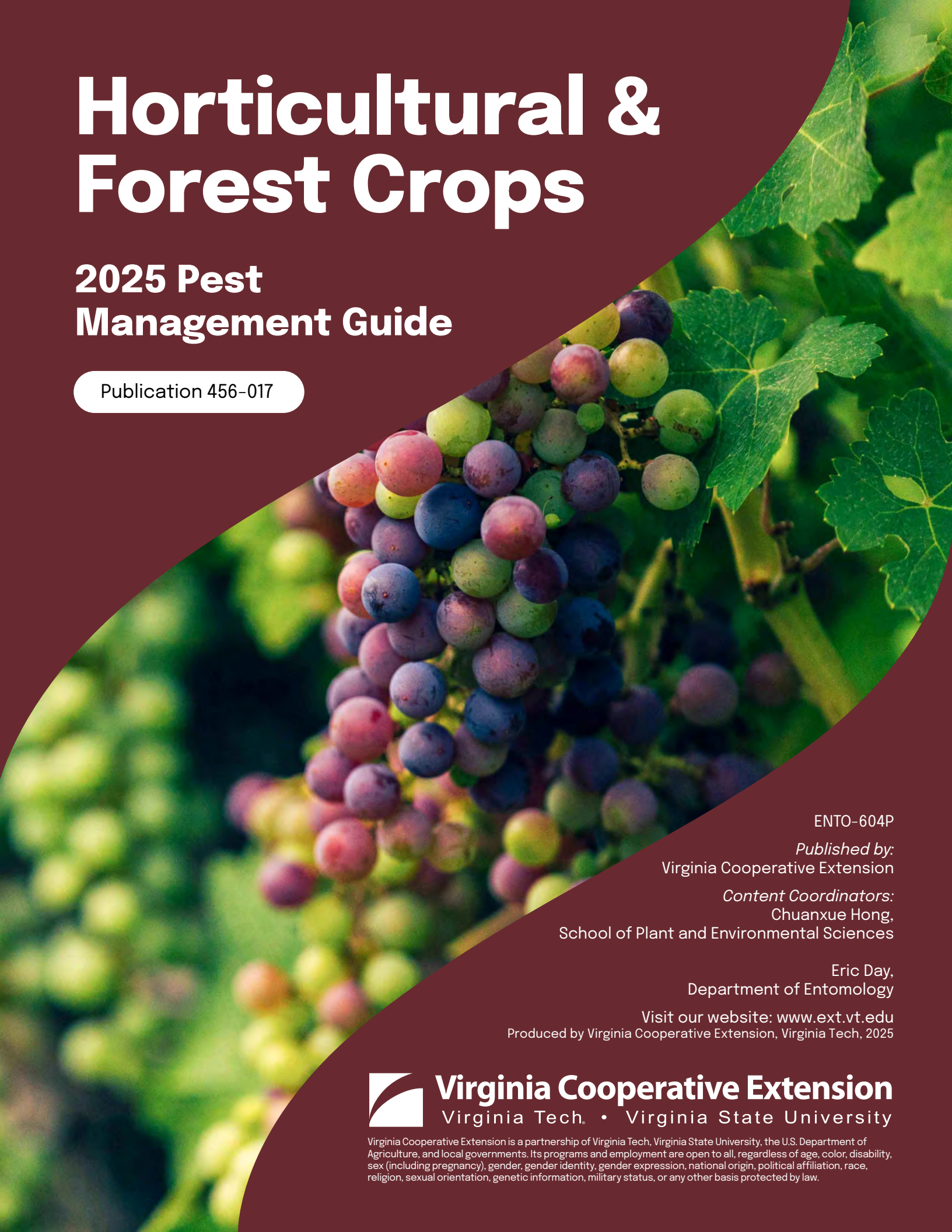
Horticultural & Forest Crops

2025 Pest Management Guide

Publication 456-017



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Virginia Cooperative Extension
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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.**

Horticultural and Forest Crops - 2025 - Chapter Section Table of Contents

Cover photograph courtesy of Sam Dean.

Table of Contents

8. Pests of Forestry and Christmas Trees

Regulations and Basic Information: Safe and Effective Use

Rachel Parson, Extension Associate, Virginia Tech Pesticide Programs
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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. The problem may not even be a pest problem, but nutrient deficiency or weather conditions. 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 https://ext.vt.edu/offices.html 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, and the Soil 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 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 farm worker protection, record keeping, 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 Applicators, Commercial 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 VDACS. The act and regulations which support it affect pesticide use in Virginia. Information concerning regulatory changes affecting pesticide use is available from Virginia Tech, VDACS-OPS 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 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 land) 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 recommendations for hire (ex. as a crop consultant).
  - **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. Private pesticide applicators must accumulate three credits per category every two years before their certificate expires. Private pesticide applicators may accumulate up to four years of recertification credit. Persons who fail to recertify will not be able to renew their certificates.

Virginia Cooperative Extension (VCE), pesticide-related trade and

professional organizations, and others offer pesticide applicator 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:
https://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 commercial 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 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 applicator must be accessible to the applicator by being either 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;
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 an restricted-use pesticide, the commercial 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.

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 record keeping 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 record keeping. 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.

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 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, back siphoning, 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.

The agency will inform users of enforceable use limitations by means of ESPP Bulletins Live! Two. 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.

Table 1.1 - Pesticide Application Record for Agricultural Producers in Virginia

Note: WPS requires posting of all pesticide application information at a central location for 30 days after the restricted-entry interval expires. USDA records of restricted-use pesticide applications must be kept for two years.

[3]Year Mo/Date ■ [1]Timeof Day	[2]Crop or Commodity	[3]Location & 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 (Hours)	Expiration (Mo/Date/Time)

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

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, and 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 of 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.

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 SDS before making a commitment to purchase. If a salesperson does not provide the information you request, the "bargain" is better passed by.

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.

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 (1-45) 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.

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, 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: https://poisoncenters.org/

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, WV
West Virginia Poison Center
3110 MacCorkle Ave., SE, Charleston, WV 25304
(800) 222-1222 www.wvpoisoncenter.org/

RICHMOND, VA
Virginia Poison Center
Virginia Commonwealth University Medical Center, VCU Health System
830 East Main Street, 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 https://poisoncenters.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 field 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:	
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 (804) 371-6560 Office of Pesticide Services Field Operations
For Assistance with Spills and Emergencies Take time to write your local emergency numbers in the space provided.	**State Police:**
	Fire Department:
	Ambulance:
	Virginia Department of Emergency Management (VDEM) (804) 897-6500 (Mon-Fri) 8:15am-5pm pio@vdem.virginia.gov - E-mail monitored during regular business hours. **Emergency Operations Center (804) 674-2400 (800) 468-8892** https://www.vaemergency.gov/contact 24 hours / day
	Local Emergency Services Coordinator:
	Local Emergency Response Council:

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/	(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 www.vdacs.virginia.gov/pesticides.shtml	(804) 786-3798
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 https://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 vetmed.vt.edu/ **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	(540) 231-4621 (hospital) Ask your veterinarian to call on your behalf (888) 426-4435

■ Pesticide Information Directory (continued)

General Information (cont.)		
Toxicology Information	**Virginia Dept. of Health** Division of Environmental Epidemiology/Toxicology Program 109 Governor Street, P.O. Box 2448, Richmond, VA 23218 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 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/

National Association of Landscape Professionals (NALP)
12500 Fair Lakes Circle, Suite 200
Fairfax, VA 22033
(800) 395-2522 (703) 736-9666 www.landscapeprofessionals.org

Virginia Turfgrass Council (VTC)
P.O. Box 5989, Virginia Beach, VA 23471
(757) 464-1004 vaturf.org/

Virginia Nursery and Landscape Association
5101 Monument Avenue
Suite 203
Richmond, VA 23230
804-256-2700 vnla.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 face shields), head (hats and hoods), and trunk 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.

2. Nitrile, Neoprene, or PVC - 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 (Table 1.3) for PPE material options.

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.

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 heavily 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 1.3 - EPA Chemical Resistance Category Selection Chart

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

	Type Of Personal Protective Material							
Selection Category Listed On Pesticide Label	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

[1]Includes 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.

Table 1.4 - Table 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
B = Bait
C = Concentrate
D = Dust
DF = Dry Flowable (see WDG)
E or EC = Emulsifiable Concentrate
F = Flowable
G = Granule
H/A = Harvest Aid
IE = Invert Emulsion
LC = Liquid Concentrate
M = Microencapsulated
P = Pellet
RTU = Ready to Use
S = Solution
SP = Soluble Powder
ULV = Ultra Low Volume
W or WP = Wettable Powder
WDG = Water Dispersible Granule (see DF)
WS = Water Soluble
WSP = Water Soluble Packet

■ 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]
[1] Example: 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. [2] Approximate 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
[1]1 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
[1]Based 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

	Concentrate lbs/A															
lbs/gal	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

	lbs										
% Active ingredients	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
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). Pesticides which have been canceled are given only as a reference to their toxicity and should not be used.

