be made as a directed spray in a 16- to 24-inch band centered between rows. Broadcast rates for layby applications must be adjusted based on the width of the intended spray band and soil texture.* Any spray contacting tobacco leaves may cause deformations. Crop injury may result if winter wheat and winter barley are planted in the fall (after a spring application) when no-till planting procedures are used. Do not feed forage or graze livestock for 75 days after planting wheat or barley in treated land.

Spartan 4F, Blanket 4F, Shutdown, and Sulfentrazone 4SC (sulfentrazone)

Do not use in tobacco greenhouses, impregnate on fertilizer, or apply after transplanting. Do not apply to soils classified as sands that contain less than 1 percent organic matter or shallow groundwater. Don't incorporate more than 2 inches deep or perform tillage operations that may concentrate the product in the bed. *Most tobacco fields in Virginia contain coarse to medium-textured soils. The 8 to 10 fl.oz. rates are appropriate for these conditions. Crop injury can occur when incorporation is poor, transplants are set too shallow, or heavy rain falls near transplanting.* Splashing of treated soil onto young tobacco can cause localized burning. Don't apply sulfentrazone herbicides more than once per site per season. See label for rotational crop restrictions.

Spartan Charge (sulfentrazone + carfentrazone)

Do not use in tobacco greenhouses. May be tank-mixed with liquid fertilizer, but perform a jar test before mixing to ensure compatibility. See label for instructions. Do not apply to soils classified as sands that possess less than 1 percent organic matter. Broadcast applications require at least 10 gallons of water per acre. Don't incorporate more than 2 inches deep or perform tillage operations that may concentrate the product in the bed. *Most tobacco fields in Virginia contain coarse to medium-textured soils. The 5.7 to 12.8 fl.oz. rates are appropriate for these conditions. Crop injury can occur when incorporation is poor, transplants are set too shallow, or heavy rain falls near transplanting.* Splashing of treated soil onto young tobacco can cause localized burning. Don't apply Spartan Charge more than once per site per season. See label for rotational crop restrictions. The following table presents rates of Spartan Charge with rates equivalent to those in Spartan 4F:

SPARTAN CHARGE CONVERSION TABLE	
Rate of Spartan Charge	Rate of Spartan 4F
5.7 fl oz/acre	4.5 fl oz/acre
7.6 fl oz/acre	6.0 fl oz/acre
10.2 fl oz/acre	8.0 fl oz/acre
12.8 fl oz/acre	10.1 fl oz/acre
15.2 fl oz/acre	12.0 fl oz/acre

Do not seed small grains within 4 months of application, or plant cotton within 18 months or canola within 24 months. See label for other crop rotational restrictions.

Weed Control in Peanuts

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Effective weed management is essential for profitable peanut production. Peanuts are not very competitive with weeds and thus require higher levels of weed control than most other agronomic crops to avoid yield losses. Weeds may also decrease digging efficiency, so effective late-season weed control can minimize losses during harvest. A weed management program in peanuts consists of good weed control in rotational crops; cultivation, if needed; establishment of a satisfactory stand and growing a competitive crop; and proper selection and use of herbicides. Finally, weeds interfere with fungicide movement into the peanut canopy, often referred to as deposition, and this can negatively affect disease control.

1. *Crop rotation.* Rotate peanuts with corn, cotton, or grain sorghum to help manage various pests, including weeds. Crop rotation allows the use of different herbicides on the same field in different years. Crop and herbicide rotation, along with good weed control in the rotational crops, helps prevent the buildup of problem weeds and helps keep the overall weed population at lower levels. Crop rotation will also help reduce the chance of developing populations of weeds that are resistant to herbicides.
2. *Cultivation.* Cultivation can supplement chemical weed control. However, cultivation can damage the crop and reduce yield if not done properly. Moving soil onto the lower branches and around the base of the plants causes physical damage and enhances development of stem and pod diseases. Deep cultivation also destroys residual herbicide barriers and brings up additional weed seeds. Cultivate when peanuts are small. Set sweeps to run flat and shallow to avoid throwing soil onto the peanut plants. Generally, in-season cultivation of peanuts is not recommended.
3. *Weed identification and scouting.* All fields, regardless of the crop being grown, should be surveyed for weeds between mid-August and the first killing frost. Record the weed species present and note the general level of infestation of each species (light, moderate, or heavy). Weeds present in the fall will be the ones most likely to be problems the following year. Knowing what problems to expect allows you to better plan a weed management program for the following crop. Scout peanut fields weekly from planting through mid-July to determine if or when postemergence herbicide treatment is needed. Proper weed identification is necessary because species respond differently to various herbicides. Contact your county Extension center for aid in weed identification. Timely application of postemergence herbicides is critical for effective control. Cultivation may be more appropriate if herbicide-resistant biotypes increase in prevalence.

Comments of Peanut Herbicides

Preplant Burndown Herbicides

Glyphosate (various formulations) and Gramoxone SL (other formulations are available) are relatively nonselective herbicides that control many of the winter weeds present in reduced tillage fields (Table 5.93). Harmony Extra and 2,4-D (various formulations) can also be applied. Harmony Extra can be applied no closer to planting than 45 days before planting. 2,4-D should be applied at least 30 days before planting.

Preplant Incorporated, Preemergence, and Postemergence Herbicides

Numerous herbicides are labeled for use in peanuts (Tables 5.93, 5.94, 5.95). Timely application of the appropriate herbicide at the correct rate is essential for successful weed control in peanuts. Additional information on feeding restrictions of peanut hay (Table 5.96), suggested rain-free period to maintain control (Table 5.97), and rotation restrictions on herbicide use (Table 5.98) are provided.

Reduced Rates of Herbicides

When crop prices are low, producers are looking for ways to reduce production costs. One possibility is to reduce the application rate of herbicides. Under certain environmental conditions and with certain weed species or weed complexes, specific herbicides can be applied below the manufacturer's suggested use rate without sacrificing weed control. However, growers are cautioned that herbicides applied at reduced rates often do not control weeds adequately when environmental conditions (soil moisture in particular) do not favor herbicide activity. Applying herbicides at reduced rates to large weeds or weeds that are "hardened" often results in poor control as well. Weeds can also be more difficult to control if they were injured by herbicide

with previous treatment. Using reduced rates will require that growers apply herbicides in a timelier manner and when weeds are not stressed. Regardless of the previously mentioned factors relative to reduced rates, manufacturers of herbicides will not back up their products when they are applied below the suggested use rate. Liability falls exclusively to the grower.

Compatibility of Agrochemicals

Compatibility is an important consideration when applying two or more products in the same tank. See chapter 9 for more information on agrochemical compatibility. Consult product labels, chapter 8, and your county Extension agent for more information on agricultural chemical compatibility.

Table 5.93 - Chemical Weed Control in Peanuts

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Preplant Incorporated, Annual grasses and small-seeded broadleaf weeds		
alachlor, MOA 15 (Intro 4 EC)	2 to 3 (2 to 3 qt)	Incorporate no deeper than 2 inches; see label for specific instructions. Unless shallowly incorporated, Intro is more consistently effective when applied preemergence. Weak on Texas panicum. Do not apply more than 3 qt of Intro per acre per season. Before using Intro, check with buyers to determine if there are marketing restrictions on Intro-treated peanuts.
acetochlor, MOA 15 (Warrant 3 ME)	0.94 to 1.5 (1.25 to 2 qt)	Apply and incorporate in top 2 inches of soil. Do not apply more than 4 qt of Warrant per acre per year.
ethalfuralin, MOA 3 (Sonalan 3 EC)	0.56 to 0.75 (1.5 to 2 pt)	Controls common annual grasses including Texas panicum. Use 3 pt Prowl or 2 pt ethalfuralin for control of broadleaf signalgrass, Texas panicum, and fall panicum. Incorporate 3 inches deep for Texas panicum; otherwise, incorporate 2 to 3 inches deep. See labels for maximum waiting period between application and incorporation. Immediate incorporation is best. Dual Magnum, Outlook, or Warrant may be tank mixed with Prowl or Sonalanto suppress yellow nutsedge.
pendimethalin, MOA 3 (Prowl H2O 3.8 EC) (Prowl 3.3 EC)	0.71 to 1.43 (1.5 to 3 pt) (1.7 to 3.5 pt)	
Preplant Incorporated, Annual grasses, small-seeded broadleaf weeds, and nutsedge		
dimethenamid, MOA 15 (Outlook 6.0 L)	0.75 to 1 (16 to 21 fl oz)	Apply and incorporate in top 2 inches of soil within 14 days of planting. Use high rate of Dual Magnum, Dual, or Outlook for yellow nutsedge and broadleaf signalgrass. Not effective on purple nutsedge. Weak on Texas panicum. May be tank mixed with Prowl or Sonalan.
metolachlor, MOA 15 (Dual Magnum 7.62 EC) (Dual 8 EC)	0.95 to 1.27 (1 to 1.33 pt) (1.5 to 2 pt)	

Table 5.93 - Chemical Weed Control in Peanuts (cont.)

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Preplant Incorporated, Broadleaf weeds and suppression of nutsedge		
diclosulam, MOA 2 (Strongarm 84 WDG)	0.024 (0.45 oz)	Effective on common cocklebur, morningglory, common ragweed, eclipta, and common lambsquarters. Suppresses yellow and purple nutsedge. Does not control sicklepod. More effective when applied in combination with Dual, Outlook, Warrant, Prowl, or Sonalan. See label for rotation restrictions, especially corn and grain sorghum. Growers are cautioned that Strongarm can occasionally injure cotton the following year on soils with a shallow hardpan (less than 10 inches) and/or loam soils. Cotton grown under early season stress resulting from conditions such as excessively cool, wet, dry, or crusted soils may be particularly susceptible to carryover of Strongarm. The rotation interval between applying Strongarm to peanut and then planting cotton is 18 months in Camden, Currituck, Pasquotank, and Perquimans counties. Some weed species have developed resistance to Strongarm including common ragweed and Palmer amaranth.
Preplant Incorporated, Annual grasses, broadleaf weeds, and suppression of nutsedge		
diclosulam, MOA 2 Strongarm	0.024 (0.45 oz)	Effective on annual grasses, common cocklebur, common ragweed, eclipta, morningglory, and common lambsquarters. Suppresses purple and yellow nutsedge. Does not control sicklepod. See Strongarm label for rotation restrictions.
+	+	
pendimethalin, MOA 3 (Prowl H2O 3.8 EC) (Prowl 3.3 EC)	0.71 to 1.43 (1.5 to 3 pt) (1.7 to 3.5 pt)	
or	or	
ethalfluralin, MOA 3 (Sonalan 3 EC)	0.56 to 0.75 (1.5 to 2 pt)	
or	or	
metolachlor, MOA 15 (Dual Magnum 7.62 EC) (Dual 8 EC)	0.95 to 1.27 (1 to 1.33 pt) (1.5 to 2 pt)	
or	or	
dimethenamid (Outlook 6.0 L)	0.75 to 1 (16 to 21 fl oz)	
or	or	
acetochlor (Warrant 3 ME)	0.95 to 1.5 (1.24 to 2 qt)	

Table 5.93 - Chemical Weed Control in Peanuts (cont.)

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
PPI followed by PRE, Annual grasses, broadleaf weeds, and suppression of nutsedge		
pendimethalin, MOA 3 (Prowl H2O 3.8 EC) (Prowl 3.3 EC)	0.71 to 1.43 (1.5 to 3 pt) (1.7 to 3.5 pt)	Controls most broadleaf weeds. Will not control sicklepod and is marginal on certain large-seeded broadleaf weeds. Do not incorporate Valor SX. Valor SX should be applied to the soil surface immediately after planting. Significant injury can occur if flumioxazin is incorporated or applied 3 or more days after planting. Significant injury from Valor SX has been noted in some years even when applied according to label recommendations. However, injury is generally transient and does not affect yield. See previous comments about cotton response to Strongarm applied the previous year on some soils. Up to 3 oz per acre of Valor SX can be applied to peanut but injury potential increases. See product label for sprayer cleanup before other uses.
or	or	
ethalfuralin, MOA 3 (Sonalan 3 EC)	0.56 to 0.75 (1.5 to 2 pt)	
or	or	
metolachlor, MOA 15 (Dual Magnum 7.62 EC) (Dual 8 EC)	0.95 to 1.27 (1 to 1.33 pt) (1.5 to 2 pt)	
or	or	
dimethenamid, MOA 15 (Outlook 6.0L)	0.75 to 1 (16 to 21 oz)	
or	or	
acetochlor, MOA 15 (Warrant 3 ME)	0.95 to 1.5 (1.24 to 2 qt)	
followed by		
diclosulam, MOA 2 (Strongarm 84 WDG)	0.024 0.45 oz	
or	or	
flumioxazin, MOA 14 (Valor SX 51 WDG)	0.063 (2 oz)	
Split application (PPI + POST), Most broadleaf weeds and nutsedge		
imazethapyr, MOA 2 (Pursuit 2 AS)	0.031 + 0.031 (2 + 2 oz)	Effective on most common broadleaf weeds and yellow and purple nutsedge. Does not control eclipta, lambsquarters, ragweed, or croton. Pursuit will usually control seedling johnsongrass and foxtails. For control of other annual grasses, Pursuit may be tank mixed with Dual Magnum, Dual, Outlook, Prowl H2O, Prowl, or Sonalan and incorporated. See label for incorporation directions and rotational restrictions. Some weed species have developed resistance to Pursuit. Research in N.C. has generally shown more effective control of a broader spectrum of weeds with split applications of half of the Pursuit applied preplant incorporated followed by the other half applied early postemergence.

Table 5.93 - Chemical Weed Control in Peanuts (cont.)

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Preemergence, Annual grasses and small-seeded broadleaf weeds		
alachlor, MOA 15 (Intro 4 EC)	2 to 3 (2 to 3 qt)	Apply as soon after planting as possible. All herbicides are weak on Texas panicum. Before using Intro, check with buyers to determine if there are marketing restrictions on Intro-treated peanuts.
dimethenamid, MOA 15 (Outlook 6.0 L)	0.75 to 1 (16 to 21 fl oz)	
metolachlor, MOA 15 (Dual Magnum 7.62 EC) (Dual 8 EC)	0.95 to 1.27 (1 to 1.33 pt) (1.5 to 2 pt)	
acetochlor (Warrant 3 ME)	0.95 to 1.5 (1.25 to 2 qt)	An alternative MOA for the control of Palmer amaranth and other small seeded broadleaf and grass weeds. Brake will cause temporary peanut injury in the form of bleaching. Plant peanut at least 1.5" deep. Apply prior to planting (up to 14 days) or preemergence within 36 hours after planting. Brake needs at least 0.5" of moisture for activation as soon as possible.
fluridone, MOA 12 (Brake 1.2 SL)	0.1125-0.15 (12-16 oz)	
Preemergence, Broadleaf weeds		
flumioxazin, MOA 14 (Valor SX 51 WDG)	0.063 (2 oz)	Apply within 2 days after planting. Significant injury can occur if Valor SX is incorporated or applied 3 or more days after seeding. Controls carpetweed, common lambsquarters, Florida pusley, nightshade, pigweeds, prickly sida, and spotted spurge. Does not control sicklepod, yellow and purple nutsedge, or annual grasses. Morningglory control is marginal where Valor SX is applied at 2 oz per acre. Significant injury from Valor SX has been noted in some years even when applied according to label recommendations. However, injury is generally transient and does not affect yield. Injury may occur if excessive and forceful rainfall occurs when peanut is emerging. Peanut recovers from injury by midseason in most instances. Up to 3 oz per acre of Valor SX can be applied to peanut, but injury potential increases. See product label for comments on sprayer cleanup before other uses.

Table 5.93 - Chemical Weed Control in Peanuts (cont.)

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Preemergence, Annual grasses, broadleaf weeds, and suppression of nutsedge		
flumioxazin, MOA 14 (Valor SX 51 WDG)	0.063 (2 oz)	Apply within 2 days after planting. Significant injury can occur if applied 3 or more days after planting. The combination of Valor SX and Dual, Dual Magnum, Warrant, or Outlook does not control sicklepod but will control annual grasses (except Texas panicum) and will suppress yellow nutsedge. Valor SX and Warrant will not suppress yellow nutsedge. Significant injury from Valor SX has been noted in some years even when applied according to label recommendations. However, injury is generally transient and does not affect yield. Injury may occur if excessive and forceful rainfall occurs when peanut is emerging. Peanut recovers from injury by midseason in most instances. Up to 3 oz per acre of Valor SX can be applied to peanut but injury potential increases. See product label for comments on sprayer cleanup before other uses.
+	+	
metolachlor, MOA 15 (Dual Magnum 7.62 EC) (Dual 8 EC)	0.95 to 1.27 (1 to 1.33 pt) 1.5 to 2 pt)	
or	or	
dimethenamid, MOA 15 (Outlook 6.0L)	0.75 to 1 (16 to 21 fl oz)	
or	or	
acetochlor, MOA 15 (Warrant 3 ME)	0.94 to 1.5 (1.25 to 2 qt)	
diclosulam, MOA 2 (Strongarm 84 WDG)	0.024 (0.45 oz)	Effective on common cocklebur, morningglory, common ragweed, eclipta, and common lambsquarters. Suppresses yellow and purple nutsedge. Does not control sicklepod. More effective when applied in combination with Dual, Dual Magnum, Outlook, Prowl, Sonalan, or Warrant. See label for rotation restrictions, especially corn and grain sorghum. See previous comments on possible cotton injury from Strongarm applied the previous year on some soils.
sulfentrazone, MOA 14	0.07 to 0.12	Do not apply Spartan Charge after peanuts crack soil. Application immediately after planting is advised. See label for specific rates based on soil texture and organic matter content. See product label for comments on application with other herbicides. Rotation restriction for planting cotton following Spartan Charge at recommended rates for peanut is 12 months.
+		
carfentrazone, MOA 14 (Spartan Charge (0.35 + 3.15 F))	(3 to 5 fl oz)	
diclosulam, MOA 2 (Strongarm 84 WDG)	0.024 (0.45 oz)	Effective on annual grasses, common cocklebur, common ragweed, eclipta, morningglory, and common lambsquarters. Suppresses purple and yellow nutsedge. Does not control sicklepod. See label for rotation restrictions. Some weed species have developed resistance to Strongarm. See previous comments on carryover potential to cotton on some soils and restrictions on planting corn or grain sorghum after use in peanut.
+	+	
metolachlor, MOA 15 (Dual Magnum 7.62 EC) (Dual 8 EC)	0.95 to 1.27 (1 to 1.33 pt) 1.5 to 2 pt)	
or	or	
dimethenamid, MOA 15 (Outlook 6.0 L)	0.75 to 1 (16 to 21 oz)	
or	or	
acetolchlor, MOA 15 (Warrant 3 ME)	0.94 to 1.5 (1.25 to 2 qt)	

Table 5.93 - Chemical Weed Control in Peanuts (cont.)

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Preemergence, Most annual broadleaf weeds and nutsedge		
imazethapyr, MOA 2 (Pursuit 2 AS)	0.063 (4 fl oz)	Effective on most common broadleaf weeds and yellow and purple nutsedge. Does not control ragweed, eclipta, lambsquarters, or croton. Pursuit may be tank mixed with Dual, Dual Magnum, Warrant, or Outlook for annual grass control. See label for rotational restrictions. Some weed species have developed resistance to Pursuit. Research in N.C. has generally shown more effective control of a broader spectrum of weeds with split applications of half of the Pursuit applied preplant incorporated followed by the other half applied early postemergence.
Cracking stage, Emerged annual grasses and broadleaf weeds		
paraquat, MOA 22 (Gramoxone 2.5 SL) (Parazone 3 SL)	0.13 (11 oz) (8 oz)	Apply at ground cracking for control of small emerged annual grasses and broadleaf weeds. May be tank mixed with Dual, Dual Magnum, Outlook, or Warrant for residual control. Tank mix may increase injury to emerged peanuts. Add 1 pint nonionic surfactant per 100 gallons spray solution. Follow all safety precautions on label. Applying Basagran at 0.5 pt per acre will reduce injury.
Cracking stage and Postemergence, Additional residual control of annual grasses and certain small-seeded broadleaf weeds		
alachlor, MOA 15 (Intro 4 EC)	2 to 3 (2 to 3 qt)	Use as a supplement to preplant or preemergence herbicides to provide additional residual control of annual grasses and certain small-seeded broadleaf weeds such as pigweed and eclipta. This treatment will not control emerged grasses or broadleaf weeds. See product labels for recommended tank mixtures with contact and systemic herbicides with foliar activity on weeds. With the exception of Anthem Flex, these herbicides do not provide appreciable control of weeds that have emerged. Total amount of Warrant that can be applied PRE + early POST = 8 pt/A/year. Do not apply Zidua preemergence to peanuts. For Zidua, total of 2 applications (5 oz/A of 4.17SC/year) can be applied.
dimethenamid, MOA 15 (Outlook 6.0L)	0.75 to 1 (16 to 21 oz)	
metolachlor, MOA 15 (Dual Magnum 7.62 EC) (Dual 8 EC)	0.95 (1 pt) (1.5 pt)	
acetochlor, MOA 15 (Warrant 3 ME)	0.95 to 1.5 (1.25 to 2 qt)	
pyroxasulfone, MOA 15 (Zidua 4.17SC)	0.08 to 0.11 (2.4 to 3.3 oz)	
Pyroxasulfone, MOA 15 +	0.073 +	
Carfentrazone, MOA 15 (Anthem Flex)	0.005 (2.5 oz)	

Table 5.93 - Chemical Weed Control in Peanuts (cont.)