This list is for information purposes only and was 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:

A	- acaricide	IGR	- insect growth regulator
Anti	- antibiotic	M	- molluscicide
Av	- avicide	Mi	- miticide
B	- bactericide	N	- nematicide
F	- fungicide	PGR	- plant growth regulator
Fum	- fumigant	R	- rodenticide
H	- herbicide	Rep	- repellent
H A	- harvest aid (defoliant)	T	- termiticide
I	- insecticide	V	- vertebrate control

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 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.

RESTRICTED-USE PESTICIDES (1)

Those active ingredients having some or all products designated as restricted use are marked with a superscript one (1) in Table 1.15. 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 1.14 - Toxicity Categories

Toxicity Category	Signal Words* Required on Label by EPA	Oral LD50 (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.

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
abamectin	Agri-Mek[1], Avid, Sirocco[2]	I, Mi	IRAC-6	Warning
acephate	Orthene, Precise	I	IRAC-1	Caution
acequinocyl	Kanemite, Shuttle	Mi	IRAC-20	Caution
acetamiprid	Assail, Tristar	I	IRAC-4	Caution
acetic acid	Green Gobbler	H	-	Danger
acibenzolar-s-methyl	Actigard	F	FRAC-21	Caution
acifluorfen	Ultra Blazer	H	WSSA-14	Danger
afidopyropen	Ventigra	I	IRAC-9	Caution
Agrobacterium radiobacter	Galltrol-A	B	-	Caution
allyl isothiocyanate	Dominus	Fum	-	Danger
aluminum tris	see fosetyl-Al			
ametoctradin	Orvego[2], Zampro[2]	F	FRAC-45	Caution
aminocyclopyrachlor	Method	H	WSSA-4	Caution
aminopyralid	Milestone	H	WSSA-4	Caution
azadirachtin	Aza-Direct, Azatin, Azatrol, Ornazin, Neemix	F, I, IGR, Rep	-	Caution
azoxystrobin	Heritage, TopGuard EQ[2]	F	FRAC-11	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)
Bacillus amyloliquefaciens	Double Nickel, Triathlon, Cease, Stargus	B, F	-	Caution
Bacillus mycoides	LifeGard	F	FRAC-P5	Caution
Bacillus popilliae	Milky spore	I	-	Caution
Bacillus thuringiensis subsp. galleriea	Beetle Gone!, Grub Gone!	I	-	Caution
Bacillus thuringiensis subsp. kurstaki	DiPel, Thuricide	I	IRAC-11	Caution
Bacillus thuringiensis subsp. israelensis	Gnatrol	I	IRAC-11	Caution
Beauveria bassiana	Botanigard, Mycotrol	I	-	Caution
benefin (benfluralin)	Balan	H	WSSA-3	Caution
bensulide	Betamec, Betasan	H	WSSA-8	Caution
bentazon	Basagran	H	WSSA-6	Caution
benzovindiflupyr	Aprovia, Aprovia Top[2]	F	FRAC-7	Warning-Danger
bifenazate	Acramite, Engulf, Floramite, Sirocco[2]	Mi	IRAC-20	Caution-Warning
bifenthrin	Brigade[1], OnyxPro[1], Sniper[1], Talstar	I	IRAC-3	Caution-Warning
bispyribac-sodium	Tradewind, Velocity	H	WSSA-2	Caution
BLAD	Fracture	F	FRAC-BM1	Caution
Bordeaux mixture	copper sulfate and hydrated lime	B, F	-	Caution-Danger
boscalid	Emerald, Endura, Pageant[2]	F	FRAC-7	Caution-Warning
bromacil	various	H	WSSA-5	Caution
buprofezin	Applaud, Talus	I	IRAC-16	Caution
Burkholderia spp.	Majestene, Venerate	I, N	-	Caution
calcium polysulfide (lime sulfur)	various	F, Mi	FRAC-M2	Danger
capric/caprylic acids	FireWorxx	H	-	Caution
captan	Captan, Captec	F	FRAC-M4	Warning-Danger
carbaryl	Sevin	I	IRAC-1A	Caution
carfentrazone-ethyl	Aim, Quicksilver	H	WSSA-14	Caution
chlorantraniliprole	Acelepryn, Altacor, Coragen, Mainspring	I	IRAC-28	Caution
chlorfenapyr	Pylon	I, Mi	IRAC-13	Caution
chloropicrin	Tri-Pic[1]	Fum	-	Danger (Poison)
chlorothalonil	Bravo, Concert II[2], Daconil, Echo, Zing![2]	F	FRAC-M5	Caution-Warning
chlorsulfuron	Telar	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)
cinnamaldehyde	Seican	I, Mi	-	Caution
clethodim	Envoy Plus, Select	H	WSSA-14	Caution
clofentezine	Apollo, Zorro	Mi	IRAC-10	Caution
clopyralid	Lontrel, Stinger, Transline	H	WSSA-4	Caution
clothianidin	Arena, Belay	I	IRAC-4	Caution
copper hydroxide	Kalmor, Kocide	B, F	FRAC-M1	Caution-Warning
copper octanoate (copper soap)	Camelot O, Grotto, CuPro 5000	B, F	FRAC-M1	Caution
(basic) copper sulfate	various	B, F	FRAC-M1	Caution-Warning
copper sulfate pentahydrate	various	B, F, H	FRAC-M1	Danger
cyantraniliprole	Exirel, Ference, Mainspring	I	IRAC-28	Warning
cyazofamid	Ranman, Segway	F	FRAC-21	Caution
cyclaniliprole	Pradia[2], Sarisa, Verdepryn	I	IRAC-28	Caution
cyflufenamid	Torino	F	FRAC-U6	Caution
cyflumetofen	Nealta, Sultan	Mi	IRAC-25	Caution
cyfluthrin	Decathlon, Tempo, Tombstone[1]	I	IRAC-3	Caution-Danger
(beta-) cyfluthrin	Baythroid[1], Tempo	I	IRAC-3	Caution-Warning
(gamma-) cyhalothrin	Declare[1], Proaxis[1]	I	IRAC-3	Caution
(lambda-) cyhalothrin	Scimitar[1], Warrior II[1]	I	IRAC-3	Caution-Warning
cymoxanil	Curzate, Tanos[2]	F	FRAC-27	Caution-Warning
cypermethrin	Cynoff	I	IRAC-3	Caution
(zeta-) cypermethrin	Mustang Maxx[1]	I	IRAC-3	Warning
cyprodinil	InspireSuper[2], Palladium[2], Vangard	F	FRAC-9	Caution
cyromazine	Citation	IGR	IRAC-17	Caution
DCPA	see chlorthal-dimethyl			
dazomet	Basamid[1]	Fum	-	Danger (Poison)
deltamethrin	DeltaGard	I	IRAC-3	Caution
diazinon	Diazinon[1]	I	IRAC-1	Caution
dicamba	Banvel, Vanquish	H	WSSA-4	Caution-Warning
dichlobenil	Casoron, Barrier	H	WSSA-20	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)
(1,3-) dichloropropene	Telone[1]	Fum	-	Warning-Danger
difenoconazole	Aprovia Top[2], Inspire Super[2], Revus Top[2]	F	FRAC-3	Caution-Warning
diflubenzuron	Adept, Dimilin[1]	IGR	IRAC-15	Caution
dimethenamid-P	FreeHand[2], Tower	H	WSSA-15	Caution-Warning
dimethoate	Dimethoate	I, Mi	IRAC-1	Caution-Warning
dimethomorph	Forum, Orvego[2], Stature, Zampro[2]	F	FRAC-40	Caution
dinotefuran	Safari, Scorpion, Transtect, Venom, Zylam	I	IRAC-4	Caution
diquat dibromide	Diquat, Eliminator, Reward, Weedtrine-D	H	WSSA-22	Caution-Warning
dithiopyr	Dimension, Fortress[2]	H	WSSA-3	Caution-Warning
diuron	Karmex	H	WSSA-7	Caution
emamectin benzoate	Proclaim[1], TREE-age[1]	I	IRAC-6	Caution-Warning
endothall	Aquathol, Hydrothol	H		Danger
EPTC	Eptam	H	WSSA-8	Warning
esfenvalerate	Asana[1]	I	IRAC-3	Warning
ethofumesate	Prograss	H	WSSA-8	Caution-Danger
ethoprop	Mocap[1]	I, N	IRAC-1	Danger (Poison)
etoxazole	Beethoven, Tetrasan, Zeal	I, Mi	IRAC-10	Caution
etridiazole	Terrazole, Truban	F	FRAC-14	Caution-Danger
famoxadone	Tanos[2]	F	FRAC-11	Caution
fenamidone	Fenstop, Reason	F	FRAC-11	Caution-Warning
fenazaquin	Magister, Magus	Mi	IRAC-21	Warning
fenbuconazole	Indar	F	FRAC-3	Caution
fenbutatin-oxide	Vendex[1]	Mi	IRAC-12	Danger (Poison)
fenhexamid	Decree, Elevate	F	FRAC-17	Caution
fenoxaprop-p-ethyl	Acclaim	H	WSSA-1	Caution
fenpropathrin	Danitol[1], Tame[1]	I, Mi	IRAC-3	Warning
fenpyroximate	Akari, Portal	I, Mi	IRAC-21	Warning
ferbam	Ferbam	F	FRAC-M3	Warning
flonicamid	Aria, Beleaf, Pradia[2]	I	IRAC-29	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)
florpyrauxifen-benzyl	ProcellaCOR	H	WSSA-4	Caution
fluazifop-p-butyl	Fusilade, Ornamec	H	WSSA-1	Caution
fluazinam	Omega, Secure	F	FRAC-29	Warning
fludioxonil	Medallion, Miravis Prime[2], Palladium[2]	F	FRAC-12	Caution
fluensulfone	Fluensulfone, Nimitz	N	-	Caution
flumioxazin	Broadstar, Chateau, Clipper, Fuerte[2], Sureguard	H	WSSA-14	Caution
fluopicolide	Adorn, Presidio	F	FRAC-43	Caution
fluropyram	Broadform[2], Luna Experience[2]	F	FRAC-7	Caution
fluoxastrobin	Disarm, Fame	F	FRAC-11	Caution
flupyradifurone	Altus, Sivanto	I	IRAC-4	Caution
fluridone	Avast!, Sonar	H	WSSA-12	Caution
flurprimidol	Cutless	PGR	-	Caution-Warning
flutianil	Gatten	F	FRAC-U13	Warning
flutolanil	Pedigree, Prostar	F	FRAC-7	Caution