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Cracking stage, Most annual broadleaf weeds and nutsedge		
imazethapyr, MOA 2 (Pursuit 2 AS)	0.063 (4 oz)	Effective on most common broadleaf weeds and yellow and purple nutsedge. Does not control ragweed, eclipta, lambsquarters, or croton. If weeds are emerged, add surfactant or crop oil according to label directions. See label for rotational restrictions. Pursuit may be tank mixed with paraquat. Some weed species have developed resistance to Pursuit.
Cracking stage, Some emerged broadleaf weeds and suppression of eclipta and yellow nutsedge		
diclosulam, MOA 2 (Strongarm 84 WDG)	0.024 (0.45 oz)	Strongarm can be applied through the cracking stage. Add 1 quart nonionic surfactant per 100 gallons. The spectrum of weeds controlled is much narrower when applied to emerged weeds. Strongarm will not control emerged common lambsquarters or pigweeds but will control common ragweed and morningglories and will suppress yellow nutsedge and eclipta. See product labels for information on mixing Strongarm with other herbicides. Some weed species have developed resistance to Strongarm. See product label for carryover potential to cotton, corn, and grain sorghum. Strongarm suppresses emerged marestail and dogfennel more effectively than other postemergence broadleaf herbicides when applied to small weeds.
Postemergence, Annual broadleaf weeds		
acifluorfen, MOA 14 (Ultra Blazer 2 L)	0.25 to 0.38 (1 to 1.5 pt)	Apply when weeds are small and actively growing. Use minimum of 20 GPA and high pressure (40 to 60 psi). See label for species controlled, maximum weed size to treat, and addition of surfactant. Do not apply more than 2 pints per acre per season. May make sequential applications of 0.25 pound followed by 0.25 pound per acre. Allow at least 15 days between sequential applications. Can be applied with residual herbicides for improved control.
acifluorfen, MOA 14 (Ultra Blazer 2 L)	0.25 to 0.38 (1 to 1.5 pt)	Addition of 2,4-DB to Ultra Blazer improves control of certain weeds when weed size exceeds that specified on the Ultra Blazer label. See label suggestions on use of surfactant or crop oil. Apply when peanuts are at least 2 weeks old and before pod filling begins. Can be applied with residual herbicides for improved control.
+	+	
2,4-DB, MOA 4 (Butyrac 200 2 L)	0.25 (16 fl oz)	

Table 5.93 - Chemical Weed Control in Peanuts (cont.)

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Postemergence, Annual broadleaf weeds (cont.)		
bentazon, MOA 6 (Basagran 4 L) (Basagran 5 L)	0.75 to 1 (1.5 to 2 pt) (1 to 1.5 pt)	Apply when weeds are small and actively growing. Use minimum of 20 GPA and high pressure (40 to 60 psi). See label for addition of oil concentrate, species controlled, and maximum weed size to treat. Basagran (4L) may also be applied at 1 pint per acre for control of cocklebur, jimsonweed, and smartweed 4 inches or less. Two applications (7-10 days apart) will be required for the control of yellow nutsedge. Do not apply more than 4 pints (4L formulation) of bentazon per acre per season. Can be applied with residual herbicides for improved control.
bentazon, MOA 6 (Basagran 4 L) + acifluorfen, MOA 14 (Ultra Blazer 2 L)	0.5 to 1 (1 to 2 pt) + 0.25 to 0.38 (1 to 1.5 pt)	See above comments for Ultra Blazer and Basagran. See labels for weeds controlled, maximum weed size to treat, and use of adjuvants. Can be applied as a tank mixture or as Storm 4L. Can be applied with residual herbicides for improved control.
bentazon, MOA 6 + acifluorfen, MOA 14 (Storm 4L)	0.5 + 0.25 (1.5 pt)	These rates of bentazon and acifluorfen (Ultra Blazer and Basagran) may not provide consistent control of lambsquarters, prickly sida, spurred anoda, and morningglory. Can be applied with residual herbicides for improved control.
bentazon, MOA 6 (Basagran 4 L) + acifluorfen, MOA 14 (Ultra Blazer 2 L) + 2,4-DB, MOA 4 (Butyrac 200 2 L)	0.5 (1 pt) + 0.25 (1 pt) + 0.125 to 0.25 (8 to 16 fl oz)	Adding 2,4-DB will improve control of larger morningglory, cocklebur, common ragweed, pigweed, jimsonweed, and citron. Add surfactant or crop oil according to label directions. Apply when peanuts are at least 2 weeks old. Do not apply after pod filling begins. See comments for Ultra Blazer and Basagran alone. Can be applied with residual herbicides for improved control.
bentazon, MOA 6 (Basagran 4 L) + 2,4-DB, MOA 4 (Butyrac 200 2 L)	0.75 to 1 (1.5 to 2 pt) + 0.125 (8 fl oz)	Addition of 2,4-DB to Basagran improves control of morningglories. See above comments for Basagran. Add surfactant or crop oil according to label directions. Do not make more than two applications per year. Apply when peanuts are at least 2 weeks old and not within 45 days of harvest. Can be applied with residual herbicides for improved control.

Table 5.93 - Chemical Weed Control in Peanuts (cont.)

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Postemergence, Annual broadleaf weeds (cont.)		
imazapic, MOA 2 (Cadre 2 AS) (Impose 2 AS)	0.063 (4 fl oz)	Controls most broadleaf weeds except ragweed, croton, lambsquarters, and eclipta. Apply before weeds exceed 2 to 4 inches; see label for specific weed sizes to treat. Add nonionic surfactant at 1 quart per 100 gallons or crop oil concentrate at 1 quart per acre. A soil-applied grass control herbicide should be used. However, Cadre will usually control escaped broadleaf signalgrass, large crabgrass, fall panicum, and Texas panicum but not goosegrass. Cadre can be mixed with Cobra, Ultra Blazer, and 2,4-DB. See label for rotational restrictions. Some weed species have developed resistance to Cadre. Can be applied with residual herbicides for improved control.
imazethapyr, MOA 2 (Pursuit 2 L)	0.063 (4 fl oz)	Effective on most common broadleaf weeds and yellow and purple nutsedge. Does not control eclipta, lambsquarters, ragweed, or croton. Apply when weeds are 3 inches tall or less. Add surfactant or crop oil according to label directions. See label for rotational restrictions. Pursuit may be tank mixed with Basagran, Ultra Blazer, Gramoxone, and 2,4-DB. Some weed species have developed resistance to Pursuit.
2,4-DB, MOA 4 (Buryrac 200 2 L)	0.2 to 0.25 (12 to 16 fl oz)	Effective on cocklebur and morningglory; pitted morningglory may be only partially controlled. Best results achieved when applied to small weeds. May use two applications per year. Do not apply within 45 days before harvest.
lactofen, MOA 14 (Cobra 2 EC)	0.2 (12.5 fl oz)	Apply after peanuts have at least six true leaves. Apply to actively growing peanut. Controls most annual broadleaf weeds. See label for species controlled and maximum weed size to treat. Add nonionic surfactant at 1 quart per 100 gallons or crop oil concentrate or methylated seed oil at 1 to 2 pints per acre. See label on when to use various adjuvants. Allow at least 14 days between applications. Can be tank mixed with Basagran, Pursuit, Cadre, 2,4-DB, and/or Select. Can be applied with residual herbicides for improved control. Other formulations of lactofen are available.
lactofen, MOA 14 (Cobra 2 EC)	0.2 (12.5 fl oz)	See above comments for Basagran and Lactofen alone. See labels for weeds controlled, maximum weed size to treat, and use of adjuvants. Can be applied with residual herbicides for improved control.
+	+	
bentazon, MOA 6 (Basagran 4 L)	0.75 to 1 (1.5 to 2 pt)	

Table 5.93 - Chemical Weed Control in Peanuts (cont.)

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Postemergence, Annual broadleaf weeds (cont.)		
lactofen, MOA 14 (Cobra 2 EC)	0.2 (12.5 fl oz)	Adding 2,4-DB will improve control of larger morningglory, cocklebur, common ragweed, jimsonweed, and citron. See above comments for bentazon, lactofen, and 2,4-DB. See labels for weeds controlled, maximum weed size to treat, and use of adjuvants. Can be applied with residual herbicides for improved control.
+	+	
bentazon, MOA 6 (Basagran 4 L)	0.75 to 1 (1.5 to 2 pt)	
+	+	
2,4-DB, MOA 4 (Butyrac 200 2 L)	0.125 to 0.25 (8-16 fl oz)	
lactofen, MOA 14 (Cobra 2 EC)	0.2 (12.5 fl oz)	See above comments for imazapic and lactofen. See labels for weeds controlled, maximum weed size to treat, and use of adjuvants. Some weed species have developed resistance to Cadre. Can be applied with residual herbicides for improved control.
+	+	
imazapic, MOA 2 (Cadre 2 AS) (Impose 2 AS)	0.063 (4 fl oz)	
lactofen, MOA 14 (Cobra 2 EC)	0.2 (12.5 fl oz)	See above comments for imazethapyr and lactofen. See labels for weeds controlled, maximum weed size to treat, and use of adjuvants. Some weed species have developed resistance to Pursuit.
+	+	
imazethapyr, MOA 2 (Pursuit 2 AS)	0.063 (4 fl oz)	
paraquat, MOA 22 (Gramoxone 2 SL) (Parazone 3 SL)	0.13 (11 fl oz) (8 fl oz)	See label for weeds controlled and maximum weed size to treat; best results if weeds 1 inches or less. A postemergence application may be made following an at-crack application. Do not make more than two applications per season, do not apply later than 28 days after ground cracking, and do not apply if peanuts are under stress or have significant injury from thrips feeding. Gramoxone is more effective when applied within 2 weeks after peanut emergence. Add 1 pint of nonionic surfactant per 100 gallons of spray solution. Will cause foliar burn on peanuts, but peanuts recover, and yield is not affected. Follow all safety precautions on label. Can be applied with residual herbicides for improved control.
paraquat, MOA 22 (Gramoxone 2 SL) (Parazone 3 SL)	0.13 (11 oz) (8 oz)	See previous comments for paraquat alone. Adding Basagran improves control of common ragweed, prickly sida, smartweed, lambsquarters, and cocklebur and reduces injury to peanuts from paraquat. May be applied any time from ground cracking up to 28 days after ground cracking. Add 1 pint of nonionic surfactant per 100 gallons of spray solution. Can be applied with residual herbicides for improved control.
+	+	
bentazon, MOA 6 (Basagran 4 L)	0.25 to 0.75 (0.5 to 1.5 pt)	

Table 5.93 - Chemical Weed Control in Peanuts (cont.)

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Postemergence, Annual broadleaf weeds (cont.)		
paraquat, MOA 22 (Gramoxone 2 SL) (Parazone 3 SL)	0.13 (11 fl oz) (8 fl oz)	See previous comments for paraquat alone. Storm improves control of common ragweed, smartweed, lambsquarters, common cocklebur, tropic croton, and spurred anoda. May be applied anytime from ground cracking up to 28 days after ground cracking. Add 0.5 pint of nonionic surfactant per 100 gallons of spray solution. The mixture of Gramoxone SL and Storm is more injurious than these herbicides applied alone. Can be applied with residual herbicides for improved control.
+	+	
bentazon, MOA 6	0.5	
+	+	
acifluorfen, MOA 14 (Storm 4 L)	0.25 (1 pt)	
Postemergence, Florida beggarweed		
chlorimuron, MOA 2 (Classic 0.25 DF)	0.008 (0.5 oz)	Use only for control of Florida beggarweed. Apply from 60 days after crop emergence to within 45 days of harvest. Application to peanuts less than 60 days old will result in crop injury and yield reduction. Some peanut varieties are more sensitive to classic compared with others, not all varieties have been tested for Classic use. Apply before Florida beggarweed has begun to bloom and before it has reached 10 inches tall. Larger beggarweed may only be suppressed. Add 1 quart of nonionic surfactant per 100 gallons spray solution; do not add crop oil. May be tank mixed with 2,4-DB; see label for rates and precautions. Recommended as a salvage treatment only.
Postemergence, Yellow nutsedge		
bentazon, MOA 6 (Basagran 4 L)	0.75 to 1 (1.5 to 2 pt)	Apply when nutsedge is 6 to 8 inches tall. A repeat application 7 to 10 days later may be needed. Adding crop oil concentrate at 1 quart per acre will increase control. Do not apply more than 2 pints of Basagran per season. Not effective on purple nutsedge.
Postemergence, Yellow and purple nutsedge		
imazapic, MOA 2 (Cadre 2 AS) (Impose 2 AS)	0.063 (4 fl oz)	Apply postemergence when nutsedge is 4 inches or less. Add nonionic surfactant at 1 quart per 100 gallons or crop oil concentrate at 1 quart per acre. See label for rotational restrictions.
imazethapyr, MOA 2 (Pursuit 2 AS)	0.063 (4 fl oz)	Apply before nutsedge is larger than 3 inches tall. Add surfactant at 1 quart per 100 gallons or crop oil concentrate at 1 quart per acre. Do not mix with Basagran for nutsedge control. See label for rotational restrictions. A split application with half of the Pursuit applied preplant incorporated and half applied early postemergence may be more effective than applying all of the Pursuit at one time.

Table 5.93 - Chemical Weed Control in Peanuts (cont.)

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Postemergence, Annual grasses		
clethodim, MOA 1 (Select Max 0.97 EC) (Various "2 EC" formulations)	0.094 to 0.125 (9 to 16 fl oz) (6 to 8 fl oz)	Apply Select and Poast to actively growing grass not under drought stress. Consult labels for maximum grass size to treat. Apply in 5 to 20 GPA at 40 to 60 psi. Do not cultivate within 7 days before or after application. Add 2 pints crop oil to Poast. See label for adjuvant use with Select or Select Max. Some broadleaf/sedge herbicides and fungicides can reduce the efficacy of Select and Poast when applied in tank mixtures. See product labels for specific instructions concerning compatibility with other chemicals. Apply the highest rate of a clethodim product when tank mixing with broadleaf/sedge herbicides or fungicides.
sethoxydim, MOA 1 (Poast 1 EC) (Poast Plus 1.5 EC)	0.19 (1.5 pt) (1 pt)	
Postemergence, Bermudagrass		
clethodim, MOA 1 (Select Max 0.97 EC) (Various "2 EC" formulations)	0.125 to 0.25 (12 to 32 fl oz) (8 to 16 fl oz)	Apply to actively growing bermudagrass before runners exceed 6 inches. In most cases, a second application will be needed. Make second application if regrowth occurs. See comments under annual grasses for adjuvant selection and tank mixing for these herbicides.
sethoxydim, MOA 1 (Poast 1 EC) (Poast Plus 1.5 EC)	0.28 (2.25 pt) (1.5 pt)	
Postemergence, Rhizome johnsongrass		
clethodim, MOA 1 (Select Max 0.97 EC) (Various "2 EC" formulations)	0.125 to 0.25 (12 to 32 fl oz) (8 to 16 fl oz)	Apply to actively growing johnsongrass before it exceeds 25 inches tall. Add 2 pints per acre of crop oil concentrate. A second application of the same rates can be made if needed before new plants or regrowth exceeds 12 inches.
sethoxydim, MOA 1 (Poast 1 EC) (Poast Plus 1.5 EC)	0.28 (2.25 pt) (1.5 pt)	

Table 5.93 - Chemical Weed Control in Peanuts (cont.)

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Postemergence, Suppression of large Palmer amaranth and other pigweed species that are resistant to the ALS inhibiting herbicides imazapic, chlorimuron, imazethapyr, and diclosulam		
2,4-DB, MOA 4 (Buryrc 200 2 SL)	0.25 (16 fl oz)	Suppresses and does not completely control Palmer amaranth and other pigweed species that exceed 8 inches. Suppression of weeds exceeding 12 inches will be less than suppression of smaller weeds. Do not expect suppression to exceed 60%. Applying 2,4-DB 3 to 4 days prior to Ultra Blazer or Cobra may be more effective than tank mixtures of 2,4-DB with Ultra Blazer or Cobra. Cobra is generally more effective on larger Palmer amaranth and other pigweed species than Ultra Blazer. Apply crop oil concentrate at 1 gallon per 100 gallons water with acifluorfen or lactofen. See product labels for comments on spray volume and effects on peanut especially during pod set and pod fill. Higher spray volumes are more effective by increasing spray coverage of the contact herbicides Ultra Blazer and Cobra. Two applications of 2,4-DB spaced 10 to 14 days apart will suppress Palmer amaranth and other pigweed species. Although suppression by 2,4-DB is lower than sequential or tank mix application of 2,4-DB and acifluorfen or lactofen within two weeks after application, suppression by sequential applications of 2,4-DB 4 to 5 weeks after initial application is only slightly lower than suppression by sequential or tank mix application of 2,4-DB and Ultra Blazer or Cobra.
+	+	
lactofen, MOA 14 (Cobra 2 EC)	0.20 (12.5 fl oz)	
or	or	
acifluorfen, MOA 14 (Ultra Blazer 2 L)	0.38 (1.5 pt)	
2,4-DB, MOA 4 (Butyrac 200 2 SL)	0.25 (16 fl oz)	
then	then	
lactofen, MOA 14 (Cobra 2 EC)	0.20 (12.5 fl oz)	
or	or	
acifluorfen, MOA 14 (Ultra Blazer 2 L)	0.38 (1.5 pt)	
2,4-DB, MOA 4 (Butyrac 200 2 L)	0.25 (16 oz)	
then	then	
2,4-DB, MOA 4 (Butyrac 200 2 L)	0.25 (16 oz)	
paraquat, MOA 22 (Gramoxone SL)	See comments	Apply in a roller/wiper implement. Best control achieved when at least 60% coverage of weed foliage occurs. Do not allow paraquat to contact peanut foliage. Mix 1 part Gramoxone SL (other formulations may not be labeled) with 1 to 1.5 parts water to prepare 40 to 50% solution. Add nonionic surfactant at 1 quart per 100 gallons. Adjust equipment to apply up to 2 pints per acre of the herbicide-water mixture.

Table 5.93 - Chemical Weed Control in Peanuts (cont.)

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Postemergence, Late-season residual control of annual grasses and certain small-seeded weeds		
dimethenamid, MOA 15 (Outlook 6.0 L)	0.75 to 1 (16 to 21 fl oz)	Will not control emerged grasses or weeds; apply following a cultivation or appropriate postemergence herbicide if emerged grasses or broadleaf weeds are present. Benefit likely only on very sandy fields heavily infested with annual grasses that receive above normal rainfall during the first 4 to 5 weeks of the growing season. Lay-by of Dual Magnum, Outlook, Warrant, or Anthem Flex may also be of value in fields with a history of eclipta problems; the application must be made before eclipta emerges. Rates are on a broadcast basis; apply in an 18-inch band to row middles. Anthem Flex also provides post-emergence control of broadleaf weeds. Anthem Flex improves the control of emerged morningglory. This product may cause leaf burn and stunting but does not lead to yield reduction. See labels for preharvest intervals.
metolachlor, MOA 15 (Dual Magnum 7.62 EC)	0.64 to 0.84 (0.67 to 0.88 pt)	
acetochlor, MOA 15 (Warrant 3 ME)	0.95 to 1.5 (1.25 to 2 qt)	
Pyroxasulfone, MOA 15	0.073	
+	+	
Carfentrazone, MOA 15 (Anthem Flex)	0.005 (2.5 oz)	
Postemergence, Harvest Aide for morningglory control		
Carfentrazone, MOA 14 (Aim 2 EC)	0.016 to 0.031 (1.0 to 2.0 oz)	Aim desiccates annual morningglory. Apply with nonionic surfactant at 1 quart per 100 gal or crop oil concentrate at 1 gal per 100 gal within 7 days of optimum pod maturity and digging and vine inversion. Do not apply earlier in the season. Yield reductions occur when applied prior to 7 days before optimum pod maturity.