flutriafol	Rhyme, TopGuard EQ[2]	F	FRAC-3	Caution-Warning
fluvalinate	Mavrik	I, Mi	IRAC-3	Caution-Warning
fluxapyroxad	Merivon[2], Xzemplar	F	FRAC-7	Caution-Warning
foramsulfuron	Revolver	H	WSSA-2	Caution
fosamine	Krenite	H	WSSA-27	Caution
fosetyl-AI (aluminum tris)	Aliette, Chipco Signature, Signature Xtra Stressgard	F	FRAC-P7	Caution
Gliocladium virens	Soil Gard	F	-	Caution
glufosinate-ammonium	Finale, Rely	H	WSSA-10	Warning
glyphosate	Accord, Rodeo, Roundup	H	WSSA-9	Caution
GS-omega/kappa-Hxtx-Hv1a	Spear-Lep, Spear T	I	IRAC-32	Caution
halosulfuron-methyl	Sandea, Sedgehammer	H	WSSA-2	Caution
hexazinone	Velpar	H	WSSA-5	Danger
hexythiazox	Hexygon, Onager, Savey	Mi	IRAC-10	Caution
hydramethylnon	Amdro, MaxForce	I	IRAC-20	Caution
hydrogen peroxide	OxiDate, Rendition, ZeroTol	B, F	-	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)
imazamox	Clearcast	H	WSSA-2	Caution
imazapyr	Arsenal, Habitat, Stalker, Topsite	H	WSSA-2	Caution
imazaquin	Image	H	WSSA-2	Caution
imidacloprid	Admire Pro, Marathon, Merit, Prokoz Zenith	I	IRAC-4	Caution
indaziflam	Alion, Esplanade, Marengo, Specticle	H	WSSA-29	Caution
indoxacarb	Advion, Avaunt, Provaunt	I	IRAC-22	Caution
iprodione	Nevado, OHP Chipco 26019, Rovral	F	FRAC-2	Caution
iron phosphate	Sluggo	M	-	Caution
Isaria fumosorosea	PFR-97	I, Mi	-	Caution
isofetamid	Kabuto, Kenja, Tekken[2]	F	FRAC-7	Caution
isoxaben	Fortress[2], Gallery, Gemini[2], Snapshot[2], Trellis	H	WSSA-21	Caution
kaolin clay	Surround	CP	-	Caution
kinoprene	Enstar	IGR	IRAC-7	Caution
kresoxim-methyl	Sovran	F	FRAC-11	Caution
lime sulfur	see calcium polysulfide			
malathion	Malathion	I	IRAC-1	Caution-Warning
mancozeb	Dithane, Fore, Gavel[2], Manzate, Penncozeb, Protect	F	FRAC-M3	Caution
mandestrobin	Intuity	F	FRAC-11	Caution
mandipropamid	Revus, Revus Top[2]	F	FRAC-40	Caution
mecoprop	MCPP-p	H	WSSA-4	Caution
mefenoxam	see metalaxyl-M			
mefentrifluconazole	Avelyo, Maxtima, Navicon[2]	F	FRAC-3	Caution
mefluidide	Embark	PGR	-	Caution
mesotrione	Callisto, Tenacity	H	WSSA-27	Caution
metalaxyl-M (mefenoxam)	MetaStar, ReCon, Ridomil Gold, Subdue, Ultra Flourish	F	FRAC-4	Caution-Warning
metaldehyde	Deadline, Metarex	M	-	Caution
metam-potassium	k-pam[1]	Fum	-	Danger (Poison)
metam-sodium	Vapam[1]	Fum	-	Danger (Poison)
metconazole	Quash, Tourney	F	FRAC-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)
methiocarb	Mesurol[1]	I, M, Mi	IRAC-1	Danger (Poison)
methomyl	Lannate[1]	I	IRAC-1	Danger (Poison)
(S-) methoprene	Extinguish	IGR	IRAC-7	Caution
methoxyfenozide	Intrepid	I	IRAC-18	Caution
methyl bromide	Meth-O-Gas[1], Terr-O-Gas[1]	Fum	-	Danger (Poison)
(S-) metolachlor	Pennant Magnum	H	WSSA-15	Caution
metrafenone	Vivando	F	FRAC-U8	Caution
metribuzin	Sencor	H	WSSA-5	Caution
metsulfuron-methyl	Escort	H	WSSA-2	Caution
mineral oil	Damoil, JMS Stylet-Oil, Omni Supreme, SuffOil-X	F, I, Mi	-	Caution
MSMA	Drexel, Target	H	WSSA-17	Caution
myclobutanil	Eagle, Rally, Sonoma	F	FRAC-3	Caution-Warning
napropamide	Devrinol	H	WSSA-15	Caution
neem oil	Triact, Trilogy	F, I, Mi, Rep	-	Caution
norflurazon	Solicam	H	WSSA-12	Caution
novaluron	Pedestal, Rimon	IGR	IRAC-15	Caution-Warning
orthoboric acid	Niban	I, M	-	Caution
oryzalin	Oryzalin, Rout[2], Surflan	H	WSSA-3	Caution
oxadiazon	Ronstar	H	WSSA-14	Caution-Warning
oxathiapiprolin	Orondis Gold 200	F	FRAC-49	Caution
oxyfluorfen	Biathlon[2], Goal, Goaltender, Rout[2]	H	WSSA-14	Caution-Warning
paclobutrazol	Bonzi, Cambistat, Profile, Trimmit	PGR	-	Caution
paraquat	Gramoxone[1]	H	WSSA-22	Danger (Poison)
PCNB	see pentachloronitrobenzene			
pelargonic acid	Scythe	H	WSSA-27	Warning
pendimethalin	Corral, FreeHand[2], Pendulum, Prowl	H	WSSA-3	Caution
penoxsulam	Galleon, Sapphire	H	WSSA-2	Caution
pentachloronitrobenzene (PCNB)	Terraclor, Turficide	F	FRAC-14	Caution
penthiopyrad	Fontelis, Velista	F	FRAC-7	Caution
permethrin	Astro, Perm-Up	I	IRAC-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)
phosmet	Imidan	I	IRAC-1	Warning
picloram	Tordon[1]	H	WSSA-4	Caution-Danger
piperonyl butoxide	(used as a pesticide synergist)			
polyoxin D	Affirm, Endorse, OSO, Ph-D, Veranda	F	FRAC-19	Caution
potassium bicarbonate	Kaligreen	F	-	Caution
potassium phosphite	ProPhyt, Viathon[2]	F	-	Caution
potassium salts of fatty acids (insecticidal soap)	M-Pede, various	F, I, Mi	-	Caution-Warning
potassium silicate	Carbon Defense	F, I, Mi	-	Caution
phosphorous acid and salts (phosphonate)	Alude, Appear, Fosphite, K-phite, ProPhyt, Reliant	F	FRAC-P7	Caution
prodiamine	Barricade, Biathlon[2], Fuerte[2], Gemini[2]	H	WSSA-3	Caution
prometon	Pramitol	H	WSSA-5	Caution-Warning
pronamide	Kerb[1]	H	WSSA-3	Caution
propamocarb hydrochloride	Banol	F	FRAC-28	Caution
propiconazole	Banner Maxx, Bumper, Concert II[2], Propimax, Tilt	F	FRAC-3	Caution-Warning
prothioconazole	Proline	F	FRAC-3	Caution
Pseudomonas chlororaphis	Zio	F	-	Caution
pydiflumetofen	Posterity, Miravis Prime[2]	F	FRAC-7	Caution
pymetrozine	Endeavor, Fulfill	I	IRAC-9	Caution-Warning
pyraclostrobin	Cabrio, Empress, Insignia, Merivon[2], Navicon[2], Pageant[2]	F	FRAC-11	Caution-Warning
pyraflufen-ethyl	Venue	H	WSSA-14	Caution
pyrethrins	Pyganic, Pyrethrum	I	IRAC-3	Caution
pyridaben	Nexter, Sanmite	I, Mi	IRAC-21	Warning
pyridalyl	Overture	I	-	Caution
pyrifluquinazon	PQZ, Rycar	I	IRAC-9	Caution
pyrimethanil	Scala	F	FRAC-9	Caution
pyriofenone	Seido	F	FRAC-50	Caution
pyriproxyfen	Distance, Esteem, Fulcrum	IGR	IRAC-7	Caution
quinclorac	Drive	H	WSSA-4, WSSA-26	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)
quinoxyfen	Quintec	F	FRAC-13	Caution
rimsulfuron	Matrix	H	WSSA-2	Caution
Reynoutria sachalinensis	Regalia	F	FRAC-P5	Caution
sethoxydim	Poast, Segment	H	WSSA-1	Caution-Warning
siduron	Tupersan	H	WSSA-7	Caution
simazine	Princep	H	WSSA-5	Caution
spinetoram	Delegate, Radiant, XXpire[2]	I	IRAC-5	Caution
spinosad	Conserve, Entrust, Seduce	I	IRAC-5	Caution
spirodiclofen	Envidor	Mi	IRAC-23	Caution
spiromesifen	Forbid, Judo, Oberon, Savate	I, Mi	IRAC-23	Caution
spirotetramat	Kontos, Movento	I	IRAC-23	Caution
Streptomyces lydicus	Actinovate	F	-	Caution
streptomycin sulfate	Agri-Mycin	F	FRAC-25	Caution
sulfentrazone	Dismiss, Zeus	H	WSSA-14	Caution
sulfometuron-methyl	Oust	H	WSSA-2	Caution
sulfoxaflor	Closer, XXpire[2]	I	IRAC-4	Caution
sulfur	Acoidal, Microthiol Dispress	F, Mi	FRAC-M2	Caution
tebuconazole	Luna Experience[2], Orius, Tekken[2], Torque, Viathon[2]	F	FRAC-3	Caution
tebufenozide	Confirm	I	IRAC-18	Caution
tebuthiuron	Spike, Sprakil	H	WSSA-7	Caution
tetraconazole	Mettle	F	FRAC-3	Caution
thiamethoxam	Actara, Flagship, Meridian	I	IRAC-4	Caution
thiophanate-methyl	3336, Protocol[2], Topsin,	F	FRAC-1	Caution
thiram	Spotrete, Thiram	F	FRAC-M3	Caution
tolfenpyrad	Apta, Hachi-Hachi	F, I	FRAC-39, IRAC-21	Warning
topramezone	Pylex	H	WSSA-27	Caution
triadimefon	Bayleton, Strike[2]	F	FRAC-3	Caution
trichlorfon	Dylox	I	IRAC-1	Caution
Trichoderma spp.	Bio-Tam, Obtego	F	-	Caution
triclopyr	Garlon, Renovate	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	Broadform[2], Compass, Flint, Strike[2]	F	FRAC-11	Caution
trifloxysulfuron-sodium	Monument	H	WSSA-2	Caution
triflumizole	Procure, Terraguard, Trionic, Viticure	F	FRAC-3	Caution
trifluralin	Preen, Snapshot[2], Treflan	H	WSSA-3	Caution
trinexapac-ethyl	Primo Maxx	PGR	-	Caution
triticonazole	Trinity, Triton	F	FRAC-3	Caution
ziram	Ziram	F	FRAC-M3	Danger
zoxamide	Gavel[2], Zing![2], Zoxium	F	FRAC-22	Caution

Regulations and Basic Information: Protecting Honey Bees

James Wilson, Extension Apiculturist,
Department of Entomology, Virginia Tech

Honey bees are a valuable service to apiculture and agriculture not only because of 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.

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. The USDA Forest Service also has some general recommendations specific to agroforestry and pollinator management. 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 habitat and nutrition information section of the HBHC website. Please see the below table for links to each of the resources mentioned above.

Online resources for pollinator protection information:

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 Habitat and Nutrition Recommendations	https://www.fs.usda.gov/nac/assets/documents/workingtrees/brochures/WTPollinators.pdf
USDA Forest Service "Working Trees for Pollinators"	https://www.fs.usda.gov/nac/assets/documents/workingtrees/brochures/WTPollinators.pdf

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: https://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 Points:

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

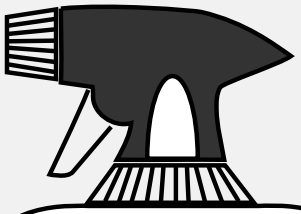
1. Contact beekeepers with honey bee hives near areas to be treated with pesticides that are hazardous to honey bees.
2. Do not apply pesticides that are toxic to honey bees on crops in bloom.
3. Use pesticides that are less toxic to honey bees when such choices are consistent with pest control recommendations (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.

NAPPC

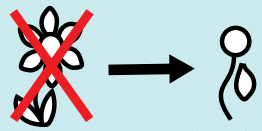
PROTECT POLLINATORS READ PESTICIDE LABELS

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

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!**

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)

Pest	(oz/acre)
Aphids	0.75 - 1.5 (0.023 - 0.047 lb/acre)
San Jose scale	2.75 (0.086 lb/acre)

Advisory Pollinator Statement: Notifying known beekeepers within 1 mile of the treatment area 48 hours before the product is applied
The RT25 for this product is less than or equal to 3 hours.

Restrictions:
- Do not apply this product any time between 3 days prior to bloom and until petal fall.

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 Kormann 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.

The SARE FFAR North Central IPM Center USDA National Institute of Food and Agriculture U.S. DEPARTMENT OF AGRICULTURE

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

Acramite (bifenazate)

Actara, Centric, Platinum, Helix, Cruiser, Adage (thiamethoxam)

Acephate

Admire, Advantage, Gaucho, Merit, Premise, Touchstone (imidacloprid)

Advantage

Ambush (permethrin)

Ammo (Fury) (>.025 lb/A) (cypermethrin)

Apollo, Ovation (clofentezine)

Asana (esfenvalerate)

Avaunt (Advion) (indoxacarb)

Avid (avermectin)

Baygon (propoxur)

Baythroid (cyfluthrin)

Bidrin (dicrotophos)

Capture, Annex, Brigade (bifenthrin)

Carzol

Clutch (clothianidin)

Commodore (lambda-cyhalothrin)

Comply (fenoxycarb)

Curacron (profenofos)

Cygon (dimethoate)

Cymbush

Danitol (fenopropathin)

Dasanit (fensulfothion)

DDVP (dichlorvos)

Decis (decamethrin)

Delegate, Radiant (spinetoram)

Denim (emamectin benzoate)

Dibrom (naled)

Dimate (dimethoate)

Diazinon (spectracide)

Dimecron (phosphamidon)

Dinotefuran

Dursban, Eradex (chlorpyrifos)

Endigo

Envidor (spirodiclofen)

Flagship (thiamethoxam)

Fipronil

Gardstar (carbofuran)

(permethrin)[1]

Imidan (phosmet)

Karate

Lannate D (methomyl)

Lindane

Lorsban (chlorphyrifos)

Malathion

Matacil (aminocarb)

Mesurol (methiocarb

Monitor (methamidophos)

Nexter (pyridaben)

Nudrin (methomyl)