Table 5.94 - Weed Response to Preplant Incorporated, Preemergence, At-Cracking, and Postemergence Herbicides in Peanuts

Herbicides Key: PPI = Preplant Incorporated; PRE = Preemergence; AC= At-Cracking; POST = Postemergence

	Prowl or Sonalan PPI	Dual Magnum or Dual PPI	Outlook PPI	Strongarm PPI or PRE	Prowl or Sonalan + Strongarm PPI	Pursuit PPI + POST	Dual Magnum or Dual PRE	Intro PRE	Brake PRE	Outlook PRE	Valor SX PRE	Prowl or Sonalan PPI + Valor SX PRE	Dual Magnum, Dual, Outlook or Warrant + Valor SX PRE	Dual Magnum or Dual AC ¹	Intro AC ¹	Outlook AC ¹	Gramoxone SL AC or POST	Strongarm AC ²	Gramoxone + Strongarm AC ²	Zidua, AC ² , or POST ¹	Anthem Flex, AC ² , or POST ¹
Bermudagrass	N	N	N	N	N	N	N	N	P	N	N	N	N	N	N	N	P	N	P	N	N
Black nightshade	N	F	F	F	N	N	F	FG	-	F	E	E	E	F	FG	F	PF	N	G	F	F
Broadleaf signalgrass	G	E	G	FG	P	G	G	FG	FG	FG	P	G	FG	G	FG	FG	E	N	GE	FG	FG
Carpetweed	G	G	FG	FG	G	G	FG	FG	-	G	-	G	G	FG	FG	G	FG	-	G	G	G
Cocklebur	N	N	N	N	G	G	GE	N	G	N	PF	PF	PF	N	N	N	E	E	E	N	N
Common ragweed	N	P	PF	PF	G	G	P	PF	FG	F	FG	G	GE	PF	PF	F	F	E	E	F	F
Crabgrass	E	E	E	E	P	E	F	E	FG	E	PF	E	E	E	E	E	G	N	G	E	E
Crowfootgrass	E	E	E	E	-	-	E	E	-	E	PF	G	G	E	E	E	E	N	GE	E	E
Dayflower	P	GE	-	GE	-	G	-	GE	-	P	-	F	GE	GE	-	-	-	-	G	-	-
Eclipta	N	G	G	FG	G	GE	P	FG	-	FG	G	G	GE	FG	FG	FG	FG	NP	FG	FG	FG
Fall panicum	G	E	E	E	P	E	PF	E	-	E	PF	FG	GE	E	E	E	E	N	GE	E	E
Florida beggarweed	N	PF	PF	F	F	F	P	F	P	F	G	GE	E	F	F	F	E	FG	G	F	F
Foxtails	E	E	E	E	P	E	G	E	FG	E	PF	E	E	E	E	E	E	N	GE	E	E
Goosegrass	E	E	E	E	P	E	PF	E	FG	E	PF	GE	E	E	E	E	E	N	GE	E	E
Jimsonweed	N	N	N	N	GE	G	N	-	N	G	G	GE	N	N	N	N	E	-	E	N	N
Johnsongrass, Seedling	G	G	G	PF	PF	N	G	GE	PF	P	PF	N	FG	PF	PF	PF	E	N	GE	PF	PF
Johnsongrass, Rhizome	P	PF	PF	N	N	N	P	FG	N	N	N	N	N	N	N	N	P	N	P	N	N
Lambsquarters	G	NG	G	F	FG	FG	GE	FG	F	-	FG	GE	GE	F	F	FG	F	N	G	FG	FG
Morningglory	P	P	P	N	N	G	G	N	F	N	FG	G	G	N	N	N	F	GE	E	N	GE

Table 5.94 - Weed Response to Preplant Incorporated, Preemergence, At-Cracking, and Postemergence Herbicides in Peanuts (cont.)

	Prowl or Sonalan PPI	Dual Magnum or Dual PPI	Outlook PPI	Strongarm PPI or PRE	Prowl or Sonalan + Strongarm PPI	Pursuit PPI + POST	Dual Magnum or Dual PRE	Intro PRE	Brake PRE	Outlook PRE	Valor SX PRE	Prowl or Sonalan PPI + Valor SX PRE	Dual Magnum, Dual, Outlook or Warrant + Valor SX PRE	Dual Magnum or Dual AC ¹	Intro AC ¹	Outlook AC ¹	Gramoxone SL AC or POST	Strongarm AC ²	Gramoxone + Strongarm AC ²	Zidua, AC ² , or POST ¹	Anthem Flex, AC ² , or POST ¹
Nutsedge, Yellow	N	G	FG	FG	FG	FG	FG	P	P	F	P	PF	FG	FG	P	F	PF	PF	G	F	F
Nutsedge, Purple	N	N	N	FG	FG	FG	N	N	P	N	P	P	P	N	N	N	PF	NP	PF	N	N
Palmer amaranth and other pigweed	G	E	G	G	E	E	G	GE	GE	GE	E	E	E	G	GE	GE	E	NP	E	GE	GE
Prickly sida	N	P	P	P	FG	FG	P	P	-	P	FG	G	G	P	P	P	F	-	G	P	P
Purslane	G	GE	GE	G	-	G	G	FG	G	G	GE	GE	GE	GE	P	P	-	-	-	G	P
Sicklepod	N	NP	NP	NP	P	P	NP	PF	P	NP	P	PF	PF	NP	PF	NP	G	N	G	NP	NP
Smartweed	N	N	N	N	G	G	N	N	-	N	-	-	-	N	N	N	G	-	E	N	N
Spurge spp.	P	F	F	PF	P	P	F	P	-	F	G	G	G	N	N	N	FG	-	FG	N	N
Spurred anoda	N	N	N	N	FG	FG	N	N	G	N	F	FG	FG	N	N	N	P	-	G	N	F
Texas panicum	G	G	G	PF	P	G	PF	PF	PF	PF	PF	G	F	PF	PF	PF	E	N	GE	F	F
Tropic croton	N	N	N	N	PF	P	N	N	G	N	-	-	-	N	N	N	F	-	F	N	N
Velvetleaf	N	N	N	N	GE	FG	N	N	-	N	F	FG	FG	N	N	N	F	-	FG	N	N

¹Residual control only (except morningglory control by Anthem Flex).
²Assumes weeds are 1- to 2-inches tall or smaller.
 Key:
 E = Excellent control, 90% or better G = Good control, 80%-90% F = Fair control, 50%-80%
 P = Poor control, 25%-50% N = Essentially no control, less than 25%
 Stage: PPI = Preplant soil incorporated POE = Postemergence PRE = Preemergence AC = At cracking

Table 5.95 - Weed Response to Postemergence Herbicides in Peanuts

Herbicides Key: PPI = Preplant Incorporated; PRE = Preemergence; AC= At-Cracking; POST = Postemergence

	Butyrac 200	Gramoxone ¹	Gramoxone + Basagran	Gramoxone + Storm	Basagran	Basagran + Butyrac 200	Ultra Blazer	Ultra Blazer + Butyrac 200	Ultra Blazer + Basagran ²	Storm	Storm + Butyrac 200	Pursuit + Butyrac 200	Cadre or Impose	Cobra	Cobra + Basagran	Cobra + Basagran + Butyrac 200	Cobra + Cadre or Impose	Cobra + Pursuit	Poast or Poast Plus	Clethodim products
Bermudagrass	N	P	P	P	N	N	N	N	P	N	N	N	N	N	N	N	N	N	FG	G
Black nightshade	N	PF	PF	G	P	P	G ¹	G ¹	G ¹	G ¹	G ¹	G	G	G ¹	G ¹	G ¹	G	G	N	N
Broadleaf signalgrass	N	GE	E	GE	N	N	NP	NP	P	NP	NP	G	G	N	N	N	G	G	E	E
Carpetweed	P	FG	FG	G	P	P	GE	E	E	G	G	FG	FG	G	G	G	G	G	N	N
Cocklebur	E	G	E	E	E	E	G	E	E	E	E	E	E	G	G	E	E	E	N	N
Common ragweed	PF	F	G	E	G ⁴	G ⁴	E ¹	E ¹	E ¹	E ¹	E ¹	P	PF	E	E	E	E	E	N	N
Crabgrass	N	G	G	G	N	N	N	N	N	N	N	FG	FG	N	N	N	FG	FG	GE	GE
Crowfootgrass	N	GE	G	GE	N	N	P	P	P	P	P	P	G	N	N	N	G	P	F	G
Dayflower	-	G	G	FG	G	G	-	-	G	FG	FG	-	G	-	G	G	G	-	N	N
Eclipta	P	F	F	FG	FG	FG	G	G	G	FG	FG	P	F	G	G	G	G	G	N	N
Fall panicum	N	GE	G	GE	N	N	PF	PF	P	PF	PF	PF	G	N	N	N	G	PF	E	E
Florida beggarweed	P	G	GE	G	N	P	PF	F	F	P	P	P	F	F	F	F	F	F	N	N
Foxtails	N	GE	G	GE	N	N	PF	PF	P	PF	PF	G	G	N	N	N	G	G	E	E
Goosegrass	N	GE	G	GE	N	N	N	N	N	N	N	N	F	N	N	N	F	N	GE	GE
Jimsonweed	P	G	E	E	E	E	E	E	E	E	E	G	E	E	E	E	E	E	N	N
Johnsongrass, Seedling	N	GE	GE	GE	N	N	P	P	P	P	P	GE	E	N	N	N	E	GE	E	E
Johnsongrass, Rhizome	N	P	P	P	N	N	N	N	N	N	N	F	FG	N	N	N	FG	F	G	GE
Lambsquarters	PF	F	G	G	FG	G ⁴	G	G	GE	G	G	P	PF	P	FG	G	PF	P	N	N
Morningglory, Pitted	FG	F	FG	E	P	G	E	E	E	E	E	G	GE	G	G	G	GE	G	N	N
Morningglory, Others	E	F	FG	E	P	E	GE	E	E	GE	E	E	G	G	G	E	G	E	N	N
Nutsedge, Yellow	N	PF	FG	G	G ³	G	N	N	G	F	F	F	G	N	G ³	G ³	G	F	N	N
Nutsedge, Purple	N	PF	PF	PF	NP	P	N	N	P	N	N	FG	G	N	P	P	G	FG	N	N
Palmer amaranth and other pigweed	PF	G	G	E	N	P	E	E	E	E	E	E	E	E	E	E	E	E	N	N
Prickly sida	F	F	G	G	G	G	N	F	G	FG	G	P	G	G	G	G	G	G	N	N
Purslane	FG	-	G	G	G	G	E	E	E	GE	GE	FG	-	E	E	E	E	E	N	N
Sicklepod	G ³	G	G	G	N	G ⁶	NP	G ⁶	NP	NP	G ⁶	G ⁶	E	P	P	G ⁶	E	F	N	N
Smartweed	PF	G	E	E	E	E	GE	E	E	E	E	G	F	F	E	E	F	G	N	N
Spurge spp.	P	F ¹	F ¹	F ¹	P	P	F ¹	F ¹	F ¹	PF ¹	PF ¹	PF ¹	-	F ¹	F ¹	F ¹	F ¹	-	N	N
Spurred anoda	P	P	FG	G	G	GE	P	P	G	F	F	F	G	F	G	GE	G	F	N	N
Texas panicum	N	GE	G	GE	N	N	NP	NP	NP	NP	NP	NP	G	N	N	N	G	NP	E	E
Tropic croton	PF	F	F	G	F	F	G	G	G	G	G	P	P	G	G	G	G	G	N	N
Velvetleaf	P	F	G	FG	G	G	PF	PF	FG	FG	FG	FG	G	G	G	G	G	G	N	N

Table 5.95 - Weed Response to Postemergence Herbicides in Peanuts (cont.)

Herbicides Key: PPI = Preplant Incorporated; PRE = Preemergence; AC= At-Cracking; POST = Postemergence

¹Assumes weeds are 1 to 2 inches tall or smaller.

²Assumes optimum rates and ratios of Basagran and Blazer; see labels.

³Two applications, 10 to 14 days apart.

⁴Assumes optimum conditions and addition of crop oil concentrate.

⁵Ratings assume weeds in one- to two-leaf stage.

⁶Assumes follow-up treatment with 2,4-DB.

Key:

E = Excellent control, 90% or better G = Good control, 80%-90% F = Fair control, 50%-80%

P = Poor control, 25%-50% N = Essentially no control, less than 25%

Table 5.96 - Restriction on Feeding Peanut Hay to Livestock Following Treatment with Herbicides

Feeding Restricted (Do not feed treated hay to livestock.)	No Feeding Restrictions or Defined Feeding Restrictions*
2,4-DB, Aim, Cadre, clethodim-containing products, Cobra, Impose, Poast, Poast Plus, Pursuit, Sonalan, Storm, Ultra Blazer	Basagran, Dual Magnum, Gramoxone SL, Outlook, Prowl, Zidua

*See product labels for specific information.

Table 5.97 - Suggested Rain-free Periods After Application of Postemergence Herbicides

Herbicide	Rain-free Period (hours)	Herbicide	Rain-free Period (hours)
2,4-DB	NR**	Paraquat	0.5
Arrow	1	Poast	1
Basagran	NR*	Poast Plus	1
Ultra Blazer	NR*	Pursuit	1
Cadre, Impose	3	Select, Select MAX	1
Classic	1	Storm	NR*
Cobra	1		

* No restriction listed on label. Suggest 4 to 6 hours for best results.

** No restriction listed on label. Suggest at least 1 hour for best results.

Table 5.98 - Restrictions on Crop Rotation of Herbicides with Significant Residual Activity Applied to Peanuts

Herbicide	Corn	Cotton	Soybeans	Tobacco	Wheat	Grain Sorghum
Anthem Flex	NR	2 months	NR	9 months	4 – 6 months ***	6 – 12 months ***
Cadre, Impose	9 months	18 months	9 months	9 months	4 months	18 months
Pursuit	NR/8.5 months*	9.5 months/ 18 months*	NR	9.5 months	4 months	18 months
Strongarm	18 months**	9 months	NR	> 18 months	4 months	18 months
Valor SX	NR	NR	NR	NR	4 months	NR
Prowl	Following year	NR	NR	NR	4 months	NR
Outlook	NR	Following year	NR	NR	4 months	NR
Dual Magnum	NR	NR	NR	NR	4.5 months	NR
Warrant	NR	NR	NR	NR	4 months	NR
Zidua	NR	NR	NR	18 months	4 – 6 months ***	6 – 12 months ***

NR = no restriction.

*No restriction and 9.5 months if applied postemergence; 8.5 and 18 months if applied preplant incorporated.

See label on rainfall and temperature requirements.

**No restriction if appropriate IMI-tolerant corn hybrid is planted. See label for specific instructions.

***See label for Anthem Flex and Zidua rates.

Preventing and Managing Herbicide-Resistant Weeds

Populations of weeds that were once controlled by specific herbicides have developed resistance to these herbicides. Historically, the resistance of individual weeds within a population of a species has rarely occurred. However, increased selection pressure and the occurrence of cross and multiple resistance have resulted in increased frequency of herbicide resistance in some peanut fields. Two steps are critical to prevent yield loss from weed interference and preserve herbicide effectiveness: (1) determine whether weed escapes are herbicide resistant, and (2) develop an appropriate management strategy for herbicide-resistant weeds. While most weed escapes are the result of an application error or weather conditions, herbicide resistance is a real threat. Indicators of herbicide resistance, approaches to managing herbicide-resistant weed populations, and classification of resistance potential by mode of action are listed in Tables 5.99 and 5.100. Note that herbicides that are generally not prone to having resistance populations develop can become ineffective if they are used repeatedly without implementation of other weed management practices. The intensity of selection pressure (frequency of application) and likelihood of resistance to develop for a particular herbicide are the two essential elements in determining occurrence of herbicide resistant biotypes. Contact your local Cooperative Extension agent if herbicide resistance is suspected.

In North Carolina and Virginia, populations of Palmer amaranth and common ragweed resistant to acetolactate synthase (ALS) inhibiting herbicides have been confirmed. The effectiveness of the herbicides Cadre, Pursuit, and Strongarm will be less in fields where resistant populations exist. To manage weeds in these fields, growers must use herbicides with a different mode of action from the ALS-inhibiting herbicides. This goal can be accomplished in a variety of ways, including application of herbicide mixtures to broaden the spectrum of control.

While not confirmed, it is speculated that populations of Palmer amaranth resistant to PPO-inhibiting herbicides (Valor SX, Cobra, Ultra Blazer, and Storm) are present in North Carolina. Although PPO-herbicide-resistant weeds have not been documented in Virginia, it has been suggested to prevent weeds escaping PPO-inhibiting herbicides from reproducing when these weed escapes are first observed. Experiences with development of Palmer amaranth resistance to glyphosate and ALS-inhibiting herbicides reminds us that recognizing and addressing resistant populations when they first develop is critical.

Table 5.99 - Identification and Management of Herbicide-Resistant Weeds**Possible reasons why herbicides do not control weeds that are NOT associated with herbicide resistance:**

- Improper herbicide choice or rate.
- Poor or improper application of herbicide.
- Poor timing of herbicide application.
- Weather conditions were not favorable when herbicide was applied.
- Weeds emerged after the postemergence herbicide was applied.
- Other chemicals antagonized the herbicide.

Indicators suggesting that weeds are resistant to herbicides:

- Herbicide normally controls the weed in question.
- Performance poor on one species while other species are controlled well. Poor control is confined to spots in the field.
- Some plants of the weed in question are controlled well while other plants of that species are controlled poorly.
- Field history of heavy use of herbicides with the same mechanism of action.

Steps to take to prevent or manage herbicide resistance:

- Rotate herbicides having different mechanisms of action.
- Use tank mixes or sequential applications of herbicides having different mechanisms of action.
- Be especially vigilant when using herbicides with higher risk of resistance development.
- Integrate nonchemical controls when possible.
- Avoid allowing weeds to produce seeds when herbicide resistance is suspected.

Additional key points:

Although some herbicides inherently are at low risk for resistance development, selection pressure (the frequency of herbicide applications with the same mode of action) can overcome the low or moderate theoretical possibility of resistance developing. Spraying weeds that are large and beyond the recommendation on the herbicide label is equivalent to applying herbicides at rates lower than the recommended labeled rates applied to small weeds. This approach increases the decreases the length of time (number of generations) required for weed populations to become resistant.

Table 5.100 - Herbicide Categories Prone to Have Weeds Develop Resistance

Trade Name	Common Name	Family	MOA
ALS* Inhibitors—Weeds highly susceptible to developing resistance			
Cadre, Impose, Pursuit	imazapic, imazethapyr	Imidazolinone	2
Strongarm	diclosulam	Triazolopyrimidine	2
Classic	chlorimuron	Sulfonyl urea	2

Table 5.100 - Herbicide Categories Prone to Have Weeds Develop Resistance (cont.)

Trade Name	Common Name	Family	MOA
ACCase* Inhibitor—Weeds moderately to highly susceptible to developing resistance			
Arrow, Clethodim, Cleanse, Select, Select MAX, Tapout, Volunteer	clethodim	cyclohexanedione	1
Poast, Poast Plus	sethoxydim	cyclohexanedione	1
Microtubule Assembly Inhibition—Weeds moderately susceptible to developing resistance			
Prowl	pendimethalin	dinitroaniline	3
Sonalan	ethafluralin	dinitroaniline	3
Herbicides at low to moderate risk for resistance development			
Aim	carfentrazone ethyl	aryltriazinone	14
Anthem Flex	pyroxasulfone + carfentrazone ethyl	pyrazole + aryltriazinone	15
Basagran	bentazon	benzothiadiazole	6
Cobra	lactofen	diphenylether	14
Gramoxone SL	paraquat	bipyridilium	22
Dual Magnum	metolachlor	chloroacetamide	15
Intrro	alachlor	chloroacetamide	15
Outlook	dimethenamid	chloroacetamide	15
Spartan Charge	carfentrazone + sulfentrazone	triazolinone + triazolinone	14
Storm	acifluorfen + bentazon	diphenylether + benzothiadiazole	14 + 6
Ultra Blazer	acifluorfen	diphenylether	14
Valor SX (various formulations)	flumioxazin	N-phenylphthalimide derivative	14
Warrant	acetochlor	chloroacetamide	15
Zidua	pyroxasulfone	pyrazole	15
2,4-DB (various formulations)	2,4-DB	phenoxy	4

*ALS = acetolactate synthase; ACCase = acetyl CoA carboxylase; MOA, mode of action.