Orthene (acephate)

Pay Off (flucythrinate)

Pirimiphos-methyl (Execute, Actellic)

Poncho, Titan, Clutch, Acceleron, Arena, Belay, Celero (clothianidin)

Pounce (permethrin)

Prallethrin

Proaxis (gamma-cyhalothrin)

Proclaim (emamectin)

Provado (imidacloprid)

Pylon, Phantom (chlorfenapyr)

Pyramite

Rebelate (dimethoate)

Resmethrin

Scout (tralomethrin)

Sevin (carbaryl)[3]

Sniper

Spectracide

Steward (indoxacarb)

Sumithion (fenitrothion)

Supracide (methidathion)

Swat (bonyl)

Synthrin (resmethrin)

Talstar

Tameron (methamidophos)

Tefluthrin (Force)

Temik (aldicarb)

TEPP

Tralomethrin (Saga)

Trimax

Vapona (dichlorvos)

Venom (dinotefuran)

Warrior (lambda-cyhalothrin)

Zectran (mexacarbate)

Zephyr (Agri-Mek) (abamectin)

Zeta-cypermethrin

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

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

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

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

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)

Acramite, Floramite (bifenazate)

Assail (acetamiprid)

Banol (carbanolate)

Bolstar (sulprofos)

Calypso (thiacloprid)

Carzol (formetanate)

Ciodrin (crotoxyphos)

Coumaphos[1] (Agridip, Asunthol)

Counter (terbufos)

Decis, Battalion (deltamethrin)

Di-Syston (disulfoton)

Dyfonate (fonofos)

Elgetol (dinitrocresol)

endrin

Esteem (pyriproxyfen)

Ethodan (Ethion)

Larvin (thiocarb)

Metasystox (demeton-s-methyl)

Metasystox R (oxydemeton-methyl)

Mocap (ethoprop)

Oil sprays (superior type)

Rimon, Pedestal (novaluron)

Conserve SC, Entrust, Success (spinosad)

Spirotetramet (Movento)

Systox (demeton)

Trigard (cyromazine)

Thimet (phorate)[2]

Trithion, Thiodan (carbophenothion)

Vydate (oxamyl)

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

[2]Thimet EC should only be applied during late evening.

Relative Toxicity of Pesticides to Honey Bees by Laboratory and Field Tests
GROUP III. RELATIVELY NON-TOXIC
These can be used around honey bees with a minimum of injury; safest if applied in the evening or early morning.

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

[1]*tau*-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.

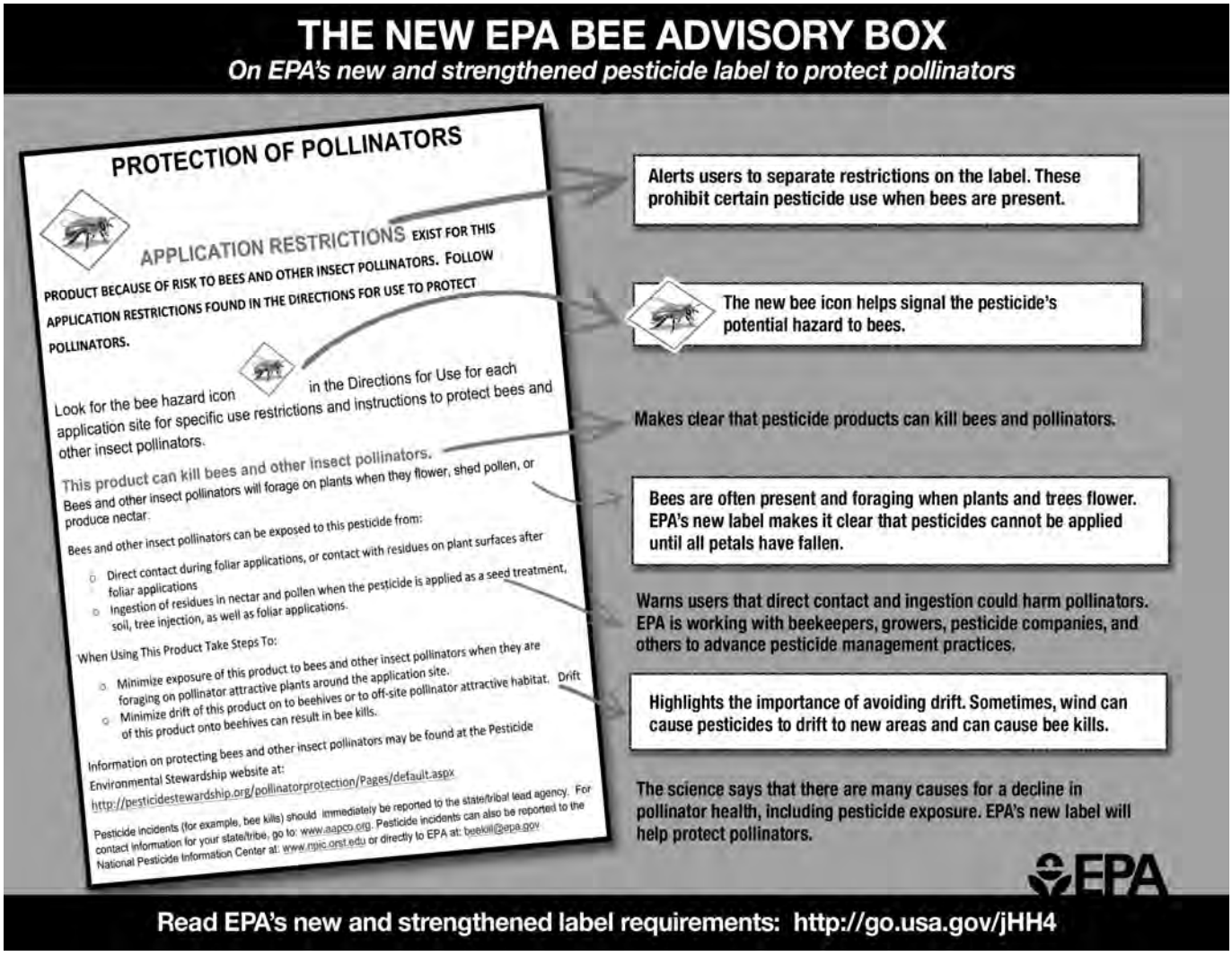
Afugan (pyrazophos)
Arasan (thiram)
Bayleton (triadimefon)
Benlate (benomyl)
Bordeaux mixture
Boscalid (emerald, endura, pristine)
Bravo (chlorothalonil)
Captan
Carbendazim (Fungisol, Polyphase)
Copper oxides
Copper oxychloride sulfate
Copper sulfate
Cupric hydroxide (Kocide)
Cyprix (dodine)
Cyprodinil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

[1]Checkmite (coumaphos) strips can be used in honey bee hives to treat for varroa mites and small hive beetles.
[2]Thimet EC should only be applied during late evening.

Herbicides, Defoliants and Desiccants

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

[1]Slightly toxic to honey bees



Commercial Small Fruit: Diseases and Insects

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Effective control of pests that occur in commercial small fruit crops is obtained only through the judicious use of pesticides combined with sound management practices, nutrition, and sanitation. Close observation should be used to determine which pests are present and when treatments should be applied to be most effective. Pesticides are used most frequently by the grower for pest control, and they usually are applied as sprays or occasionally as dusts. The problem of selecting the correct pesticide to do a specific job continues to be challenging to commercial growers. The success or failure of any spray program is not due entirely to the specific pesticide or amount placed in the sprayer tank, but is also influenced by proper timing, thorough application, and weather conditions at the time of application.

The pesticides recommended here have proven to be effective and useful in the control of various common diseases and insects. Differences may exist among them in their effectiveness against specific pest organisms. It has become increasingly evident that no spray program can provide equally satisfactory results in all plantings for all pests. Use extreme caution and read label thoroughly when using highly toxic pesticides.

Integrated Pest Management (IPM) is the use of all suitable tactics to maintain a pest population below an economically damaging level. One such tactic is that of chemical control. Growers may use insecticides to quickly reduce a pest population that is not controlled by other means. Contrary to a commonly held belief, organic growers utilize chemical control as well as other, "conventional" growers. The difference lies in the nature of the insecticides selected — organic growers are restricted to naturally derived materials, generally botanical or mineral products, while conventional growers usually use synthetic materials. Many naturally derived insecticides are substantially less toxic and more environmentally selective than older materials.

Other IPM tactics are appropriately used by both types of growers, namely biological control (use of predators, parasites and pathogens), cultural control (modifying crop production procedures to suppress problems), physical control (exclusion and hand-picking), and resistant varieties.