Table 5.101 - General Recommendations on Herbicides to Use in a Comprehensive Weed Management Program for Peanuts

Herbicide	Timing	Should these herbicides be used?
Prowl or Sonalan	Preplant incorporated	Yes. These herbicides are relatively inexpensive and provide early season control of grasses and small-seeded broadleaf weeds. Although Prowl can be applied preemergence, it is generally more effective incorporated. Sonalan always needs to be incorporated. These herbicides are an important part of a comprehensive weed management strategy and should always be applied.
Dual Magnum (various formulations), Outlook, or Warrant	Preplant incorporated or preemergence	Yes. These herbicides are important in suppressing yellow nutsedge, especially Dual Magnum, and provide control of small-seeded broadleaf weeds including pigweeds. While these herbicides do not control weeds for the entire season, they provide good early-season control and are an important foundation of a comprehensive weed management strategy for peanuts.

Table 5.101 - General Recommendations on Herbicides to Use in a Comprehensive Weed Management Program for Peanuts (cont.)

Herbicide	Timing	Should these herbicides be used?
Valor SX (various formulations) or Strongarm	Preemergence	Yes. Under current situations with increased prevalence of Palmer amaranth and traditional broadleaf weeds such as eclipta, common ragweed, and common lambsquarters, one of these two herbicides is needed in a comprehensive weed management strategy for peanuts. Valor SX provides excellent rotation options for crops grown the following season, while Strongarm will carry over to corn and grain sorghum, and there is some concern about carryover to cotton on some soils. Weeds present, especially Palmer amaranth, that express resistance to Strongarm keep this herbicide from being a complete answer in some fields. Although Valor SX is effective early in the season, the rate used in peanut (2 oz/acre) generally does not control morningglories and will not control other weeds season-long every year.
Brake	Preemergence	Yes. Brake is an alternative MOA for the control of Palmer amaranth and other small seeded broadleaf and grass weeds. Brake will cause temporary peanut injury in the form of bleaching. Plant peanut at least 1.5" deep. Apply prior to planting (up to 14 days) or preemergence within 36 hours after planting. Brake needs at least 0.5" of moisture for activation as soon as possible. Some cultivars may exhibit more foliar injury (bleaching) than other cultivars (cosmetic/no yield loss). Brake should be used in combination with other at-plant residual herbicides such as Dual Magnum, Outlook, Prowl, Sonalan, Strongarm, Valor, Warrant. Crop rotation restrictions: cotton/peanut = 0 months; soybean/sweet potato = 2 months; wheat/barley/rye = 8 months (grain) or 5 months (cover crop only); corn/sorghum = 10 months; sunflower = 18 months; tobacco = 18 months. Do not apply Brake to the same field more than 2 years in a row.
Paraquat plus Basagran plus Anthem Flex, Dual Magnum (various formulations), Outlook, Warrant, or Zidua	At cracking or early postemergence	Yes. Given that Palmer amaranth is present in many fields and that preplant incorporated and preemergence herbicides often are incomplete in control due to weather conditions or poor incorporation, this treatment (paraquat, with Gramoxone SL being the most prevalent commercial product) can often clean up fields when applied on time, taking pressure off of other postemergence options. Basagran reduces injury from paraquat. In fields with known histories of Palmer amaranth and other problematic weeds, applying Anthem Flex, Dual Magnum, Outlook, Warrant, or Zidua with paraquat plus Basagran will improve early-season weed control. Apply paraquat early in the season, no later than 28 days after peanuts emerge, but preferably within the first three weeks. Anthem Flex causes more injury than other residual herbicides, but injury is transient and research data indicate that it does not adversely affect peanut yield.

Table 5.101 - General Recommendations on Herbicides to Use in a Comprehensive Weed Management Program for Peanuts (cont.)

Herbicide	Timing	Should these herbicides be used?
Cobra, Ultra Blazer, Storm, Basagran	Postemergence	Most likely. These herbicides should be applied as needed. In fact, many if not most peanut fields will need at least one application of these herbicides. Weed size has a major impact on the degree of control obtained with these herbicides. If weeds exceed 3 inches, control is often incomplete. When preplant incorporated or preemergence herbicides are not applied or are marginally effective, growers often have to apply repeat applications of these herbicides (Cobra, Storm, Ultra Blazer). Multiple applications in some cases can negatively affect peanut yield. For this reason growers are encouraged to have a comprehensive program of preplant incorporated and preemergence herbicides and apply paraquat plus Basagran to take the pressure off of Cobra, Storm, and Ultra Blazer. Note that Storm does not contain sufficient Ultra Blazer to control Palmer amaranth and other weeds in most cases, so adding additional Ultra Blazer to Storm is recommended in some circumstances. Residual herbicides can be added to improve control (see comments under Paraquat plus Basagran).
Postemergence grass herbicides (clethodim and sethoxydim are active ingredients in these herbicides)	Postemergence	Most likely. Preplant incorporated and preemergence herbicides often control annual grasses through midseason and sometimes late into the season. However, many fields need a postemergence application of sethoxydim (several formulations) or clethodim (several formulations). These herbicides should be applied as needed because grasses often cause peanut pod loss during the digging process.
Cadre, Pursuit	Postemergence	In many cases. Pursuit is used much less often now than in previous years. Cadre (also formulated as Impose) is a very good herbicide that controls yellow and purple nutsedge, annual grasses in many cases, and a range of broadleaf weeds. The challenge with Cadre is presence of resistant Palmer amaranth and carryover potential to cotton and grain sorghum. Cadre continues to be a good option for peanut growers as long as they realize carryover potential and know whether or not resistance to this herbicide is present in certain fields. Residual herbicides can be added to improve control.
2,4-DB	Postemergence	Yes. The broadleaf herbicides mentioned above, with the exception of paraquat, benefit from the addition of 2,4-DB. For example, when Palmer amaranth is slightly larger than the size recommended for complete control by Cobra, Ultra Blazer, or Storm, the inclusion of 2,4-DB can help obtain complete control. 2,4-DB is often effective when applied alone, but this is very species dependent. For example, common cocklebur can be controlled completely by 2,4-DB. 2,4-DB is also a viable option for suppression of escapes of sicklepod and Palmer amaranth when applied sequentially.

Cotton

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Table 5.102 - Early Preplant Burndown and Preplant Incorporated

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Barnyardgrass, broadleaf signalgrass, carpetweed, crabgrass, fall panicum, Florida pusley, foxtails, goosegrass, johnsongrass seedlings, lambsquarters, pigweed, purslane, sandbur, Texas panicum, wild cane, shattercane	Pendimethalin 0.5-0.75 lb ai	Prowl 3.3EC 1.2-1.8 pt or Prowl H ₂ O 3.8ACS 1.1-1.6 pt	Apply and incorporate 1-2 inches deep within 7 days after application. Follow label for proper soil incorporation procedures. Lower rate is safest to cotton.
Barnyardgrass, broadleaf signalgrass, carpetweed, crabgrass, fall panicum, Florida pusley, foxtails, goosegrass, johnsongrass seedlings, lambsquarters, pigweed, purslane, sandbur, Texas panicum, wild cane, shattercane	Trifluralin 0.5-0.75 lb ai	Treflan 4EC 1.0-1.5 pt	Incorporate within 24 hours after application. Follow label for proper soil incorporation procedures. Lower rate is safest to cotton.
Controls most annual grasses and broadleaf weeds	Glyphosate 0.56-1.13 lb ae	Numerous brands and formulations	Apply any time prior to planting. Control of cutleaf eveningprimrose, field pansy, Carolina geranium, and wild radish may not be adequate. Rates suggested for terminating cover crops: Wheat < 12 in.: 0.56 lb ae Wheat > 12 in.: 0.75 lb ae Rye < 12 in.: 0.56 lb ae Rye > 12 in.: 0.75 lb ae
Controls most annual grasses and broadleaf weeds. Better activity on broadleaf weeds compared to glyphosate alone.	Fomesafen 0.25-0.37 lb ai + Glyphosate 0.99-1.5 lb ae	Flexstar GT 3.5EC 3.5-5.3 pt	Apply Flexstar GT 7-14 days before planting. Very effective on glyphosate resistant and ALS-resistant biotypes that has not emerged yet. Apply only to coarse textured soils (sandy loam, loamy sand, sandy clay loam). Rainfall or irrigation (around 0.25") within 7 days of application is required to activate the residual herbicide. Some crinkling or spotting on cotton foliage may occur if heavy rainfall occurs during or soon after emergence.

Table 5.102 - Early Preplant Burndown and Preplant Incorporated (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Many grass and broadleaf weeds	Paraquat 0.65-1 lb ai	Numerous brands and formulations	Apply any time prior to planting to control emerged weeds. Add nonionic surfactant at 1 pt per 100 gal or crop oil concentrate at 1 gal per 100 gal. Follow directions and precautions on label. Not effective on cutleaf eveningprimrose, horseweed, or larger wild mustard and wild radish. Apply 0.63 lb ai for wheat and 0.5 lb ai for rye cover crops.
Many grass and broadleaf weeds	Glufosinate 0.53-0.79 lb ai	Liberty 280 SL 2.34L 29-43 fl oz	Can be applied prior to emergence of any transgenic or conventional cotton variety to control emerged weeds. If applied at rates greater than 29 oz, the seasonal total applied cannot exceed 72 fl oz. Control greatly affected by temperature; apply on a sunny day with temperature above 75 degrees. Two hours of sunshine before a morning application is suggested. Less effective than glyphosate on grasses.
Many broadleaf weeds	2,4-D 0.24-0.95 lb ae	Numerous brands and formulations	Most, but not all, brands of 2,4-D may be applied at least 30 days ahead of cotton planting. Excellent control of cutleaf eveningprimrose. Not effective on Carolina geranium. To control glyphosate-resistant horseweed, 0.95 lb ae is needed. Cotton containing the Enlist trait can be planted anytime following Enlist One application.
Many broadleaf weeds	Glyphosate 0.74-1.0 lb ae + 2,4-D 0.7-0.95 lb ae	Enlist Duo 3.3S 3.5-4.75 pt	Apply at least 30 days ahead of planting any cultivar not containing the Enlist trait. Enlist Duo may be applied through planting for Enlist cultivars. See website listed on Enlist Duo label for details on tank mixing and use of drift reduction agents. Excellent control of cutleaf eveningprimrose. To control glyphosate-resistant horseweed 4.75 pt/A is needed. Current label does not allow tank mixing with other herbicides.

Table 5.102 - Early Preplant Burndown and Preplant Incorporated (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Many broadleaf weeds	Dicamba 0.25 lb ai	Clarity 4S	Following application of dicamba and a minimum of 1 in. of rainfall, a waiting period of at least 21 days is required before planting and cultivar not containing the XtendFlex trait. Engenia and XtendiMax can be applied through planting of XtendFlex cultivars. See websites listed on Engenia and XtendiMax labels for details on tank mixing and use of drift reduction agents. Suppresses Carolina geranium and curly dock. Less effective on cutleaf eveningprimrose than 2,4-D. Clarity will control horseweed. Applicators must hold a VA pesticide license and receive annual training to use Engenia and Xtendimax.
		8 fl oz	
		or	
		Engenia 5S	
		6.4 fl oz	
		or	
		XtendiMax 2.9S	
		11 fl oz	
Lambsquarters, morningglory species, nightshade species, pigweed species, velvetleaf, spurred anoda, purslane, hemp sesbania, prostrate spurge, and Pennsylvania smartweed	Carfentrazone 0.008-0.016 lb ai	Aim 2EC 0.5-1 fl oz	There is no waiting period between application and cotton planting. Added to glyphosate, Aim will increase speed of control and may improve control of some species. Will not control cutleaf eveningprimrose or horseweed.
Common ragweed, smooth pigweed, morningglory species, and velvetleaf	Flumiclorac pentyl ester 0.013-0.027 lb ai	Resource 0.86EC 2-4 fl oz	There is no waiting period between application and cotton planting. Added to glyphosate, Resource will increase speed of control and may improve control of some species. Will not control cutleaf eveningprimrose or horseweed.
Common ragweed, pigweed species, morningglory species, and velvetleaf	Pyraflufen ethyl 0.0008-0.0032 lb ai	ET 0.208EC 0.5-2 fl oz	There is no waiting period between application and cotton planting. Added to glyphosate, ET will increase speed of control and may improve control of some species. Will not control cutleaf eveningprimrose or horseweed.

Table 5.102 - Early Preplant Burndown and Preplant Incorporated (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Lambsquarters, morningglory species, nightshade species, pigweed species, velvetleaf, spurred anoda, purslane, hemp sesbania, prostrate spurge, and Pennsylvania smartweed.	Flumioxazin 0.031 to 0.063 lb ai	Valor SX 1-2 oz or Valor EZ (4SC) 1 to 2 fl oz	In no-till or stale seedbed system, a minimum of 14 days must pass and a 1 in. rainfall must occur between Valor SX application and cotton planting when Valor SX is applied at 1 oz/A; 21 days must pass when applied at 1.5 to 2 oz/A. If a strip-till operation occurs between Valor SX application and cotton planting, the waiting interval can be reduced to 14 days for the 2 oz/A rate. However, strip-tillage after Valor SX will reduce or eliminate weed control in the tilled strip. Adding Valor SX to glyphosate will improve control of cutleaf eveningprimrose and wild radish. Applied at 1 oz/A, Valor SX will give 2 to 4 weeks residual control of lambsquarters, pigweed, prickly sida, spurge, and Florida pusley. At 2 oz/A, Valor SX will give 6 to 8 weeks residual control of these species. Application to cover crops or dense winter vegetation may reduce residual control. Will not control emerged horseweed. Carefully follow label direction for cleaning out the sprayer after each day's use. Generic brands of flumioxazin include Outflank and Panther.
Carolina geranium, common chickweed, curly dock, henbit, swinecress, Virginia pepperweed, wild mustard, and wild radish	Thifensulfuron 0.0156 lb ai + Tribenuron 0.0078 lb ai	Harmony Extra SG with TotalSol 50WDG 0.75 oz	Harmony Extra should be applied at least 14 days prior to planting. Add nonionic surfactant according to Harmony Extra label. Not effective on cutleaf eveningprimrose or horseweed.
Common chickweed, curly dock, dandelion, Carolina geranium, henbit, lambsquarters, pigweed species, smartweed species, velvetleaf, wild mustard, and wild radish	Rimsulfuron 0.0156 lb ai + Thifensulfuron 0.0156 lb ai	Leadoff 33.4 WDG 1.5 oz	Can be applied from late fall to 30 days prior to planting. Controls emerged winter annual weeds plus provides residual control of later emerging winter weeds. See Leadoff label for adjuvant recommendations. Can be tank mixed with glyphosate and 2,4-D. Does not substitute for Valor SX. The best fit for Leadoff is a late fall or winter application (December to early March) followed by another burndown application containing Valor SX 2 to 4 weeks prior to planting. Crusher 50 WDG is a generic containing a 1:1 ratio of rimsulfuron:thifensulfuron.

Table 5.102 - Early Preplant Burndown and Preplant Incorporated (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Carolina geranium, common chickweed, curly dock, henbit, swinecress, Virginia pepperweed, wild mustard, and wild radish	Thifensulfuron 0.008-0.013 lb ai + Tribenuron 0.008-0.013 lb ai	FirstShot SG 50WDG 0.5-0.8 oz	FirstShot should be applied at least 14 days prior to planting. Add nonionic surfactant according to FirstShot label. Weed control similar to Harmony Extra. Not effective on cutleaf eveningprimrose or horseweed. Generic brands containing a 1:1 ratio of thifensulfuron:tribenuron include Edition BroadSpec and Rapport BroadSpec.
Fair control of cocklebur, morningglory species, jimsonweed, sicklepod, prickly sida, and sesbania; good control of lambsquarters, pigweed species, purslane, and ragweed	Diuron 0.5-1 lb ai	Direx 4L 1-2 pt	Apply 15 to 45 days ahead of planting. Can improve control of certain weeds, including cutleaf eveningprimrose, when tank mixed with Gramoxone. If Cotoran is applied preemergence, reduce Cotoran rate to account for residual activity of Direx. Do not apply Di-Syston or Thimet in-furrow.
Horseweed, pigweeds, and henbit etc.	Oxyfluorfen 0.25-0.5 lb	Goal 2XL 1.0-2.0 pt	Apply Goal 2XL at least 7 days before planting cotton. Can be tankmixed with glyphosate or paraquat for control of larger winter annual broadleaf weed or annual grasses in fallow beds.

Table 5.103 - Preemergence

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Fair control of cocklebur, morningglories, jimsonweed, sicklepod, and tropic croton; good control of lambsquarters, pigweed species, prickly sida, and ragweed	Fluometuron 1.0-2.0 lb ai	Cotoran 4L 1.0-2.0 qt	Apply to soil surface after planting, before crop and weeds emerge. On light, sandy soils, low in organic matter, use no more than 1.0 lb ai/A. Not labeled for use on sand or loamy sand soils.
Fair control of cocklebur, morningglories, jimsonweed, sicklepod, prickly sida, and sesbania; good control of lambsquarters, pigweed species, purslane, and ragweed	Diuron 0.5-1 lb ai	Direx 4L 1-2 pt or Diruon 4L	Apply to soil surface after planting, before crop and weeds emerge. On light, sandy soils, low in organic matter, use no more than 0.5 lb ai/A. Not labeled for use on sand or loamy sand soils. Do not apply Di-Syston or Thimet in-furrow. May be mixed with Prowl, Reflex, Staple, or Warrant.
Annual grasses and pigweed species	Acetochlor 1.125 lb ai	Warrant 3ME 3 pt	Research to date indicates good crop tolerance. May be mixed with Cotoran, Direx, Prowl, or Reflex. Any conditions that delay emergence of cotton may cause growth reduction and uneven growth. If soil is left undisturbed, a waiting interval of 3 weeks is suggested before replanting cotton. Following a deep tillage operation (heavy enough to bring nontreated soil into the planting zone), cotton may be replanted after waiting 2 weeks.

Table 5.103 - Preemergence (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Annual grasses and many broadleaf weeds	Acetochlor 1.06 lb ai + Fomesafen 0.24 lb ai	Warrant Ultra 3.45CS 3 pt	Warrant Ultra is a premix formulation containing 2.82 lb/gal acetochlor plus 0.63 lb/gal fomesafen. Use preemergence only on coarse-textured soils. Warrant Ultra at 3 pt/A has the equivalent of 15.4 fl oz/A of Reflex. See comments for Reflex below.
Barnyardgrass, broadleaf signalgrass, carpetweed, crabgrass, fall panicum, Florida pusley, foxtails, goosegrass, johnsongrass seedlings, lambsquarters, pigweed, purslane, sandbur, Texas panicum, wild cane, shattercane	Pendimethalin 0.5-0.75 lb ai	Prowl 3.3EC 1.2-2.4 pt or Prowl H ₂ O 3.8ACS 1.1-1.6 pt	Apply at planting or up to 2 days following planting to a firm seedbed. Prowl must be activated by rainfall or irrigation, preferably within 2 days of application.
Pigweed species, eclipta, lambsquarters, eastern black nightshade, purslane, ragweed, prickly sida; partially controls spurred anoda, cocklebur, morningglories, and yellow nutsedge	Fomesafen 0.25 lb ai	Reflex 2L 1 pt	Suggested primarily for control of Palmer amaranth. Also effective on yellow nutsedge. Label restricts application to coarse-textured soils. May be mixed with Cotoran, Direx, Prowl, Staple, or Warrant. See label for specific comments on tank mixing. In a tank mix, one may consider reducing the Reflex rate to 12 fl oz/A to reduce the potential for crop injury.
Redroot pigweed, smooth pigweed, prickly sida, spotted spurge, spurred anoda, velvetleaf, and suppresses jimsonweed, ladythumb smartweed, Pennsylvania smart and several morningglory species	Pyriithiobac 0.033-0.053 lb ai	Staple LX 3.2SL 1.3-2.1 oz	Use the higher rate for harder to control weeds but do not exceed 2.1 fl oz/A and do not use on soils with less than 0.5% organic matter. Staple Herbicide may be mixed with several other preemergence herbicides (Cotoran, Direx, Karmex, or Cotton Pro) taking care not to exceed recommended rates of these herbicides for soil types. Do not apply more than 5.1 fl oz/A Staple Herbicide per acre per year.
Herbicide-resistant Palmer amaranth	Fluridone 0.15-0.3 lb ai	Brake 1.2F 16-32 fl oz	Label specifies to tank mix with another residual herbicide when Brake is applied at less than 21 fl oz/A. Suggested tank mixes include Cotoran, Direx, Reflex, or Warrant. If applied alone, Brake will be most effective at 32 fl oz/A. See label for rotational restrictions. Suggested primarily for fields infested with herbicide-resistant Palmer amaranth. Preliminary data also suggest Brake has some common ragweed activity.

Table 5.104 - Postemergence Over-the-top: Annual Grasses

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Barnyardgrass, broadleaf signalgrass, fall panicum, foxtails, johnsongrass seedlings, crabgrass, shattercane, Texas panicum, volunteer corn	Clethodim 0.094-0.25 lb ai + (see remarks)	Select 2EC 6.0-16.0 oz or Select Max 0.97EC 9.0-16.0 oz + (see remarks)	Apply to actively growing grasses at the rate and size range indicated on the label for the individual grass species. Apply with 5.0-40.0 gal of water/A and 30-60 psi. Under certain conditions use a minimum of 10.0 gal - see label. Do not use flood-type nozzles. Always add 2.0 pt/A crop oil concentrate to Select. For Select Max, add 0.25% nonionic surfactant, 1% crop oil concentrate, or 1% methylated seed oil. May be weak on goosegrass.
Barnyardgrass, broadleaf signalgrass, fall panicum, foxtails, johnsongrass, crabgrass, shattercane, Texas panicum, and volunteer corn	Sethoxydim 0.19-0.28 lb ai + crop oil concentrate	Poast 1.5EC 1.0-1.5 pt or Poast Plus 1EC 1.5-2.25 + crop oil concentrate 2.0pt	Apply to actively growing grasses at the rate and size range indicated on the label for the individual grass species with 5.0 gal of water/A and 40-60 psi. Do not use flood type nozzles. Always add 2.0 pt/A crop oil concentrate.
Barnyardgrass, broadleaf signalgrass, fall panicum, foxtails, johnsongrass seedlings, Texas panicum, goosegrass, shattercane and volunteer corn	Fluazifop-P 0.19 lb ai + crop oil concentrate or nonionic surfactant	Fusilade DX 2EC 12.0 oz + crop oil concentrate 0.5-1.0% v/v or nonionic surfactant 0.25% v/v	Apply to actively growing grasses at the rate and growth stage indicated on the label. Apply with a minimum of 10 gal of water/A and 30-60 psi. Do not use flood nozzles. Add 0.5-1.0% v/v crop oil concentrate or 0.25% v/v nonionic surfactant to the spray mixture.
Barnyardgrass, broadleaf, signalgrass, crabgrass, fall panicum, field sandbur, seedling johnsongrass, shattercane, Texas panicum, volunteer small grains	Fluazifop-P plus fenoxaprop-P 0.12-0.16 lb ai + crop oil concentrate or nonionic surfactant	Fusion 2EC 8.0-10.0 oz + crop oil concentrate 0.5-1.0% v/v or nonionic surfactant 0.25-0.5% v/v	Apply to actively growing grasses at the rate and growth stage listed on the label in 5.0-40.0 gal of water/A at 30-60 psi. Do not apply Fusion with recirculating sprayers, rope-wick applicators, controlled droplet applicators, or any similar devices. Add 0.5-1.0% v/v crop oil concentrate or 0.25-0.5% v/v nonionic surfactant to the spray mixture.
Barnyardgrass, broadleaf signalgrass, fall panicum, field sandbur, seedling johnsongrass, shattercane, Texas panicum	Quizalofop 0.034-0.069 lb ai + crop oil concentrate or nonionic surfactant	Assure II 0.88EC 5.0-12.0 oz + crop oil concentrate 1% v/v or nonionic surfactant 0.25% v/v	Apply to actively growing grasses at the rate and growth stage listed on the label. Apply with a minimum of 10.0-15.0 gal water/A and 25-60 psi. May be weak on crabgrass. See label for rate to control specific grasses.

Table 5.105 - Postemergence Over-the-top: Perennial Grasses

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Bermudagrass (wiregrass)	Clethodim 0.125-0.25 lb ai + crop oil concentrate + (sequential treatment on regrowth) Clethodim 0.125-0.25 lb ai + crop oil concentrate	Select 2EC 8.0-16.0 oz or Select Max 0.97EC 12.0-32.0 oz + (see remarks) + (sequential treatment on regrowth) Select 2EC 8.0-16.0 oz or Select Max 0.97EC 12.0-32.0 oz + (see remarks)	Apply to actively growing bermudagrass at the rate and stage indicated on the label. Apply the first application to bermudagrass with 3- to 6-inch runners. Apply regrowth treatments to bermudagrass with 3- to 6-inch runners. Always add 2.0 pt/A crop oil concentrate to Select. For Select Max, add 0.25% nonionic surfactant, 1% crop oil concentrate, or 1% methylated seed oil.
	Fluazifop-P + fenoxaprop-ethyl 0.19 lb ai + crop oil concentrate or nonionic surfactant + (sequential treatment on regrowth) Fluazifop P + fenoxaprop-ethyl 0.12 lb ai + crop oil concentrate or nonionic surfactant	Fusion 2EC 12.0 oz + crop oil concentrate 0.5-1.0% v/v or nonionic surfactant 0.25-0.5% v/v + (sequential treatment on regrowth) Fusion 2EC 8.0 oz + crop oil concentrate 0.5-1.0% v/v or nonionic surfactant 0.25-0.5% v/v	Make first application to 4- to 8-inch runners. Apply a second treatment to 4- to 8-inch runners if regrowth occurs. Use a minimum of 15.0 gal/A spray solution. Add 0.5-1.0% v/v crop oil concentrate or 0.25-0.5% v/v nonionic surfactant to the spray mixture.
	Sethoxydim 0.28 lb ai + crop oil concentrate + (sequential treatment on regrowth) Sethoxydim 0.19 lb ai + crop oil concentrate	Poast 1.5EC or Poast Plus 1EC 2.25 pt + crop oil concentrate 2.0 pt + (sequential treatment on regrowth) Poast 1.5EC 1.0 pt or Poast Plus 1EC 1.5 pt + crop oil concentrate 2.0 pt	Apply to actively growing grass. Apply first treatment to bermudagrass plants with stolons (runners) less than 6 inches in length. Apply regrowth treatments to bermudagrass plants with runners less than 4 inches in length. Add 2.0 pt/A crop oil concentrate.

Table 5.105 - Postemergence Over-the-top: Perennial Grasses (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Bermudagrass (wiregrass), Rhizome johnsongrass	Fluazifop-P 0.19 lb ai +	Fusilade DX 2EC 12.0 oz +	Apply to actively growing johnsongrass 8-18 inches high.
	crop oil concentrate or nonionic surfactant +	crop oil concentrate 0.5-1.0% v/v or nonionic surfactant 0.25-0.5% v/v +	Apply regrowth treatments when 6-12 inches high. Add 0.5-1.0% v/v crop oil concentrate or 0.25-0.5% v/v nonionic surfactant to the spray mixture. OR Apply to actively growing bermudagrass with 4- to 8-inch runners. Apply regrowth treatments to bermudagrass with a runner length of 4-8 inches. Add 0.5-1.0% v/v crop oil concentrate or 0.25-0.5% v/v to the spray mixture.
	(sequential treatment on regrowth) Fluazifop-P 0.125 lb ai +	(sequential treatment on regrowth) Fusilade DX 2EC 8.0 oz +	
	crop oil concentrate or nonionic surfactant	crop oil concentrate 0.5-1.0% v/v or nonionic surfactant 0.25-0.5% v/v	
	Quizalofop 0.07-0.08 lb ai +	Assure II 0.88EC 10.0-12.0 oz +	Apply to actively growing johnsongrass when 10 to 24 inches tall or bermudagrass up to 6-inch runners. Apply regrowth treatments to 6- to 10-inch johnsongrass, or bermudagrass with 3- to 6-inch runners. Add 0.5-1.0% v/v crop oil concentrate or 0.25-0.5% v/v nonionic surfactant to the spray mixture.
	crop oil concentrate or nonionic surfactant +	crop oil concentrate 1.0% v/v or nonionic surfactant 0.25% v/v +	
	(sequential treatment on regrowth) Quizalofop 0.05 lb ai +	(sequential treatment on regrowth) Assure II 0.88EC 10.0 oz +	
	crop oil concentrate or nonionic surfactant	crop oil concentrate 1.0 % v/v or nonionic surfactant 0.25% v/v	

Table 5.105 - Postemergence Over-the-top: Perennial Grasses (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Rhizome johnsongrass	Clethodim 0.125-0.25 lb ai + crop oil concentrate + (sequential treatment on regrowth)	Select 2EC 8.0-16.0 oz or Select Max 0.97EC 12.0-32.0 oz + (see remarks)	Apply to actively growing johnsongrass at the rate and stage indicated on the label. Apply the first application to johnsongrass 12-24 inches high. Apply regrowth treatments to 6- to 18-inch johnsongrass. Always add 2.0 pt crop oil concentrate to Select. For Select Max, add 0.25% nonionic surfactant, 1% crop oil concentrate, or 1% methylated seed oil.
	Clethodim 0.094-0.16 lb ai + crop oil concentrate	(sequential treatment on regrowth) Select 2EC 6.0-8.0 oz or Select Max 0.97EC 12.0-32.0 oz + (see remarks)	
	Fluazifop-P + fenoxaprop-ethyl 0.16-0.19 lb ai + crop oil concentrate or nonionic surfactant + (sequential treatment on regrowth)	Fusion 2EC 10.0-12.0 oz + crop oil concentrate 0.5-1.0% v/v or nonionic surfactant 0.25-0.5% v/v + (sequential treatment on regrowth)	Make first application to actively growing johnsongrass before the boot stage and a second application when regrowth is 4 to 6 inches tall. Add 0.5-1.0% v/v crop oil concentrate or 0.25-0.5% v/v nonionic surfactant to the spray mixture.
	Fluazifop-P + fenoxaprop-ethyl 0.12 lb ai + crop oil concentrate or nonionic surfactant	Fusion 2EC 8.0 oz + crop oil concentrate 0.5-1.0% v/v or nonionic surfactant 0.25-0.5% v/v	
	Sethoxydim 0.28 lb ai + crop oil concentrate + (sequential treatment on regrowth)	Poast 1.5 pt or Poast Plus 2.25 pt + crop oil concentrate 2.0 pt + (sequential treatment on regrowth)	Apply to actively growing johnsongrass. Apply first treatment to johnsongrass 15 to 20 inches high. Apply regrowth treatments to 6- to 10-inch johnsongrass.
	Sethoxydim 0.19 lb ai + crop oil concentrate	Poast 1.0 pt or Poast Plus 1.5 pt + crop oil concentrate 2.0 pt	

Table 5.106 - Postemergence: Over-the-top

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Controls most annual grasses and broadleaf weeds in conventional and reduced tillage production systems. Control or temporary suppression of many perennial weeds including bermudagrass, hemp dogbane, horsenettle, nutsedges, rhizome johnsongrass, and trumpetcreeper	Glyphosate 0.75-1.0 lb ai	Numerous brands and formulations	For use only on cotton varieties designated as Roundup Ready Flex, GlyTol, Enlist, or XtendFlex. Some brands of glyphosate are not registered for use on these varieties (see labels). Glyphosate will be most effective as a component of a program that includes the use of standard preplant incorporated, preemergence, and postemergence herbicides. Adjuvant recommendations vary by glyphosate products. See labels for specification. Observe all labels regarding seasonal maximums and take extreme caution to avoid drift to adjacent vegetation.
Controls many annual broadleaf weeds and suppresses annual grasses in conventional and reduced tillage production systems. Suppression may be expected of pigweed spp. and most grasses after just a single glufosinate application.	Glufosinate 0.53-0.79 lb ai	Liberty 280 2.34L 29-43 fl oz	For use only on cotton varieties designated as LibertyLink, Enlist, or XtendFlex. Apply postemergence over-the-top to cotton at emergence until the early-bloom stage of cotton development. Flat-fan nozzles and a minimum of 15 gpa are recommended. Application time of day is important. Two hours of sunshine before a morning application is suggested. Do not apply later than 1 hour before sunset. Multiple applications are allowed. Liberty at 22 to 29 fl oz can be applied three times, with a seasonal maximum of 87 fl oz. If applied at rates greater than 29 oz, only two applications are allowed and the season total should not exceed 72 fl oz. For best results, broadleaf weeds should be 2 to 3 in. tall and grasses 1 to 2 in. tall. Liberty should not be mixed with postemergence grass herbicides, such as Assure, Fusilade, Poast, or Select. If applying Liberty and grass herbicide separately then maintain a gap of 5 days between applications. Postemergence grass control reduces when tankmix application of Liberty with either of grass herbicide, such as, clethodim, fluzifop, quizalofop, and sethoxydim is applied.

Table 5.106 - Postemergence: Over-the-top (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Controls many annual broadleaf weeds and suppresses annual grasses in conventional and reduced tillage production systems. Suppression may be expected of pigweed spp. and most grasses after just a single glufosinate application.	Glufosinate 0.55 lb ai	Liberty 280 2.34L 29 fl oz	Phytogen cultivars with the WideStrike trait can be treated with Liberty. Tolerance to Liberty in these cultivars is not complete, and varying levels of crop injury may be observed. Greater injury can be expected when Liberty is mixed with insecticides or other herbicides. Growers assume the liability of crop injury when cotton with the WideStrike trait is treated with Liberty. It is suggested that the rate not exceed 29 fl oz per application with a maximum of two applications per year. It is also suggested that Liberty not be applied beyond the 8-leaf stage of cotton and that AMS not be included in the application. See above comments concerning Liberty application to Liberty Link cultivars, including application time of day.
Many broadleaf weeds	Glyphosate 1.0 lb ae + 2,4-D 0.95 lb ae	Enlist Duo 3.3S 4.75 pt	For use only on cotton varieties designated as Enlist. Enlist Duo contains the choline salt of 2,4-D. It is the only brand of 2,4-D registered for this use. Can be applied from cotton emergence to mid-bloom. Can be applied twice postemergence; allow minimum of 12 days between applications. See website Enlisttankmix.com for approved adjuvants, drift reduction agents, and other tank mixes. See Enlist Duo federal label for details on drift management, including recommended nozzles and pressures, wind speed, boom height, temperature inversions, buffers, and susceptible plants.

Table 5.106 - Postemergence: Over-the-top (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Many broadleaf weeds	2,4-D 0.95 lb ae	Enlist One 2 pt	For use only on cotton varieties designated as Enlist. Enlist One contains the choline salt of 2,4-D. It is the only brand of 2,4-D registered for this use. May be mixed with glufosinate. Can be applied from cotton emergence to mid-bloom. Can be applied twice postemergence; allow minimum of 12 days between applications. See website Enlisttankmix.com for approved adjuvants, drift reduction agents, and other tank mixes. Can be mixed with Dual Magnum, Everprex, Moccasin, Staple LX, or Warrant for residual control; the addition of these products will increase foliar burn. See Enlist One federal label for details on drift management, including recommended nozzles and pressures, wind speed, boom height, temperature inversions, buffers, and susceptible plants.
Many broadleaf weeds	Dicamba 0.5 lb ae	Engenia 5S 12.8 fl oz or XtendiMax 2.9S 22 fl oz	For use only on cotton varieties designated as XtendFlex. Should be mixed with glyphosate. Engenia and XtendiMax contain dicamba. These are the only brands of dicamba registered for this use. Can be applied any time from cotton emergence to 7 days prior to harvest. Can be applied multiple times postemergence, not to exceed a total of 51.2 oz Engenia or 88 oz of XtendiMax. Only two postemergence applications suggested, preferably before first bloom. Separate applications by at least 7 days. Engenia, FeXapan, and XtendiMax can be mixed with glyphosate, Dual Magnum, Outlook, Warrant, and various other brands of Group 15 herbicides; the addition of these products will increase foliar burn. See websites Engeniatankmix.com and xtendimaxapplicationrequirements.com for approved adjuvants, drift reduction agents, and other tank mixes. See federal labels and supplemental labels for use in dicamba-tolerant cotton for details on drift management, including recommended nozzles and pressures, wind speed, boom height, temperature inversions, buffers, and susceptible plants. Applicators must hold a VA pesticide license and receive annual training to use Engenia and Xtendimax

Table 5.106 - Postemergence: Over-the-top (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Large crabgrass, goosegrass, fall panicum, foxtails and suppression of yellow nutsedge	S-Metolachlor 0.96-1.25 lb ai	Dual Magnum 7.62EC 1.0-1.3 pt	Apply over-the-top postemergence or directed to the soil surface to cotton at least 3 in tall. Applications should be prior to weed emergence or after clean cultivation since Dual Magnum does not control emerged weeds. At least 1/2 inch of rainfall is required within 10 days after application. If rainfall does not occur, a shallow, uniform incorporation will improve control. Over-the-top postemergence applications should be made not later than 100 days before harvest and directed postemergence applications may be made not later than 80 days before harvest. Can be applied with glyphosate on Roundup Ready Flex, GlyTol, Enlist, or XtendFlex and glufosinate on LibertyLink, Enlist, or XtendFlex cotton varieties. Do not add additional spray adjuvants, surfactants, fertilizers, or their additives to these tank mixtures if applied over-the-top, or unacceptable cotton injury may occur. Follow instructions on the Dual Magnum and glyphosate labels for rates, application methods, and application timing restrictions.
Controls most annual grasses and broadleaf weeds in conventional and reduced tillage production systems. Control or temporary suppression of many weeds including hemp dogbane, yellow nutsedge, and rhizome johnsongrass. Provides residual control of large crabgrass, goosegrass, fall panicum, foxtails, and the suppression of yellow nutsedge.	[Glyphosate + S-metolachlor] 0.70-0.98 lb ae + 0.94-1.31 lb ai	Sequence 5.25L 2.5 to 3.5 pt	For use only on cotton varieties designated as Roundup Ready Flex, GlyTol, Enlist, or XtendFlex. Apply postemergence over-the-top to cotton that is 3 inches tall to the four-leaf stage of cotton development. Do not apply later or severe crop injury will occur, including yield loss. Do not exceed 2.5 pt/A of Sequence per application or 3.5 pt/A of Sequence per growing season. If tank-mixing or applications follow other s-Metolachlor products, do not exceed 1.9 lb s-Metolachlor ai/A per season on coarse-textured soils. Over-the-top postemergence applications should not be made later than 100 days before harvest. At least 1/2 inch of rainfall is required within 7 days after application to activate the s-Metolachlor. Do not add additional spray adjuvants, surfactants, or fertilizers to Sequence when applied postemergence over-the-top, or unacceptable cotton injury may occur. Extreme care must be used to avoid drift to adjacent crops or other desirable vegetation. Do not graze or feed treated cotton. See label.

Table 5.106 - Postemergence: Over-the-top (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Fall panicum, crabgrass, foxtails, goosesgrass, pigweeds, carpetweed, purslane, lambsquarters, nightshade, waterhemp	Acetochlor 0.9375-1.5 lb ai	Warrant 3ME 1.25-2 qts/A	Apply this product postemergence to cotton and preemergence to weeds. This product will not control emerged weeds. Apply when the crop is small or direct spray to the soil surface. Can be applied with glyphosate on Roundup Ready Flex, GlyTol, Enlist, or XtendFlex and glufosinate on LibertyLink, Enlist, or XtendFlex cotton varieties. DO NOT exceed 4 qt Warrant/A per season when making a second application. DO NOT make postemergence applications using a sprayable fluid fertilizer. DO NOT graze treated area or feed treated forage to livestock following application of this product. If replanting cotton into previously applied Warrant, wait at least 3 weeks prior to replanting cotton in no-till or 2 weeks if fresh soil is brought into planting zone via ripper shanks.
Cocklebur and suppression of yellow nutsedge	MSMA 0.75-1.0 lb ai	Various brands and formulations 2.66 pt MSMA (6.0 lb/gal formulations)	May be applied over-the-top of crop and weeds when cotton is 3 to 6 inches tall. Crop response may include stunting, stem reddening and delay of maturity. Check label for surfactant recommendations.
Cocklebur, jimsonweed, pigweed	Fluometuron 1.0 ai	Cotoran 4L 1.0 qt	May be applied over-the-top of crop when cotton is 3 inches, high to layby. Weeds should be 2 inches or less. For use only where crop loss due to weeds is likely. Moderate to severe crop injury may occur and may include maturity delay and yield reduction.
Pigweed species, Pennsylvania smartweed, spurred anoda, velvetleaf, jimsonweed. May be weak against tall morningglory, common cocklebur, and prickly sida	Pyrithiobac 0.065-0.095 lb ai + 0.25-0.50% nonionic surfactant	Staple LX 3.2SL 2.6-3.8 oz + nonionic surfactant at 1.0-2.0 qt/100.0 gal	Can be applied with glyphosate on Roundup Ready Flex, GlyTol, Enlist, or XtendFlex varieties or glufosinate on LibertyLink, Enlist, or XtendFlex varieties. Apply 2.6-3.8 oz Staple LX with 0.25-0.50% v/v (1.0-2.0 qt/100.0 gal) nonionic surfactant to control small annual broadleaf weeds listed. Staple may be applied postemergence broadcast over-the-top of cotton, in a band over-the-top of cotton, or post-directed to cotton but over-the-top of weeds. Make applications to small, actively growing weeds after cotton has a true leaf. Cotton may be injured from Staple LX applied under cool, wet conditions. For best control, rainfall should not occur for 4 hours. Do not exceed 5.1 fl oz/A per year. See label.