Insecticides approved for organic production and noninsecticidal management tactics listed in this guide for small fruit insect pests include:

Strawberry: Mites – Requiem Prime, Stylet oil, Trilogy, predatory mites. Leafrollers – Entrust, PyGanic, Venerate. Thrips – Aza-Direct, Entrust, PyGanic, Requiem Prime, Venerate. Aphids – virus-free plants, PyGanic. Sap beetles – sanitation.

Caneberries: Rednecked cane borer – remove galled canes. Raspberry cane borer – remove infested canes. Blackberry psyllid – PyGanic, Surround. Mites – Requiem Prime, Stylet oil. Japanese beetle – Aza-Direct, Neemix/Trilogy, Surround.

Blueberries: Blueberry tip borer – remove infested tissue when pruning. Plum curculio – Surround. Cranberry/cherry fruitworms – Entrust, *Bacillus thuringiensis*. Mites – Stylet oil. Japanese beetle – Neemix/Trilogy Thrips - Requiem Prime.

In selecting a pesticide for control of small fruit pests, there are several factors that must be considered. Degree of control desired, type of fruit finish required by the market, type of spray used, compatibility with other pesticides, effectiveness against other pests , and toxicity to insect natural enemies are some of the important factors that must be weighed. There are a large number of pesticides available for grower use which vary somewhat in their spectrum of activity and effectiveness on an individual pest.

Generally, pesticides may be used alone for a specific pest or in combination for various pests occurring at any one time.

The recommended concentration of pesticides for control of small fruit pests is based on a regular dilute (1X) spray. The application rate for strawberries is based on 100 to 150 gal per acre. Fruit rot fungicide sprays should focus the entire spray volume on the plants on the top of the beds, and should be applied using spray pressures and tips that generate fine droplets (using hollow cone or similar type nozzles). The application rate on caneberries is based on 150-250 gal per acre.

For information on small fruit pests and their control, request Virginia Cooperative Extension (VCE) Publications 444-567, 456-232, and 456-018, as well as those listed elsewhere in this volume. Also, additional information on strawberry diseases and their control is available in VCE Publication 456-038. Information on pest and beneficial species identification and monitoring is also available on-line at https://www.virginiafruit.ento.vt.edu. For additional information regarding pest management and small fruit production, consult the Mid-Atlantic Berry Guide, Virginia Cooperative Extension publication 423-020, https://njaes.rutgers.edu/pubs/publication.php?pid=AGRS-97; and the Southern Region Small Fruit Consortium, https://smallfruits.org/.

Be alert for pesticide label changes, particularly with regard to post-application re-entry and pre-harvest interval restrictions.

Fungicide Resistance Guidelines: The gray mold and anthracnose pathogens are now resistant to multiple fungicides in many strawberry fields. Resistance to Topsin-M has been found in every survey sample from Virginia, and resistance to many other fungicides has also been commonly found. Strawberry growers should focus fruit rot fungicide spray programs on broad-spectrum, "multi-site" products such as Captan and Thiram and use other products, when necessary, to increase efficacy and/or to control other diseases like anthracnose. Fruit rot spray programs should focus on the bloom period, starting promptly at first bloom. After peak bloom, sprays are usually beneficial only when wet weather conditions favor pathogen infection. Fungicide-resistant pathogens react similarly to products with the same mode of action, indicated by the same "FRAC Group number". While some strawberry fungicides contain multiple FRAC Group ingredients (Pristine, Merivon, Quadris Top, Quilt Xcel, Luna Sensation, and Luna Tranquility), resistance is now also showing up to the partner fungicides in these products. Therefore, except for Captan (FRAC Group M4), fungicides in the same FRAC Group (having the same mode of action) should NOT be applied more than twice during a single growing season, and especially not in sequential sprays. Resistance to fungicides in FRAC Group 11 (Abound, Cabrio and Pristine, Flint Extra, Luna Sensation, Merivon, Quadris Top, and Quilt Xcel) and FRAC Group 7 (Fontelis, Kenja, Pristine, Merivon, Luna Tranquility) is of particular concern. Use of

FRAC Group 11 fungicides should focus on controlling anthracnose versus other diseases, and so shouldn't be used in the fall or early in the bloom period unless anthracnose is already present. Other fruit rot fungicides should be tank-mixed with Captan or Thiram whenever possible to avoid development of fungicide resistance.

■ Strawberries

Table 2.1a - Strawberry Diseases, Pre-Planting

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Rate per Acre	Spray Timing and Remarks
Anthracnose Crown Rot *(Colletotrichum gloeosporioides; C. fragariae)*	Switch 62.5WG	5.0-8.0 fl oz	—	DIP TREATMENT. For suppression only. Wash roots of bare-root plants to remove excess soil, and then immerse plants for a minimum of 2 to 5 minutes, planting the same day, if possible. For continued control, follow-up with foliar fungicide applications 2 to 3 weeks after transplant. FRAC-12 and FRAC-9.
	Abound 2.08F	5.0-8.0 fl oz	—	DIP TREATMENT. For suppression only. Wash roots of bare-root plants to remove excess soil, and then immerse plants for 2 to 5 minutes, planting the same day, if possible. For continued control, follow-up with foliar fungicide applications 2 to 3 weeks after transplant. FRAC-11.
Rhizoctonia sp. (seedling root & basal stem rot)	Abound Flowable	—	0.4-0.8 fl oz /1,000 row feet	Spray before infection in band no wider than 7 inches, centered over (non-tarped) rows. FRAC-11.

Table 2.1b - Strawberry Diseases, Post-Planting

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Rate per Acre	Spray Timing and Remarks
Rhizoctonia sp. (seedling root & basal stem rot)	Abound Flowable	—	0.4-0.8 fl oz /1,000 row feet	Drip-irrigate plug plants with poor root systems or plants in non-fumigated beds or excessively wet beds and heavy soils. FRAC-11
Anthracnose Crown Rot: *(Colletotrichum gloeosporioides; C. fragariae)*	Captan 50W	—	3-6 lb	When risk is high for anthracnose fruit rot, begin sprays when disease is suspected or as soon as observed and continue on a 10-14 day schedule. Other than Quilt Xcel, QoI fungicides are no more effective than Captan (FRAC-M4) and Switch (FRAC-9 and FRAC-12) for anthracnose crown rot. In general, QoI fungicides should be saved for anthracnose fruit rot control. **Except for Captan, do not apply any fungicides with the same mode of action (same FRAC Group number) more than twice in a single growing season.** Captan fungicides are FRAC-M4, Switch is both FRAC-9 and FRAC-12, Protocol is both FRAC-1 and FRAC-3. Protocol is both FRAC-1 and FRAC-3, Quilt Xcel and Quadris Top are FRAC-3+11, Merivon, Luna Sensation, and Pristine are FRAC-7+11, Miravis Prime is FRAC-7+12, Cabrio, and Abound, are FRAC-11 only.
	Captan 80WDG	—	1.9-3.8 lb	
	Captan Gold 80WDG	—	1.9-3.8 lb	
	Captan Gold 4L	—	2.5 qt	
	Switch 62.5WG	—	11.0-14.0 oz	
	Protocol	—	1.33 pt	
	Miravis Prime	—	11.4-13.4 fl oz/A	
	QoI fungicides (FRAC-11):			
	Quilt Xcel	—	14.0 fl oz	
	Quadris Top	—	12.0-14.0 fl oz	
	Pristine	—	18.5-23.0 oz	
	Merivon Xemium	—	4.0-11.0 fl oz	
	Luna Sensation	—	4.0-7.6 fl oz	
	Cabrio 20EG	—	12.0-14.0 oz	
	Abound Flowable	—	6.2-15.4 fl oz	

Table 2.1b - Strawberry Diseases, Post-Planting (continued)