Table 5.106 - Postemergence: Over-the-top (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Bristly starbur, common cocklebur, coffee senna, volunteer corn (non-IT/IR), Florida beggarweed, hemp sesbania, common lambsquarters, morningglory spp., common ragweed, redweed, sicklepod, velvetleaf, volunteer soybean (non-STs), wild poinsettia, yellow nutsedge.	Trifloxysulfuron-sodium 0.0047-0.0070 lb ai + nonionic surfactant 0.25% v/v	Envoke 75WGD 0.10-0.15 oz + nonionic surfactant 1.0 qt/100.0 gal	Can be applied with glyphosate on Roundup Ready Flex, GlyTol, Enlist, or XtendFlex varieties or glufosinate on LibertyLink, Enlist, or XtendFlex varieties. Apply 0.10-0.15 oz/A Envoke with 0.25% v/v (1 qt/100.0 gal) nonionic surfactant to control small annual broadleaf weeds listed. Envoke may be applied postemergence broadcast over-the-top of cotton, or post-directed to cotton but over-the-top of weeds. Make applications to small, actively growing weeds after cotton has a minimum of 5 true leaves. Cotton may be injured from Envoke applied under cool, wet conditions and if cotton is less than in the 5-leaf stage of growth. For best control, rainfall should not occur for 3 hours. The higher rates of Envoke may be required to adequately control yellow nutsedge and velvetleaf. Envoke tank mixed with glyphosate on Roundup Ready Flex, GlyTol, or XtendFlex cotton can cause injury by way of boll loss, delayed maturity, and/or loss of yield. Sequential Envoke applications must be 14 days apart and should be used only for a salvage treatment.
Compared to Envoke alone, mix is better on jimsonweed and spurred anoda. Compared to Staple alone, mixture is better on common ragweed, common lambsquarters, tall morningglory, and sicklepod.	Trifloxysulfuron 0.0047-0.0070 lb + Pyriithiobac 0.033-0.053 lb + nonionic surfactant 0.25% v/v	Envoke 75 WDG 0.1-0.15 oz + Staple LX 3.2SL 1.3-2.1 fl oz + nonionic surfactant 0.25% v/v	Postemergence overtop of cotton with at least 5 true leaves. Use a minimum of 10 gal water/A and apply to cotton with at least 5 true leaves. Occasional yellowing of cotton leaves can occur but yields are not affected.

Table 5.107 - Postemergence Directed

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Cocklebur, yellow nutsedge, purple nutsedge	MSMA 2.0 lb ai	Various brands and formulations 2.66 pt MSMA (6.0 lb/gal formulations)	Apply as a directed spray to cotton at least 3 inches tall. Do not apply after first blooms appear. Refer to the product label to determine if surfactant should be added. Two applications/season may be made. May be tank mixed with fluometuron.
Cocklebur, jimsonweed, lambsquarters, morningglory, pigweed, ragweed, tropic croton	Diuron 0.8-1.2 lb ai + MSMA 2.0 lb ai	Direx 4L 1.6-2.4 pt + Various brands and formulations 2.66 pt MSMA (6.0 lb/gal formulations)	Apply as a directed spray to cotton at least 12 inches tall. Rate varies by soil type. See application precautions on label. Add nonionic surfactant at 1 to 2 quarts per 100 gal spray solution or crop oil at 1 gal per 100 gal spray solution. See label for rotational restrictions. Do not apply MSMA after first bloom. Aim (1 oz/A) or Cobra (6 to 8 oz/A) may be added to improve control of larger morningglory. Cotton should be at least 16 inches when applying Aim. Do not allow Aim to contact green stem tissue.
Cocklebur, jimsonweed, lambsquarters, morningglory, pigweed, ragweed, tropic croton, yellow nutsedge, and most annual grasses	Fluometuron 1.0-2.0 lb ai + MSMA 2.0 lb ai + S-metolachlor 0.95-1.27 lb ai	Cotoran 4L 1.0-2.0 qt + Various brands and formulations 2.66 pt MSMA (6.0 lb/gal formulations) + Dual Magnum 7.62EC 1-1.33 pt	Apply as directed spray to cotton at least 3 inches tall up to first bloom. Do not apply MSMA after first bloom. Add surfactant according to Cotoran label. Dual Magnum gives residual control of annual grasses and pigweed and suppresses yellow nutsedge. See comments for Cotoran + MSMA.
Cocklebur, jimsonweed, lambsquarters, morningglory, pigweed, ragweed, tropic croton	Fluometuron 1.0 lb ai	Cotoran 4L 1.0 qt	Apply as a directed spray. Apply with a nonionic surfactant at 2.0 qt/100 gal spray solution. Do not apply within 60 days of harvest. See label for crop rotation.

Table 5.107 - Postemergence Directed (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Cocklebur, lambsquarters, morningglory species, nightshade species, pigweed species, velvetleaf, spurred anoda, purslane, hemp sesbania, prostrate spurge, Pennsylvania smartweed, purple nutsedge, yellow nutsedge	Flumioxazin 0.064 lb ai + MSMA 2.0 lb ai	Valor SX 51WDG 2 oz + MSMA Various brands and formulations 2.66 pt MSMA (6.0 lb/gal formulations)	Apply as directed spray only to cotton at least 16 inches tall. Direct the spray to the lower 2 inches of the cotton stem. Do not allow spray solution to contact green portion of stem. Add nonionic surfactant at 1 qt per 100 gal spray solution. Do not use crop oil concentrate, methylated seed oil, organo-silicant adjuvants, or any adjuvant product containing any of these. Do not apply MSMA after first bloom. No rotational restrictions of concern in Virginia. May be applied under a hood on cotton at least 6 inches tall. Do not allow spray solution to contact cotton
Cocklebur, lambsquarters, morningglory species, nightshade species, pigweed species, velvetleaf, spurred anoda, purslane, hemp sesbania, prostrate spurge, Pennsylvania smartweed, purple nutsedge, yellow nutsedge, most annual grass species	[Flumioxazin + Pyroxasulfone] 0.143 lb ai + MSMA 2.0 lb ai	Fierce 76WDG 3 oz + MSMA Various brands and formulations 2.66 pt MSMA (6.0 lb/gal formulations)	Flumioxazin + pyroxasulfone is a premix product. Can be applied with hooded sprayer after cotton is at least 6 inches tall. Do not allow spray solution to contact cotton. Can be applied with layby applicator after cotton is at least 16 inches tall, but do not contact more than the lower 2 inches of cotton stalk. Add non-ionic surfactant according to label. Do not use crop oil concentrate, methylated seed oil, organo-silicant adjuvants, or any adjuvant product containing any of these. Do not apply MSMA after first bloom.
Cocklebur, jimsonweed, lambsquarters, morningglory, pigweed, ragweed, tropic croton, yellow nutsedge, and most annual grasses	Fluometuron 1.0-2.0 lb ai + MSMA 2.0 lb ai + S-metolachlor 0.95-1.27 lb ai	Cotoran 4L 1.0-2.0 qt + Various brands and formulations 2.66 pt MSMA (6.0 lb/gal formulations) + Dual Magnum 7.62EC 1-1.33 pt	Apply as directed spray to cotton at least 3 inches tall up to first bloom. Do not apply MSMA after first bloom. Add surfactant according to Cotoran label. Dual Magnum gives residual control of annual grasses and pigweed and suppresses yellow nutsedge. See comments for Cotoran + MSMA.
Cocklebur, ragweed, jimsonweed, lambsquarters, pigweed, prickly sida, smartweed, tropic croton, velvetleaf	Lactofen 0.2 lb ai + MSMA 2.0 lb ai	Cobra 2EC 12.5 oz + MSMA (6 lb/gal 2.66 pt formulations)	Apply to cotton at least 6 inches tall. Apply with nonionic surfactant (2.0 pt/100 gal spray mix) or crop oil concentrate (0.5-1.0 pt/A). Apply only with precision -directed spray equipment. Make only one application of Cobra/ season. ¹ Do not apply MSMA after first bloom.

Table 5.107 - Postemergence Directed (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Cocklebur, ragweed, jimsonweed, lambsquarters, pigweed, prickly sida, smartweed, tropic croton, velvetleaf	Lactofen 0.094-0.2 lb ai + Diuron 0.4-0.6 lb ai + MSMA 2.0 lb ai	Cobra 2EC 6-12.5 oz + Direx 4F 0.8-1.2 pt + Various brands and formulations 2.66 pt MSMA (6.0 lb/gal formulations)	Apply as directed spray or with hooded sprayer. Cotton should be at least 12 inches tall. See Cobra label for weeds controlled and directions on weed size and application rates. Add 1 qt per acre crop oil concentrate. See rotational restrictions on Direx label. Do not apply MSMA after first bloom. The herbicide combinations with MSMA do not need an additional surfactant if the MSMA already contains it. If not, then add it according to herbicide label directions.
Cocklebur, ragweed, jimsonweed, lambquarters, pigweed, prickly sida, smartweed, tropic croton, morningglory (suppression)	Prometryn 0.5-0.65 lb ai + MSMA 2.0 lb ai	Caparol 4L 1.0-1.3 pt or Cotton-Pro 4L 1.0-1.3 pt + Various brands and formulations 2.66 pt MSMA (6.0 lb/gal formulations)	Apply to cotton at least 6 inches tall. Apply only with precision -directed spray equipment. ¹ Aim (1 oz/A) or Cobra (6 to 12.5 oz/A) may be added to improve control of larger morningglory. Cotton should be at least 16 inches when applying Aim. Do not allow Aim to contact green stem tissue. Do not apply MSMA after first bloom.
Bristly starbur, common cocklebur, coffee senna, volunteer corn (non-IT/IR), Florida beggarweed, hemp sesbania, johnsongrass (seedling), common lambsquarters, morningglory spp., smooth pigweed, redroot pigweed, common ragweed, redweed, sicklepod, velvetleaf, volunteer soybean (non-STs), wild poinsettia, yellow nutsedge	Prometryn 0.790-1.185 lb ai + Trifloxysulfuron-sodium 0.0070-0.0105 lb ai + MSMA 2.0 lb ai	Various brands and formulations 2.66 pt MSMA (6.0 lb/gal formulations)	Apply 1.0-1.5 lb/A Suprend + MSMA to control small annual broadleaf weeds listed and provide some residual control of these weeds. Suprend must be applied post-directed to cotton but over-the-top of weeds. Apply to cotton at least 6 inches tall and only with precision-directed spray equipment. Sequential Suprend applications must be at least 14 days apart. Do not exceed 2.7 lbs/A of Suprend per growing season from all applications. Do not exceed a total of 0.0188 lb ai/A of trifloxysulfuron-sodium per growing season resulting from all applications of Suprend or Envoke. Do not exceed a total of 5.15 lb ai/A of prometryn per growing season resulting from all applications of Suprend, Caparol 4L, or Cotton-Pro 4L. If these totals for trifloxysulfuron-sodium and/or prometryn are exceeded, injury to cotton may result in addition to alterations in crop rotation restriction intervals. Do not apply MSMA after first bloom.

Table 5.107 - Postemergence Directed (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Annual grasses, broadleaf weeds, nutsedge, suppression of perennial weeds	Glyphosate 0.75-1.13 lb ae	Glyphosate See labels	Roundup Ready Flex, GlyTol LibertyLink, or XtendFlex cultivars only. Glyphosate alone can be directed up to 7 days prior to harvest. When using glyphosate alone, contact with cotton is not of concern; the primary reason to direct is to obtain better coverage of weeds under the crop canopy. Use of other herbicides, in addition to glyphosate, is recommended to aid in resistance management. When tank mixing, follow directions on the label of tank mix partner concerning cotton size for application, application directions, and rotational restrictions. Glyphosate-resistant Palmer amaranth and common ragweed are present in Virginia.
Annual grasses, broadleaf weeds, nutsedge, suppression of perennial weeds	Glyphosate 0.75-1.13 lb ae + Acetochlor 1.125 lb	Glyphosate See labels + Warrant 3ME 3 pt	Roundup Ready Flex, GlyTol LibertyLink, Enlist, or XtendFlex cultivars only. Can be directed up to first bloom. See comments for glyphosate applied alone. Warrant does not control emerged weeds, but it does provide residual control of pigweed and most annual grasses.
Annual grasses, broadleaf weeds, nutsedge, suppression of perennial weeds	Glyphosate 0.75-1.13 lb ae + Carfentrazone 0.016-0.024 lb	Glyphosate See labels + Aim 2EC 1-1.5 oz	Roundup Ready Flex, GlyTol LibertyLink, Enlist, or XtendFlex cultivars only. Cotton should be at least 16 inches tall. Extreme care should be exercised in application. See directions and precautions on Aim label. Contact on green stem tissue will lead to severe injury. Add crop oil concentrate according to label. See comments on Aim label concerning sprayer cleanout. Aim will improve control of larger morningglory. See comments for glyphosate alone.
Annual grasses, broadleaf weeds, nutsedge, suppression of perennial weeds	Glyphosate 0.75-1.13 lb ae + Dimethenamid-P 0.56-0.75 lb	Glyphosate See labels + Outlook 6EC 12-16 oz	Roundup Ready Flex, GlyTol LibertyLink, Enlist, or XtendFlex cultivars only. Can be directed to cotton up to mid-bloom. Outlook does not control emerged weeds, but it does provide residual control of most annual grasses and pigweed. Suggested rates are 12 oz on coarse soils, 14 oz on medium soils, and 16 oz on fine soils. See comments for glyphosate alone.

Table 5.107 - Postemergence Directed (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Annual grasses, broadleaf weeds, nutsedge, suppression of perennial weeds	Glyphosate 0.75-1.13 lb ae + Diuron 0.5-0.75 lb ai	Glyphosate See labels + Direx 4L 1-1.5 pt	Roundup Ready Flex, GlyTol LibertyLink, Enlist, or XtendFlex cultivars only. Use 1 pt of Direx on cotton 8 to 12 inches tall. Increase rate to 1.5 pt on cotton greater than 12 inches. Add surfactant according to label of glyphosate brand used. Compared to glyphosate alone, this combination controls larger morningglories and provides residual control of small-seeded broadleaves, such as pigweed. Tank mix may give less grass control of larger grasses than glyphosate alone under dry conditions. See Direx label for rotational restrictions. See comments for glyphosate alone.
Annual grasses, broadleaf weeds, nutsedge, suppression of perennial weeds	Glyphosate 0.75-1.13 lb ae + Flumioxazin 0.031-0.063 lb	Glyphosate See labels + Valor SX 51WDG 1-2 oz or Valor EZ (4SC) 1-2 fl oz	Roundup Ready Flex, GlyTol LibertyLink, Enlist, or XtendFlex cultivars only. Cotton should be at least 16 inches tall. Direct the sprayer to the lower 1 to 2 inches of the cotton stem; minimize cotton contact as much as possible. Do not allow spray solution to contact green portion of stem. Add nonionic surfactant at 1 qt per 100 gal spray solution. DO NOT use crop oil concentrate, methylated seed oil, organo-silicant adjuvants, or adjuvant products containing any of these. No rotational restriction of concern in Virginia. Compared with glyphosate alone, the combination will give better control of larger morningglories plus residual control of susceptible broadleaf weeds. May be applied under a hood on cotton at least 6 inches tall. Do not allow spray solution to contact cotton. See comments for glyphosate alone.

Table 5.107 - Postemergence Directed (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Annual grasses, broadleaf weeds, nutsedge, suppression of perennial weeds	Glyphosate 0.75-1.13 lb ae + [Flumioxazin + pyroxasulfone] 0.143 lb ai	Glyphosate See labels + Fierce 76WDG 3 oz or Fierce EZ (3.04SC) 6 fl oz	Roundup Ready Flex, GlyTol LibertyLink, Enlist, or XtendFlex cultivars only. Fierce and Fierce EZ are premixes containing flumioxazin plus pyroxasulfone. Can be applied with hooded sprayer after cotton reaches 6 inches in height. Do not allow spray solution to contact cotton. Can be applied with layby applicator after cotton is at least 16 inches tall, but do not contact more than lower 2 inches of cotton stalk. Add non-ionic surfactant according to Fierce label. Do not use crop oil, methylated seed oil, organo-silicant adjuvants or adjuvant products containing any of these. See comments for glyphosate alone.
Annual grasses, broadleaf weeds, nutsedge, suppression of perennial weeds	Glyphosate 0.75-1.13 lb ae + Fomesafen 0.25-0.375 lb ai	Glyphosate See labels + Reflex 2L 1-1.5 pt	Roundup Ready Flex, GlyTol LibertyLink, Enlist, or XtendFlex cultivars only. Use as a layby application to cotton with a minimum of 4 inches of bark on the stem. Add surfactant or crop oil according to the Reflex label. May include Caparol, Direx, Dual Magnum, Envoke, Layby Pro, or Suprend in the mixture. Do not use Reflex at layby if Reflex was used preemergence. See comments for glyphosate alone.
Annual grasses, broadleaf weeds, nutsedge, suppression of perennial weeds	Glyphosate 0.75-1.13 lb ae + Prometryn 0.5-1 lb ai	Glyphosate See labels + Caparol 1-2 pt	Roundup Ready Flex, GlyTol LibertyLink, Enlist, or XtendFlex cultivars only. Direct to cotton at least 6 to 8 inches tall. Use 1 to 1.3 pt of Caparol on cotton 6 to 12 inches tall; rate can be increased to 2 pt on cotton at least 16 inches tall. Add surfactant according to glyphosate label. See precautions and rotational restrictions on Caparol label. Compared to glyphosate alone, this combination will improve control of larger morningglory and provide residual control of small-seeded broadleaves, such as pigweed. This mixture will give less control of larger grasses than glyphosate alone under drier conditions. See comments for glyphosate alone.

Table 5.107 - Postemergence Directed (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Annual grasses, broadleaf weeds, nutsedge, suppression of perennial weeds	Glyphosate 0.75-1.13 lb ae + Pyroxasulfone 0.040-0.112 lb ai	Glyphosate See labels + Warrant 3ME 3 pt	Roundup Ready Flex, GlyTol LibertyLink, Enlist, or XtendFlex cultivars only. Zidua is labeled at a rate of 0.75 to 1.5 oz/A on coarse- and medium-textured soils and 1.5 to 2.1 oz/A on fine-textured soils. Do not use on soils with greater than 10% organic matter. Avoid contact with cotton foliage. Apply postemergence directed when cotton is from 5-leaf stage to beginning of bloom stage. Do not apply overtop. Zidua does not control emerged weeds but gives residual control of many annual grasses and pigweed species. See comments for glyphosate alone.
Annual grasses, broadleaf weeds, nutsedge, suppression of perennial weeds	Glyphosate 0.75-1.13 lb ae + Pyroxasulfone + Carfentrazone-ethyl 0.043-0.119	Glyphosate See labels + Anthem Flex (4 SE) 1.4 to 3.8 fl oz	Anthem flex contains pyroxasulfone plus carfentrazone. Apply as a directed spray only to cotton that is a minimum of 6 inches in height. Hooded or shielded sprayers should be used when cotton is less than 6 nodes to avoid contact with green tissue. Apply layby treatments as a directed spray to cotton 12 inches or greater when stem has sufficient bark of at least 4 inches in development. Direct spray solution to base of cotton plant for minimal contact to green stem tissue or foliage. Follow label directions for weed size and addition of surfactant. See Anthem Flex label for maximum application rates per season and rotational restrictions.
Annual grasses, broadleaf weeds, nutsedge, suppression of perennial weeds	Glyphosate 0.75-1.13 lb ae + S-metolachlor 0.95-1.27 lb ai	Glyphosate See labels + Dual Magnum 1-1.33 pt	Roundup Ready Flex, GlyTol LibertyLink, Enlist, or XtendFlex cultivars only. Can be applied to cotton 3 inches tall through layby. Dual Magnum does not improve control of emerged weeds, but it can give residual control of annual grasses, pigweed species, and spreading dayflower plus suppression of yellow nutsedge. Do not apply to sand or loamy sand soils. See comments for glyphosate alone.

Table 5.107 - Postemergence Directed (cont.)

Weed problem	Chemical rate per acre	Product per acre	Remarks and Precautions
Annual grasses, broadleaf weeds, nutsedge, suppression of perennial weeds	[Glyphosate + S-metolachlor] 0.70 lb ae + 0.94 lb ai	Sequence 5.25L 2.5 pt	Roundup Ready Flex, GlyTol LibertyLink, Enlist, or XtendFlex cultivars only. Glyphosate alone can be directed up to 7 days prior to harvest. When using glyphosate alone, contact with cotton is not of concern; the primary reason to direct is to obtain better coverage of weeds under the crop canopy. Use of other herbicides, in addition to glyphosate, is recommended to aid in resistance management. When tank mixing, follow directions on the label of tank mix partner concerning cotton size for application, application directions, and rotational restrictions. Glyphosate-resistant Palmer amaranth and common ragweed are present in Virginia.
Annual grasses, broadleaf weeds, nutsedge, suppression of perennial weeds	Glyphosate 0.75-1.13 lb ae + [Prometryn + Trifloxysulfuron] 0.8-1 + 0.007-0.0088 lb ai	Glyphosate See labels	Roundup Ready Flex, GlyTol LibertyLink, Enlist, or XtendFlex cultivars only. Direct to cotton at least 6 to 8 inches tall. Add surfactant according to glyphosate label. See precautions and rotational restrictions on Suprend label. Compared to glyphosate alone, this combination will improve control of larger morningglory and nutsedge, and provide residual control of small-seeded broadleaf weeds, such as pigweed. This mixture may give less control of larger grasses than glyphosate alone under drier conditions. See comments for glyphosate alone.
Annual grasses, broadleaf weeds, nutsedge, suppression of perennial weeds	Glyphosate 0.75-1.13 lb ae + Trifloxysulfuron 0.0047-0.0094 lb ai	Glyphosate See labels + Envoke 75WDG 0.1-0.2 oz	Roundup Ready Flex, GlyTol LibertyLink, Enlist, or XtendFlex cultivars only. Direct to cotton from 6 inches tall through layby. Add nonionic surfactant according to the Envoke label. Compared to glyphosate alone, the combination is more effective on nutsedge and morningglory and provides residual control of susceptible broadleaf weeds. See comments for glyphosate alone.

Table 5.108 - Relative Effectiveness of Herbicides for Grass Weed Control in Cotton¹

	Goosegrass	Broadleaf signalgrass	Crabgrass	Fall panicum	Foxtails	Johnsongrass (seedling)	Johnsongrass (rhizome)	Texas panicum	Purple & Yellow nutseidge	Shattercane	Bermudagrass
<i>Preplant Incorporated</i>											
Prowl	G	G	E	G	E	G	P	G	N	G	P
Treflan	G	G	E	G	E	G	P	G	N	G	P
<i>Preemergence</i>											
Brake + Reflex	G	F-G	G	-	-	-	N	P	P-G	-	N
Brake + Cotoran	G	P	G	F	F-G	P	N	P	N	-	N
Cotoran	F-G	P	F-G	F	G	P	P	P	P	P	P
Direx	F	P	F-G	F	F-G	P	P	P	P	P	P
Reflex	-	F-G	F-G	-	-	-	-	F	P-G	F	N
Staple LX	P-F	P	P	P-F	P	F-G	N	N	F	-	N
Warrant	E	G	E	E	E	P-F	N	P-F	P	N	N
Warrant Ultra	E	G	E	E	E	P-F	N	P-F	P	N	N
<i>Postemergence/Postemergence Directed</i>											
Assure II/Assure II	E	E	F	E	E	E	E	E	N	E	G
Caparol/Cotton-Pro	P	P	P	P	P	P	P	P	P	P	P
Cobra	P	P	P	P	P	P	P	P	P	P	P
Cotoran	P	P	P	P	P	P	P	P	P	P	P
Dual Magnum ²	E	G	E	G-E	E	F	N	P-F	F	P-F	N
Enlist Duo	E	E	E	E	E	E	G	P-F	F-G	E	F
Engenia/XtendiMax + Glyphosate	E	E	E	E	E	E	G	E	F-G	E	F
Envoke	P	P	P	P	P	P	N	P	P-G	P	N
Fusilade	E	G-E	G	E	E	E	G-E	G	N	E	G-E
Fusion	E	E	G	E	E	E	G	G	N	E	G
Layby Pro	G-E	G-E	G-E	G-E	G-E	P	P	G-E	N	P	N
Liberty 280	G	G	G	G	G	G	P-G	G	P-G	F	P
Linex	P	P	P	P	P	P	P	P	N	P	N
MSMA/DSMA	G	G	G	G	G	G	F	P-F	F-G	G	P
Poast	E	E	G	E	E	E	G	E	N	E	F-G
Glyphosate	E	E	E	E	E	E	G	E	F-G	E	F
Select Max	F	E	G	E	E	E	G	E	N	E	G
Sequence	E	E	E	E	E	E	G	E	F-G	E	P-F
Staple LX	N-P	N-P	N-P	N-P	N-P	N-P	N-P	N-P	N-F	N-P	N-P
Warrant ²	E	G	E	E	E	P-F	N	P-F	P	N	N
Zidua ²	E	G	E	G-E	E	F	N	F	P-F	P-F	N

¹E (Excellent) = 90 to 100 percent control, G (Good) = 80 to 90 percent control, F (Fair) = 60 to 80 percent control, P (Poor) = 20 to 60 percent control, N (None) = less than 20 percent control.

²Dual Magnum, Warrant, and Zidua will not control emerged weeds. These products provide residual control only.

Table 5.109 - Relative Effectiveness of Herbicides for Broadleaf Weed Control in Cotton¹

	Cocklebur	Jimsonweed	Lambsquarters	Morningglory (annual spp.)	Pigweed	Tropic Croton	Common Ragweed	Sicklepod	Smartweed	Spurred anoda	Prickly sida or teaweed	Velvetleaf
<i>Preplant Incorporated</i>												
Prowl	N	N	G	P	G	P	N	N	P	N	N	P-F
Treflan	N	N	G	P	G	P	N	N	P	N	N	N
<i>Preemergence</i>												
Brake + Reflex	G	G	E	F	E	G	G	P	-	G	-	-
Brake + Cotoran	G	G	E	G	E	F-G	E	G	G	G	G	F
Cotoran	F	F	E	F	G	F	G	F	F	F	F-G	F
Direx	F	G	E	F	G	F-G	G	F	G	F	F	P-F
Reflex	G	G	E	P-F	E	F-G	G	P	-	-	-	-
Staple LX	P	F-G	G	P-F	G	F-G	N-P	P-F	G	G	E	E
Warrant ²	N	N	P-F	N	E	N	P	N	N	N	P	N
Warrant Ultra	G	-	E	P-F	E	F-G	G	P	-	-	-	-
<i>Postemergence/Postemergence Directed</i>												
Aim	G	F	G	G	G	-	P	N-P	G	G	P	G
Assure II/Assure II	N	N	N	N	N	N	N	N	N	N	N	N
Caparol/ Cotton-Pro	E	F-G	G	F	G	G	G-E	F	G	P	F-G	F
Cobra	E	G-E	P-F	P-F	E	F-G	G	P-F	F	F	E	G
Cotoran	E	F-G	G	F	G	P-F	G-E	F	G	P	F-G	P
Dual Magnum ²	N	N	P-F	N	E	N	P	N	N	N	N	N
Enlist Duo	E	E	E	E	E	E	E	E	G	E	G	E
Engenia/XtendiMax + glyphosate	E	E	E	E	E	E	E	E	E	E	G	E
Envoke	E	E	G-E	E	G-E	P-G	G-E	E	-	P-F	F-G	G
Fusilade	N	N	N	N	N	N	N	N	N	N	N	N
Fusion	N	N	N	N	N	N	N	N	N	N	N	N
Liberty 280	E	E	G-E	E	F-G	E	E	E	E	G-E	E	G-E
Layby Pro	G-E	G	G-E	G-E	G-E	F-G	G-E	G-E	G-E	P-F	G-E	G-E
Linex	G	G	G	F-G	G-E	P-F	F-G	G	F	P	F-G	P-F
MSMA/DSMA	E	F	P-F	P	P-F	P-F	F	P	P	P	P	P
Poast	N	N	N	N	N	N	N	N	N	N	N	N
Glyphosate	E	E	F-G	F	G-E	G	F	G-E	F	G	F-G	G
Select Max	N	N	N	N	N	N	N	N	N	N	N	N
Sequence	E	E	F-G	F	G-E	G	F	G-E	G	G	F-G	G
Staple LX	G-E	E	P	G	E	N	P	N-P	G-E	F-G	F-G	E
Valor	G	F	G	G	G	-	P	N-P	G	G	P	G
Warrant ²	N	N	P-F	N	E	N	P	N	N	N	P	N
Zidua ²	N	F	F-G	N	E	N	P-F	N	F	N	N	P

¹E (Excellent) = 90 to 100 percent control, G (Good) = 80 to 90 percent control, F (Fair) = 60 to 80 percent control, P (Poor) = 20 to 60 percent control, N (None) = less than 20 percent control.

²Dual Magnum, Warrant, and Zidua will not control emerged weeds. These products provide residual control only.

Table 5.110 - Burndown Herbicides for Stale Seedbed and Conservation Tillage Cotton for Application 30 to 45 Days Prior to Planting

Weed Species/ Cover Crop	Herbicide & Rate per Acre				
	2,4D ¹ 1.0 pt	Gramoxone SL 3.0 pt	Glyphosate (see labels for rates)	Harmony Extra ² 0.5 oz	Valor ³ 1.0-1.5 oz
Annual grasses	N	G-E	E	P	P
Carolina geranium	P-F	G-E	P-F	G	G
Chickweed, common	P	E	G	E	P
Curly dock	F-G	N	P-F	G	P
Cutleaf eveningprimrose	G	P	P	F	G
Henbit	P	G	G	E	F-G
Horseweed (marestail)	P-F	P	G	G	P
Wheat/rye	N	E	E ⁴	P	P
Wild mustard	G-E	P-F	F	G	F
Wild radish	G-E	P-F	F	G	F

E (Excellent) = 90 to 100 percent control, G (Good) = 80% to 90%, F (Fair) = 60 to 80%, P (Poor) = 20 to 60%, N (None) = less than 20%.

¹Apply at least 30 days prior to planting.

²Apply at least 45 days prior to planting.

³Apply at least 30 days prior to planting (tank mixed with glyphosate products).

Table 5.111 - Burndown Herbicides for Stale Seedbed and Conservation Tillage Cotton for Application 7 to 21 Days Prior to Planting

Weed Species/Cover Crop	Herbicide & Rate per Acre		
	Clarity ¹ 8.0 oz	Gramoxone SL 3.0 pt	Glyphosate (see labels for rates)
Annual grasses	N	G-E	E
Carolina geranium	G	G-E	P-F
Chickweed, common	P-F	E	G
Curly dock	F-G	N	P-F
Cutleaf eveningprimrose	F-G	P	P
Henbit	F	G	G
Horseweed (marestail)	F	P	G
Wheat/rye	N	E	E
Wild mustard	F	P-F	F
Wild radish	F	P-F	F

E (Excellent) = 90 to 100 percent control, G (Good) = 80% to 90%, F (Fair) = 60 to 80%, P (Poor) = 20 to 60%, N (None) = less than 20%.

¹Following application of Clarity, a minimum accumulation of 1 in rainfall or irrigation water and a waiting interval of 21 days is required prior to planting cotton.

Table 5.112 - Application Rates and Perennial Grass Sizes for Treatment with Assure, Fusilade DX, Fusion, Poast, Poast Plus, Select¹, and Select Max¹

(Rain-free period is 1 hour for each herbicide listed below.)

Herbicide	Weed	Weed Size and Herbicide Rate (oz/A)	
		First Application	Second Application ²
Assure II	Rhizome johnsongrass	10- to 24-inch tall 5.0 oz	6- to 10-inch tall 5.0 oz
	Bermudagrass	up to 6-inch runners 10.0-12.0 oz	up to 6-inch runners 7.0 oz
Fusilade DX	Rhizome johnsongrass	8- to 18-inch tall 12.0 oz	6- to 12-inch tall 8.0 oz
	Bermudagrass	4- to 8-inch runners 12.0 oz	4- to 8-inch runners 8.0 oz
Fusion	Rhizome johnsongrass	8- to 18-inch tall 10.0-12.0 oz	6- to 12-inch tall 8.0 oz
	Bermudagrass	4- to 8-inch runners 12.0 oz	4- to 8-inch runners 8.0 oz
Poast	Rhizome johnsongrass	15- to 25-inch tall 24.0 oz	6- to 12-inch tall 16.0 oz
	Bermudagrass	6-inch runners 24.0 oz	1- to 4-inch runners 16.0 oz
Poast Plus	Rhizome johnsongrass	15- to 25-inch tall 36.0 oz	6- to 12-inch tall 24.0 oz
	Bermudagrass	6-inch runners 36.0 oz	1- to 4-inch runners 24.0 oz
Select	Rhizome johnsongrass	12- to 24-inch tall 8.0-16.0 oz	6- to 18-inch tall 6.0-8.0 oz
	Bermudagrass	3- to 6-inch runners 8.0-16.0 oz	3- to 6-inch runners 8.0-16.0 oz
Select Max	Rhizome johnsongrass	12- to 24-inch tall 12.0-32.0 oz	9.0-24.0 oz
	Bermudagrass	3- to 6-inch runners 12.0-32.0 oz	12.0-32.0 oz

¹Taken from product labels.²Make second application only if needed to control regrowth or new plants. Size refers to regrowth or new plants.

Table 5.113 - Application Rates and Annual Grass Sizes for Treatment with Assure II, Fusilade DX, Fusion, Poast, Poast Plus, Select¹, and Select Max¹

(Rain-free period is 1 hour for each herbicide listed below.)

Species	Poast		Poast Plus		Fusilade DX		Fusion		Assure II		Select		Select Max	
	Height (in.)	Rate (oz/A)	Height (in.)	Rate (oz/A)	Height (in.)	Rate (oz/A)	Height (in.)	Rate (oz.)	Height (in.)	Rate (oz/A)	Height (in.)	Rate (oz/A)	Height (in.)	Rate (oz/A)
Barnyardgrass	8	16	8	24	2-3	12	2-4	8	2-6	8-10	2-8	6-8	2-8	9-16
Broadleaf signalgrass	8	16	8	24	2-4	12	2-4	8-10	2-6	10	2-6	6-8	2-6	9-16
Crabgrass	6	16	6	24	1-2	12	1-4	8	2-6	8-10	2-6	6-8	2-6	9-16
Crowfootgrass	—	—	—	—	—	—	—	—	2-6	7-8	2-6	6-8	2-6	9-16
Fall panicum	8	16	8	24	2-6	12	2-6	8	2-6	7-8	2-6	6-8	2-6	9-16
Foxtails, Giant	8	16	8	24	2-6	12	2-8	7	2-8	7-8	2-12	6-8	2-12	9-16
Foxtails, Green	8	16	8	24	2-4	12	2-4	8	2-4	7-8	2-8	6-8	2-8	9-16
Foxtails, Yellow	8	16	8	24	2-4	12	2-4	8	2-4	7-8	2-8	6-8	2-8	9-16
Goosegrass	6	16	6	24	2-4	8	2-4	8	2-6	7-8	2-6	6-8	2-6	9-16
Seedling johnsongrass	8	16	8	24	2-8	6	2-8	6	2-8	5-8	4-10	6-8	4-10	9-16
Sandbur	3	20	3	30	2-6	12	2-6	8	2-6	7-8	2-6	6-8	2-6	9-16
Shattercane	18	16	18	24	6-12	6	6-12	6	6-12	5-8	4-10	6-8	4-10	9-16
Texas panicum	8	16	8	24	2-8	12	2-8	8	2-4	8-10	2-6	6-8	2-6	9-16
Volunteer corn	20	16	20	24	12-24	6	12-24	6	6-18	5-8	4-12	4-6	4-12	6-12

¹Taken from product labels; — control not claimed on label.**Table 5.114 - Rotational Restrictions**

The herbicides listed below, when used in cotton, may influence one's ability to rotate crops in a normal fashion. Labeled rotational intervals which are discussed below may be influenced by many factors such as the addition of other residual herbicides, soil type, soil pH, etc. Do not use these herbicides unless all rotational restrictions are understood.

Herbicide	Rotation Restrictions
Aim	Corn, sweetcorn, popcorn, soybeans, grain sorghum, rice, wheat, barley, oats, buckwheat, pearl millet, proso millet, rye, teosinte, triticale, and wild rice may be planted any time following an application of Aim. Root and leafy vegetables may be planted after 30 days following an application of Aim. All other crops may be planted after 12 months following an application of Aim.
Assure II	Do not rotate to crops other than soybeans or cotton within 120 days of application. See label for additional rotational crops allowed.
Caparol/Cotton-Pro	Do not plant rotational crops until the following year.
Cobra	No crop rotation restrictions.
Cotoran	Do not plant crops other than cotton within 6 months of the last application of Cotoran/Meturon.
DSMA/MSMA	No restrictive statements listed on label.
Dual	Barley, oats, rye, or wheat may be planted 4 months following application. Crops on Dual label may be planted in the spring following application. All other rotation crops may be planted 12 months after application.

Table 5.114 - Rotational Restrictions (cont.)

The herbicides listed below, when used in cotton, may influence one's ability to rotate crops in a normal fashion. Labeled rotational intervals which are discussed below may be influenced by many factors such as the addition of other residual herbicides, soil type, soil pH, etc. Do not use these herbicides unless all rotational restrictions are understood.

Herbicide	Rotation Restrictions
Envoke	Crop rotation interval restrictions based on a total of 0.4 oz/A of Envoke per season are as follows: winter wheat and transplanted tomato (3 months); cotton, field and sweet corn, grain sorghum, peanut, soybean, and transplanted tobacco (7 months); transplanted bell pepper and Irish potato (12 months but based on field bioassay); and all other crops (18 months). If there is a cotton crop failure and no more than 0.15 oz/A of Envoke has been applied, cotton or STS-soybean (sulfonyleurea-tolerant soybean) may be replanted 30 or more days after the Envoke application, or 14 or more days after the first significant rainfall (≥ 0.5 inches) following the Envoke application.
Fierce	Crop rotation restrictions based on 3 oz/A of Fierce are as follows: Alfalfa (10 months); Conv. till field corn (1 month); Reduced till field corn (7 days); Conv. till cotton (45 days); Reduced till cotton (1 month); Edible peas and other edible beans except field peas (11 months); Grass grown for seed (18 months); Lentils (6 months); Peanuts (4 months); Field Peas (6 months); Potato (4 months); Rice (10 months); Small grains other than wheat (11 months); Soybean (0 days); Sugarbeet (15 months); Sunflower (4 months); Sweet potato (4 months); Tobacco (12 months); Wheat (1 month); Other crops not listed (18 months). Rotational restrictions vary by rate. Consult the label for restrictions at higher rates.
Fusilade DX	Do not plant rotational grass crops such as corn, sorghum, and cereals within 60 days of last application.
Fusion	Do not plant rotational grass crops such as corn, sorghum, and cereals within 60 days of last application.
Glyphosate	No rotational restrictions.
Goal	Do not rotate to barley, corn, oats, sorghum, triticale, or wheat within 10 months following application. Do not direct seed any crops other than Goal-labeled crops within 60 days of treatment. Do not transplant seedling crops other than Goal-label crops within 30 days of treatment.
Layby Pro	Only cotton, corn, and grain sorghum can be planted the spring following the Layby Pro post-directed application. All other crops cannot be planted in the treated area within 1 year after the last Layby Pro application, or severe injury to subsequent crops may occur.
Liberty 280	Canola, corn, cotton, rice, soybeans, and sugar beets may be planted at any time. Root and tuber crops, leafy vegetables, brassica leafy vegetables, and small grains may be planted in 70 days. All other crops may be planted in 180 days.
Linex	Do not plant rotational crops other than corn, soybeans or potatoes within 4 months after application.
Poast/Poast Plus	No rotational restrictions.
Prowl	Winter wheat or winter barley may be planted 120 days after application. Any crop other than sugar-beets, red beets or spinach may be planted the year following application.
Reflex	Cotton, dry beans, snap beans, and soybeans may be planted any time after last Reflex application. Small grains may be planted in 4 months; corn, peanuts, peas, rice, and seed corn in 10 months. To avoid injury, do not plant alfalfa, sunflower, sugar beets, sorghum or any other crop within 18 months after last Reflex application. A maximum of 1.5 pt/A of Reflex may be applied in alternate years in Region 2 (Virginia).
Select/Select Max	No rotational restrictions.
Sequence	Barley, oats, rye, or wheat may be planted 4 months following application. All crops with a label for metolachlor (Dual) may be planted in the spring following the application. All other rotation crops may be planted 12 months after application.
Staple LX	Crop rotation interval restrictions for Staple are as follows: winter wheat (4 months); field corn, peanut, soybean, and transplanted tobacco (10 months); and all other crops are based on field bioassay or a minimum of 10 months. If there is a cotton crop failure following a Staple application, cotton may be replanted anytime (without disturbing original seedbed) or STS-soybean (sulfonyleurea-tolerant soybean) may be replanted 30 days after the Staple application.