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Rate per Acre	Spray Timing and Remarks
Anthracnose Fruit Rot: *(C. acutatum; C. fragariae)*	First bloom:			When risk is high for anthracnose fruit rot, begin sprays at first bloom and continue on a 7 to 10-day schedule. The 1st spray should apply a Captan (FRAC-M4) product, tank-mixed with a QoI fungicide (FRAC-11), a FRAC-3 fungicide (Bumper or Tilt), or Protocol (FRAC-3+1), but do not repeat use of a QoI product in the second spray. Use the same products in the 3rd spray that were used in the 1st, but rotate the fungicides applied each week thereafter. **Except for Captan, do not apply any fungicides with the same mode of action(same FRAC Group number) more than twice in a single growing season.** Under high anthracnose pressure, FRAC 11+7 products (Merivon, Luna Sensation, Pristine), Miravis Prime (FRAC-7+12), FRAC-11+3 products (Quilt Xcel and Quadris Top), or Cabrio (FRAC-11) show the best efficacy. Incorporate Switch (FRAC-9+12) into the fungicide rotation schedule when Botrytis pressure is also high. An adjuvant may be added to Miravis Prime at recommended rates.
	Captan 50W	—	3-6 lb	
	Captan 80WDG	—	1.9-3.8 lb	
	Captan Gold 80WDG	—	1.9-3.8 lb	
	Captan Gold 4L	—	1.5-3.0 qt	
	Tilt	—	4.0 fl oz	
	Protocol	—	1.33 pt	
	Miravis Prime	—	11.4 - 13.4 fl oz	
	QoI fungicides (FRAC-11):			
	Pristine	—	18.5-23.0 oz	
	Merivon Xemium	—	5.5-8.0 fl oz	
	Luna Sensation	—	4.0-7.6 fl oz	
	Quilt Xcel	—	14.0 fl oz	
	Quadris Top	—	12.0-14.0 fl oz	
	Cabrio 20EG	—	12.0-14.0 oz	
	Flint Extra	—	2.5-3.0 floz/A	
Gray Mold Fruit Rot *(Botrytis cinerea)*	Rovral 4F	—	1.5-2.0 pt (alone) 1.0 pt (tank mix)	Do not apply Rovral after first flower or more than once/season. Preventative fungicide sprays should begin at first bloom and continue on a 7- to 14-day interval. **Other than Captan (FRAC-M4), do not apply any fungicide with the same fungicidal mode of action (same FRAC Group number) more than twice in any growing season.** Ph-D, and OSO (FRAC-19) can be substituted for Captan in the beginning of the season, but may have less activity against anthracnose. Rates of Elevate may be lowered to 1.0 lb/A when tank-mixed with Captan or Thiram. Switch is a FRAC-9+12 fungicide, while Miravis Prime is a FRAC-7+12 product. Miravis Prime is FRAC-7+12, while Switch is FRAC-9+12.Fontelis and Kenja are both FRAC-7 fungicides. For early spring sprays, 9.0 fl oz Scala (FRAC-9) can be sprayed when tank-mixed with Captan or Thiram. Use of QoI fungicides should be delayed in order to avoid encouraging development of fungicide resistance in the anthracnose fruit rot pathogen. **Luna Sensation, Pristine and Merivon also contain a FRAC-7 fungicide as well as FRAC-11.**
	Elevate 50WDG	—	1.5 lb	
	Switch 62.5WSB	—	11.0-14.0 oz	
	Miravis Prime	—	11.4-13.4 fl oz/A	
	Luna Tranquility	—	16-27 fl oz	
	Fontelis	—	16-24 fl oz	
	Kenja 400SC	—	13.5-15.5 fl oz	
	Captan 50W	—	3.0-6.0 lb	
	Captan 80WDG	—	1.9-3.8 lb	
	Captan Gold 80WDG	—	1.9-3.8 lb	
	Captan Gold 4L	—	1.5-3.0 qt	
	OSO 5%SC	—	6.5-13 fl oz	
	Scala 600SC	—	18.0 fl oz (alone) 9-18 fl oz (tank mix)	
	QoI fungicides (FRAC-11):			
	Luna Sensation	—	6.0-7.6 fl oz	
	Pristine 38WSB	—	18.5-23.0 oz	
	Merivon Xemium	—	8.0-11.0 fl oz	

Table 2.1b - Strawberry Diseases, Post-Planting (continued)

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Rate per Acre	Spray Timing and Remarks
Phytophthora Crown Rot *(P. cactorum)* Leather Rot *(P. cactorum)* Red Stele *(P. fragariae)*	Aliette WDG	2.5 lb (dip)	2.5-5.0 lb (spray)	Actual rate applied should be rate per treated acre for oomycete fungicides for crown rot or red stele control. This equates to ~0.5 pt Ridomil Gold, 1 pt Ultra Flourish, or 2 pt MetaStar per acre of crop, depending on row spacing and bed width. FRAC-4. Phosphite products may be applied as dip treatments just prior to (same day as) planting or as foliar sprays after planting. For dip treatments, submerge roots and crowns in fungicide solution for 15-30 minutes. Foliar sprays after planting avoid possible spread of angular leaf spot. FRAC-33
	MetaStar 2E AG	—	2 qt (4.0 pt)	
	Phosphite products			
	Phostrol	2.5 pt (dip)	2.5-5.0 pt (spray)	
	ProPhyt	2.0 pt (dip)	2.0-4.0 pt (spray)	
	Ridomil Gold SL	—	1.0 pt	
	Ultra Flourish	—	1 qt (2.0 pt)	
Powdery Mildew *(Sphaerotheca* spp.)	Rally 40W or WSP	1.6-3.2 oz	2.5-5.0 oz	Powdery mildew in the field rarely causes damage significant enough to justify fungicide application. However, high tunnel environments can often favor powdery mildew development. Initiate applications at the first sign of infection. Repeat applications every 7-14 days. **Do not apply fungicides with the same mode of action (same FRAC Group number) more than twice in a growing season.** Rally, Procure, Mettle, Rhyme, and Tilt are FRAC-3 fungicides, while Protocol contains FRAC-3 and FRAC-1 ingredients. Quintec is FRAC-13. *Fontelis and Kenja are FRAC-7 products, while Luna Tranquility is both FRAC-7 and FRAC-9. Miravis Prime is a FRAC-7+12 fungicide", after the similar information for Luna Tranquility. Sulfur is FRAC-M2 and Torino is FRAC-U6. Apply Rhyme preventatively or when conditions favor disease; repeat as necessary up to 4 times/year (FRAC-3). Only 1 application of Gatten (FRAC-U13) is allowed per season for strawberry. Protocol should be saved primarily for anthracnose control, and it is not recommended when only powdery mildew is present.
	Procure 50WS	—	4.0-8.0 oz	
	Procure 480SC	—	4.0-8.0 fl oz	
	Mettle	—	3.0-5.0 fl oz	
	Rhyme	—	5.0-7.0 fl oz	
	Quintec	—	4.0-6.0 fl oz	
	Gatten	—	6.0-8.0 fl oz	
	Tilt	—	4.0 fl oz	
	Protocol	—	1.3 pt	
	Kenja 400SC	—	13.5-15.5 fl oz	
	Fontelis*	—	10-24 fl oz	
	Luna Tranquility	—	16-27 fl oz	
	Miravis Prime	—	11.4-13.4 fl oz	
	Sulfur	—	5.0-10.0 lb	
	QoI fungicides (FRAC-11):			QoI fungicides should be saved primarily for anthracnose control. Quadris Top and Quilt Xcel both also contain FRAC-3 fungicide. Intuity and Flint are both FRAC-11 only products.
	Intuity		6 fl oz	
	Flint Extra	—	2.5-3.0 fl oz	
	Quadris Top	—	12.0-14.0 fl oz	
	Quilt Xcel	—	14.0 fl oz	
	Torino	—	3.4 oz	Only 2 Torino sprays per year, 14 days apart.
Angular Leaf Spot *(Xanthomonas fragariae)*	Various formulations of:		See labels	Scout fields regularly for first sign of disease after plant establishment. Avoid overhead irrigation/frost protection. Begin sprays at first sign of disease and continue on 7- to 10-day interval until conditions improve or first sign of crop injury from sprays. Do not apply Actigard (FRAC-P1) within 5 days of transplanting, or to plants stressed by drought or excessive moisture, cold, etc.
	Basic copper sulfate	2.0-3.0 lb	-	
	Copper hydroxide		0.35-0.58 lb a.i.	
	Copper salts of fatty & rosin acids		3.0-4.0 pt	
	Cuprous Oxide		1.05-4.2 lb a.i.	
	Actigard 50W		0.5-0.75 oz	