Table 5.114 - Rotational Restrictions (cont.)

The herbicides listed below, when used in cotton, may influence one's ability to rotate crops in a normal fashion. Labeled rotational intervals which are discussed below may be influenced by many factors such as the addition of other residual herbicides, soil type, soil pH, etc. Do not use these herbicides unless all rotational restrictions are understood.

Herbicide	Rotation Restrictions
Treflan	Sugar beets, red beets or spinach should not be planted within 12 months of a spring application. Vegetable crops other than those listed on the Treflan label should not be planted within 5 months of application.
Valor	<p>Crop rotation interval restrictions based on a total of 2 oz/A of Valor per season are as follows: cotton, field corn, sorghum, sunflower, tobacco, and wheat (30 days); barley, dry bean, field pea, rye, and sweet corn (4 months); alfalfa, canola, clover, oats, and all other crops not listed (12 months). At least one inch of rainfall/irrigation must occur between application and planting or crop injury may occur. Successful soil bioassay must be performed prior to planting alfalfa, canola, sugar beets, and other crops not listed.</p> <p>Preplant burndown applications of Valor 51WDG may injure cotton if planted too soon. Valor at 1.0 oz/A will give 2 to 4 weeks' control of lambsquarters, pigweed, prickly sida, spurge, and Florida pusley; and at 2.0 oz/A will give 6 to 8 weeks' control of these species. Application to cover crop or dense weed stand may reduce residual control. Tillage after application will reduce or eliminate residual control. A minimum of 14 days and a 1-inch rainfall must occur between Valor application and cotton planting when Valor is applied at 1.0 oz/A; 21 days must pass and a 1-inch rainfall when applied at 1.5 to 2.0 oz/A. Valor at 2.0 oz/A may be applied up to 14 days prior to planting strip-till cotton. A tillage application must occur between application and cotton planting in order to prevent any potential injury to emerging cotton plants. Failure to conduct strip-tillage operation prior to planting may result in cotton injury. Strip-tillage operation must incorporate soil to a depth of 1 to 2 inches.</p>
Warrant	<p>Corn (all types), cotton, soybeans, and milo (sorghum) may be replanted immediately, but could result in crop injury. When planting milo use only seed treated with protectant or safener. DO NOT exceed a total of 3 lbs acetochlor/A if additional product is applied.</p> <p>Nongrass animal feeds such as alfalfa, clover, and vetch species may be planted 9 months, after application. Wheat may be planted 4 months after application.</p> <p>The following crops may be rotated in next season: buchwheat, millet (pearl and proso), oats, rye, and certain bean species (<i>see label for additional information</i>).</p>
Zidua	<p>Crop rotation restrictions based on 2 oz/A of Zidua are as follows: Alfalfa (10 months); Canola/Rapeseed (12 months); Corn (0 days); Cotton (2 months); Edible peas, succulent edible beans, and other edible dry beans (11 months); Grain sorghum (6 months); Grass grown for seed (18 months); Lentils (6 months); Peanuts (4 months); Field Peas (6 months); Potato (4 months); Rice (12 months); Small grains other than wheat (11 months); Soybean (0 days); Sugarbeet (12 months); Sunflower (4 months); Wheat (1 month); Other crops not listed (18 months). Rotational restrictions vary by rate. Consult the label for restrictions at lower or higher rates.</p>

Table 5.115 - Cotton Herbicide Half-lives and Their Potential to Injure Fall-established Cover Crops

This table does not directly address preharvest establishment of cover crops such as interseeding or aerial seeding, which may be more restrictive. Cover crops that are harvested are subject to herbicide residue restrictions, which are not addressed in this table.

Trade Name	Common Name	Normal Rate/Acre	Half-life (days) ¹	Fall-established Cover Crops		
				OK to plant	Concern for	Other
2,4-D	2,4-D	1–2 pt	7	All grasses	Wait 30 days before planting sensitive broadleaves	Amine formulations more water soluble and can leach into seed zone
Assure II/Targa 0.88E	quizalofop	8 oz	60	Most broadleaves	All grasses if less than 120 days or at high rates	Plant anything after 120 days
Caparol 4L	prometryn	3.2 pt	60	None	Most crops	12 month rotation restriction to most crops
Cotoran 4L	fluometuron	3.2 pt	85	None	Most crops if less than 4 months	Application rate and weather can greatly influence persistence
Direx 4L/Karmex DF	diuron	1 qt	90	None	Most crops	Conduct field bioassay prior to planting
Dual II Magnum 7.62E/Cinch	metolachlor	1.33 pt	15–50	Cereal grains, legumes	Annual ryegrass or other small-seeded grasses	Higher rates and later applications more of a potential problem
Envoke	trifloxysulfuron	0.10 oz	5–15	Cereal grains	Most broadleaves, especially clovers and radishes	Warm, moist conditions cause to rapidly degrade in soil
Fusilade DX	fluazifop	4 fl oz	15	Broadleaves	Cereal grains if less than 60 days	
Glyphosate 4L	glyphosate	0.75–1.25 lb ae	47 ³	All	None	Glyphosate does not have soil activity at normal use rates
Gramoxone 2S	paraquat	2 pt	1,000 ³	All	None	Paraquat does not have soil activity at normal use rates
Liberty 2.34L	glufosinate	29–43 fl oz	7 ³	All	Food or feed residues rather than crop injury may be a concern	Glufosinate has no soil activity at normal use rates

Table 5.115 - Cotton Herbicide Half-lives and Their Potential to Injure Fall-established Cover Crops (cont.)

Trade Name	Common Name	Normal Rate/Acre	Half-life (days) ¹	Fall-established Cover Crops		
				OK to plant	Concern for	Other
Linex 4L/Lorox DF	linuron	2 pt	60	Cereal grains and radishes	Clovers and rapeseed	Spring applications are safe to fall planted cover crops.
MSMA 6.0	MSMA	2.66 pt	180			No restrictive statements listed on label
Outlook 6E	dimethenamid	16 fl oz	20	Most crops should be fine	Food or feed residues rather than crop injury may be a concern.	Nonfood/feed winter cover crops should be OK after corn harvest.
Prowl H2O 3.8CS	pendimethalin	1.1–1.6 pt	44	Cereal grains	Small-seeded legumes and annual ryegrass	We have not seen this herbicide carry over in the Mid-Atlantic; nonfood/feed winter cover crops should be OK.
Resource	flumiclorac	2–4 fl oz	1–6	None	None assuming at least 30 days	No rotational crop restrictions
Reflex 2E/ Flexstar 1.88E (Warrant Ultra)	fomesafen	1.0 pt	100	Cereal grains	Small-seeded legumes, sorghum. Do not plant mustards.	Since fomesafen is often applied postemergence, soil activity can surprise users.
Select 2E	clethodim	6–16 fl oz	3	All broadleaves	None assuming at least 30 days	Plant anything after 30 days
Staple LX	pyrithiobac	1.3–2.1 oz	60	Cereal grains if more than 4 months	Most broadleaves	Conduct field bioassay prior to planting.
Treflan	trifluralin	1.0–1.5 pt/a	164	Cereal grains	Small-seeded legumes and annual ryegrass	Carry over not observed in the Mid-Atlantic; fall planted cover crops should be OK.
Valor 51WDG	flumioxazin	1.0–2.0 oz	12–20	All grasses	Small-seeded legumes and mustards	Based on the half-life, all nonfood/feed winter cover crops should be OK.
Warrant	acetochlor	3 pt	10–20	Most crops should be fine	Food or feed residues rather than crop injury may be a concern.	Nonfood/feed winter cover crops are allowed after corn harvest.

Table 5.115 - Cotton Herbicide Half-lives and Their Potential to Injure Fall-established Cover Crops (cont.)

Trade Name	Common Name	Normal Rate/Acre	Half-life (days) ¹	Fall-established Cover Crops		
				OK to plant	Concern for	Other
Zidua	pyroxasulfone	1.5 oz	20	Most crops should be fine	Food or feed residues rather than crop injury may be a concern.	Nonfood/feed winter cover crops should be OK after corn harvest.

¹ The herbicide half-life is defined as the time it takes for 50 percent of the herbicide active ingredient to dissipate. See the "Managing Herbicides" section for additional information. Herbicide half-life estimates are derived for the WSSA Herbicide Handbook and other scientific literature.

² Common small-seeded legumes include alfalfa, clovers, and hairy vetch.

³ This herbicide does not have soil residual activity at normal application rates.

Cotton Growth Regulators

William Hunter Frame, Assistant Professor, Field Crops Agronomist, Tidewater AREC

Table 6.1 - Plant Growth Regulation (PGR)

Objective	Chemical rate per acre	Product per acre	Remarks and Precautions
Plant growth regulation	mepiquat chloride 0.35 lb or mepiquat chloride + <i>bacillus cereus</i> or kinetin 0.35 lb or mepiquat pentaborate 0.82 lb	Pix, Mepex 4.0-8.0 oz or Pix Plus, Mepex 4.0-8.0 oz or Pentia 4.0-8.0 oz	Although plant growth regulator applications can be an important part of an overall cotton management program, they can result in reduced yields if applied while plants are undergoing stressful (especially moisture) conditions. Before applying plant growth regulators, variety, soil type, fertility, irrigation potential, and field history must be taken into consideration.

Note: Maximum of 48 oz of mepiquat chloride may be applied/A/growing season.

Timing Suggestions – the Modified Early Bloom Technique

The modified early bloom strategy involves the use of height to node ratios and the measurement of the most recently expanded internode length. The most recently expanded internode is measured by counting down the plant from the highest mainstem leaf (>quarter size) to the fourth leaf. Examine the internode above and below the fourth leaf and measure the larger of the two. This is a good indicator of the plant vigor over that past week or so. Long internodes will range between 2.5 to 3 inches while short internodes will be below 2.0 inches. The tables below are provided to aid in determining Pix application decisions using the modified early bloom strategy.

Table 6.2 - Matchhead Square (MHS) (typically 3rd to 4th week in June)

	Plant height		
	<17 in	17-20 in	>20 in
Height to node ratio >1.85 in	4 oz	6 oz	8 oz
Internode ¹ >2.5 in	4 oz	6 oz	8 oz

Do not apply if soil moisture is poor.

¹Most recently expanded internode (see measurement description above).

Table 6.3 - Early Bloom – Use this chart if PGR was applied at MHS

	Plant height			
	<24 in	24-27 in	27-30 in	>30 in
Internode ¹ >2.5 in	0 oz	8 oz	10 oz	12 oz

Do not apply if soil moisture is poor.

Do not apply if nodes above the highest first position white bloom <7.

¹Most recently expanded internode (see measurement description above).

6-2 Plant Regulators: *Cotton Growth Regulators*

Table 6.4 - Early Bloom – Use this chart if no PGR has been applied

	Plant height			
	<24 in	24-27 in	27-30 in	>30 in
Internode ¹ >2.5 in	6 oz	8 oz	12 oz	16 oz

Do not apply if soil moisture is poor.

Do not apply if nodes above the highest first position white bloom <7.

¹Most recently expanded internode (see measurement description above).

Table 6.5 - 10 to 14 Days after Early Bloom

	Pix applied at early bloom	
	<8 oz	>8 oz
Internode ¹ <2.5 in	0 oz	0 oz
Internode 2.5-3.5 in	12 oz	8 oz
Internode >3.5 in	16 oz	12 oz

Do not apply if soil moisture is poor.

Do not apply if nodes above the highest first position white bloom <6.

¹Most recently expanded internode (see measurement description above).

Cotton Harvest Aids

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Table 6.6 - Cotton Harvest Aids

	Defoliation Only, Field Cutout	Defoliation with Regrowth Anticipated	Defoliation and Boll Opening	Defoliation and Boll Opening With Regrowth Anticipation
Def 6/Folex 6EC	1.33-1.5 pt			
Def 6/Folex 6EC + Dropp SC		1.0-1.5 pt + 1.6-6.4 (9.6 NTE fl oz) ¹		
Def 6/Folex 6EC ethephon 6EC ²			1.0-1.5 pt + 5.3 fl oz	
Def 6/Folex 6EC ethephon 6EC ² Dropp SC				1.0-1.5 pt + 5.3 fl oz + 1.6-6.4 (9.6 NTE fl oz) ¹
ethephon 6EC ²			1.33-2.67 pt	
Finish 6SC	1.3-2.0-2.67 pt temperature related		1.3-2.0-2.67 pt temperature related	
Finish 6SC + Dropp SC		1.3-2.0 pt + 1.6-6.4 (9.6 NTE fl oz) ¹		1.3-2.0 pt + 1.6-6.4 (9.6 NTE fl oz) ¹
Finish 6SC + Def 6/Folex 6EC			1.3-2.0 pt + 1.0-1.5 pt	
FirstPick	3.0-3.5 qt		3.0-3.5 qt	
FirstPick + Dropp SC		1.5-2.0 qt + 0.8-3.2 fl oz		1.5-2.0 qt + 0.8-3.2 fl oz
FirstPick + Def 6/Folex 6EC			1.5-2.0 qt + 4.0-12.0 fl oz	
Dropp SC		1.6-6.4 (9.6 NTE fl oz) ¹		
Dropp SC + ethephon 6EC ²			1.6-6.4 (9.6 NTE fl oz) ¹ + 1.33-2.67 pt	1.6-6.4 (9.6 NTE fl oz) ¹ + 1.33-2.67 pt

¹NTE = not to exceed

²The active ingredient Ethephon is available as 6EC formulations as a number of trade name products such as Prep, Ethephon, Super Boll, etc.

³COC = crop oil concentrate

Defoliation Materials

Def 6, Folex: These phosphate-based compounds have been a standard defoliant for many years and provide good defoliation of older, more mature leaves in well cutout cotton. These products provide minimal regrowth inhibition and are typically mixed with other products (e.g. ethephon-Prep, Super Boll, etc.). They are similar in efficacy and will perform well over a wide range of environmental conditions. However, the high end of the labeled rate performs best in cool conditions. Leaf drop is fast and they only require a rain-free period of two hours. The activity of these compounds improves with increased cutout of the crop. The addition of surfactants or crop oils can increase activity under adverse conditions. The pungent odor of these products may be a consideration in populated areas.

Dropp 50 WP and SC, Freefall 50 WP, etc. (thidiazuron): Dropp and Freefall defoliate mature leaves, have excellent activity on juvenile leaves, and suppress or delay regrowth. A minimum of 0.1 pound per acre WP or 1.6 fl. ounces per acre is needed for 10 to 14 days of regrowth inhibition. Higher rates will result in longer periods of regrowth inhibition. Thidiazuron alone is usually equal to or better than other defoliant in drought-stressed situations where leaves have thick cuticles. Dropp and Freefall are

6-4 Plant Regulators: *Cotton Harvest Aids*

somewhat slower acting than other defoliant and their activity is temperature dependent. Temperatures less than 65°F will reduce activity; however, the addition of crop oil concentrate or a phosphate-type defoliant will help the activity of thidiazuron under cooler conditions. The addition of 2 to 4 ounces per acre of Def or Folex will shorten the 24-hour required rain-free period. The label provides specific tank clean-out procedures when using thidiazuron-containing materials to avoid premature defoliation when the sprayer is used the following year. When thidiazuron is tank mixed with a phosphate defoliant or insecticide, the label recommends a surfactant to aid in tank clean out. When using the WP formulation, thorough rinsing is critical.

Ginstar: Ginstar is a premix emulsifiable concentrate of thidiazuron (active ingredient in Dropp and Freefall) and diuron. Ginstar has been found to be more active under cool conditions than most thidiazuron-containing materials. Ginstar is a strong inhibitor of terminal regrowth. It is more likely to cause unwanted desiccation and sticking of cotton leaves than thidiazuron alone. Tank mixing and higher rates increase the potential for leaf sticking. Labeled rates are 6.4 to 16 ounces per acre and growers are cautioned not to exceed 8 ounces with this product until more information is available from Virginia. Growers are cautioned that rates in excess of 10 ounces have shown a tendency to desiccate leaves. The label does not allow mixing with phosphate type defoliant (Def, Folex). However, ethephon-containing materials (Prep, SuperBoll, Finish, CottonQuik, etc.) can be tank mixed at low rates for enhanced defoliation. The use of adjuvants with Ginstar is not recommended. Pay close attention to rotational restrictions on the label. Research in Virginia with this product is limited. Pay attention to label for Virginia; some other state labels differ greatly. Pay close attention to rotational restrictions on the label.

Aim, ET, Blizzard, and Resource: These products have different active ingredients (carfentrazone, pyraflufen, fluthiacet, and flumiclorac, respectively) but similar modes of action. They are all contact herbicidal defoliant that do not appear to be extremely temperature sensitive. Research indicates they can cause excessive desiccation at high rates under warm condition where rank, juvenile growth is not present. They perform best in well-cutout cotton and can be beneficial when used as a second application. They provide regrowth control but have no residual activity and are good morningglory desiccants. These products can be mixed with most other defoliant/boll openers. See labels for adjuvant requirements and use restrictions.

Finish: Finish contains the active ingredient in Prep (ethephon) and a synergist (cyclanilide) that aids in defoliation. Finish tends to open bolls more rapidly than Prep alone and thus shortens the time to harvest. It is less temperature sensitive than most products. In situations where regrowth or added defoliation is needed, thidiazuron (Dropp, Freefall, etc) and/or Def/Folex should be added to the tank.

FirstPick: FirstPick weighs 12.45 pounds per gallon and contains 2.28 pounds of ethephon (Prep) and 7.30 pounds of a synergist (AMADS). Like Finish, it is an excellent boll opener. Acceptable defoliation with FirstPick typically occurs within 7 days in well-cutout cotton containing mature leaves. FirstPick also provides limited control of terminal regrowth. Where thick regrowth is a concern, add thidiazuron (Dropp, Prep, etc.). Def/Folex may be added to enhance defoliation of juvenile or rank growth. Thorough rinsing of the tank is recommended following application.

Roundup (glyphosate, many formulations): Glyphosate can be applied as a harvest aid material. Tank mixed with defoliant or ethephon, it provides regrowth inhibition in conventional (non-Roundup Ready) cotton. It also provides excellent control of perennial grasses. Check specific product labels for registrations as a harvest aid.

Boll-opening Materials

Although some boll openers are used to enhance the activity of defoliant, they are typically used to hasten the maturity of boll opening. Boll openers are meant to open mature bolls and can alter micronaire and fiber length if applied too early. They are not systemic, making thorough coverage essential. Boll openers are most beneficial for cotton that needs to be picked between 7 to 14 days following application. The active ingredient in Prep, ethephon, is also found as a premix in several products but is below the boll-opening rate. Check labels to make sure the boll-opening rate is applied, if this is the objective.

Ethephon 6, Prep, Super Boll, FirstPick, Finish (ethephon): With adequate spray coverage, ethephon products expedite natural boll opening. While ethephon can enhance defoliation, tank mixing with defoliation products (Def, Folex, Dropp, Freefall, Ginstar, ET, Blizzard, and/or Aim) is necessary for acceptable defoliation and/or regrowth control. Allow at least 7 days following application before harvest for optimum boll-opening effect. If cotton is not picked for more than 14 days following application, there is likely no advantage to ethephon use. FirstPick and Finish are combinations of ethephon and a synergist to increase defoliation and speed boll opening over ethephon alone. Bolls that are not mature at the time of application have little chance of opening in 14 days regardless of ethephon use. Do not mix with sodium chlorate due the potential for toxic fume formation.

Gramoxone SL (paraquat): Paraquat can enhance defoliation of juvenile growth when applied in combination with other

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defoliant although it will not inhibit regrowth. It can stimulate boll opening. High rates may result in excessive desiccation and “freezing” of closed bolls. It also can be used as a spot treatment for weed desiccation. It should not be applied at weed desiccation rates before cotton is at least 90% open and the remaining 10% are mature. It is necessary to pick within 7 days following paraquat application to avoid bark contamination. Consult label for use rates and pay close attention to precautions.

6-6 *Plant Regulators: Cotton Harvest Aids*

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