Table 2.1b - Strawberry Diseases, Post-Planting (continued)				
Crop and Pest	**Chemical and Formulation**	**Rate Per 100 Gal Dilute**	**Rate per Acre**	**Spray Timing and Remarks**
	Captan 50W	—	3.0-6.0 lb	Begin applications as symptoms first appear and continue on a 7- to 14-day schedule as conditions warrant. Rally, Tilt and Mettle are FRAC-3 products; Protocol contains a FRAC-1 fungicide as well as FRAC-3; Captans and Captec are FRAC-M4; Topsin-M is FRAC-1; Rovral is FRAC-2.
	Captan 80WDG	—	1.9-3.8 lb	
	Captan Gold 80WDG	—	1.9-3.8 lb	
	Captan Gold 4L	—	1.5-3.0 qt	
	Protocol	—	1.3 pt	
	Rally 40W or WSP	—	2.5-5.0 oz	
	Mettle	—	3.0-5.0 fl oz	The 3 fl oz rate of Mettle is only for tank-mixes with non-FRAC-3 fungicides. Begin Mettle applications before disease occurs and repeat on a 21-day interval for low-to-moderate disease pressure, 14-day interval under heavy disease pressure. (FRAC -3)
	QoI Fungicides (FRAC-11)			Use of QoI fungicides for powdery mildew control may select for fungicide resistance in the anthracnose pathogens. Do not apply any QoI fungicide more than twice in a growing season. Luna Sensation, Merivon, and Pristine also contain a FRAC-7 fungicide, while Quadris Top also contains a FRAC-3 fungicide.
	Luna Sensation	—	7.6 fl oz	
	Merivon	—	8-11 fl oz	
	Pristine	—	18.5-23 fl oz	
	Quadris Top	—	12.0-14.0 fl oz	
	Rovral 4F	—	1.5-2.0 pt (alone) 1.0 pt (tank mix	Do not apply Rovral when plants are flowering.
	Tilt	—	4.0 fl oz	
	Topsin M WSB	—	0.75-1.0 lb	Topsin applications should include a Captan (FRAC-M4) or Thiram (FRAC-M3) product to minimize fungicide resistance.
	Topsin 4.5FL	—	15.0-20.0 fl oz	

PHYTOPHTHORA DISEASES (CROWN ROT, LEATHER ROT, RED STELE)

Phosphite-based products are less effective than Ridomil Gold, but should be considered when the pathogen is Ridomil-resistant or if root systems are significantly damaged but plants possess adequate foliage to absorb the product. For crown rot control, phosphite products may be applied by immersing transplants into a fungicide solution for 30 minutes just before (the same day as) planting. Foliar sprays with phosphites should begin 2-3 weeks after planting and be repeated on 30-60 day intervals. Begin spraying perennial plantings when plants start active growth in the spring. For leather rot control, begin phosphite sprays at 10% bloom and early fruit set and continue on a 7-14 day interval as long as conditions favor disease. Aliette may be applied the day of harvest (REI = 12 hr).

Ridomil Gold, MetaStar, and Ultra Flourish may each be applied up to 3 times/cropping season. For control of crown rot or red stele in annual plantings, applications can be made after transplanting, 30 days prior to harvest or fruit set, and during harvest. In established plantings, the first application should occur in the spring after the ground thaws and before first bloom, and the second in the fall after harvest. A supplemental application can be made at fruit set for leather rot control. Apply Ridomil Gold in sufficient water to move the product into the root zone. In drip-treatments, reduce the rate applied according to the ratio of bed-width to row spacing (example: 32 inch-wide bed/60 inch [5 ft] row spacing = 0.53; 0.53*1.0 pt/acre = 0.53 pt/acre for Ridomil Gold).

Caution: Abound is extremely phytotoxic to some apple cultivars, including 'Gala' and 'McIntosh'. Contact with apples should be prevented between spray drift and leftover residue in spray tanks.

Pre-Harvest Spray Intervals: Abound, Actigard, Cabrio, Elevate, Flint, Fontelis, Gatten, Intuity, Kenja, Mettle, OSO, the phosphite products, Ph-D, Pristine, Quadris Top, QuiltXcel, Rally, Ridomil Gold, Switch, Torino, and Ultra Flourish may be applied the day of harvest. Luna Tranquility, Procure, Protocol, Quintec, Scala and Topsin-M may be applied the day before harvest. Although the pre-harvest interval for Captan is 0 days, protective clothing must be worn if entering the planting within 1 day after Captan application. Preharvest intervals for most copper products are 2 days, and 3 days for Thiram.

Maximum Fungicide Uses per year: Abound – 1.9 qt; Actigard – 6.0 oz; Aliette – 30.0 lb; Azaka – 61.5 fl oz; Cabrio – 70.0 oz; Captan 80WDG – 30.0 lb; Elevate – 6.0 lb; Flint Extra – 19.2 oz; Fontelis – 72.0 fl oz; Gatten - 8 fl oz; Inspire Super - 80 fl oz; Intuity - 12 fl oz; Kenja – 54 fl oz; Luna Tranquility – 54.7 fl oz; Mettle – 20 fl oz; OSO – 78.0 fl oz ; Ph-D – 18.6 oz; Pristine – 115.0 oz; Procure – 32.0 oz; Protocol – 5.3 pt; Quadris Top – 56 fl oz; QuiltXcel – 56 fl oz; Quintec – 24.0 fl oz; Rally – 30.0 oz; Rhyme - 28 fl oz; Ridomil Gold – 3.0 pt; Scala – 54.0 fl oz; Switch – 56.0 oz; Topsin-M – 4.0 lb; Torino – 6.8 oz; Ultra Flourish – 6.0 pt.

DISEASE ALERT: NEOPESTALOTIOPSIS LEAF SPOT AND FRUIT ROT

Neopestalotiopsis leaf spot and fruit rot, caused by a *Neopestalotiopsis* sp., was first reported to cause damage in strawberry fields in Virginia in 2023. Leaf spot symptoms (e.g., light to dark brown spots) mimic other leaf spot diseases caused by *Phomopsis* or *Gnomonia* spp., while fruit rot symptoms are similar to those caused by *Colletotrichum* spp. Thus, please contact county extension agents, extension specialists, and Virginia Tech's diagnostic lab for confirmation of the Neopestalotiopsis disease. When purchasing planting materials, ensure that your nursery source does not have a history of Neopestalotiopsis. If Neopestalotiopsis is confirmed in your field, apply Switch (~50% control) to reduce loss from fruit rot.

Table 2.2 - Strawberry Insects

Crop and Pest	Chemical and Formulation	Rate per 100 Gal Dilute	Rate per Acre	Spray Timing and Remarks
Preplant				
White grubs	Diazinon AG500	1.0 pt	—	Apply diazinon in 100 gal/A with boom sprayer. Do not plant strawberries immediately following sod. Fumigant may be also used. Apply Admire Pro at or just before transplanting, or in drip irrigation just before bud opening. Incorporate Admire Pro into soil with at least 0.25 inches of irrigation or rainfall within 2 hrs of application.
	Admire Pro	—	7.0-10.5 fl oz	
Aphids	Admire Pro	—	10.5-14.0 fl oz	
	Sivanto Prime	—	7-14 fl oz	
First Cover				
Spittlebug	Sevin XLR	—	2.0 qt	First cover: When blossom buds emerge 1/2 inch from crown. Apply with ground equipment with adequate water for uniform coverage (100-300 gal/A). See Table 2.7 for REI and PHI. It is advisable to delay use of Danitol if spotted-wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Danitol 2.4EC	10.6 fl oz	—	
	Assail 30SG	—	1.9-4.0 oz	
Strawberry clipper	Brigade WSB	3.2-16.0 oz	6.4-32.0 oz	Clipper: Prebloom use only; do not apply when berries are present. Early control is important. Treat when an average of 0.6 clipped buds/foot of row are found. Do not apply when berries are present. See Table 2.7 for REI and PHI.
Spider mites	Savey 50DF Zeal 72WDG	—	2.0-3.0 oz	Do not spray for mites on a preventive basis. Rotate acaricides to delay resistance. Do not apply an acaricide more than twice/season. Savey may be applied at the rate of 6.0 oz/A under intense population pressure. See Table 2.7 for REI and PHI. Acramite may be applied once per season. Use an organosilicone (See label.) [1]Consult distributors. Nealta should be applied at the first sign of infestation. No more than one application of Nealta should be applied before changing to an acaricide of differing mode of action.
	Oberon 2SC	—	12.0-16.0 oz	
	Acramite 50WS	0.4-0.5 lb	0.75-1.0 lb	
	Agri-Mek 0.15EC	8.0 fl oz	16.0 fl oz	
	Vendex 50WP	8.0 oz	2.0 lb	
	Stylet Oil	3.0 qt	—	
	Predatory mites[1]	—	—	
	Aza-Direct	—	11.5-42.0 fl oz	
	Kanemite 15SC	—	21.0-31.0 fl oz	
	Trilogy	—	2% solution	
	Nealta 1.67WSP	—	13.7 fl oz	
Second Cover				
Tarnished plant bug	Rimon 0.83EC	—	6.0 oz	When blossoms separate in flower cluster. Treatment threshold is 1 nymph in every 1 to 2 flower clusters. See Table 2.7 for PHI and REI. Actara provides suppression only. Use of Danitol or Brigade should be delayed if spotted-wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Brigade WSB	3.2-16.0 oz	—	
	Danitol 2.4EC	10.7 fl oz	11.5-42.0 fl oz	
	Aza-Direct	—	4.0-6.9 oz	
	Assail 30SG	—	2.0-3.0 oz	
	Actara 25 WDG	—	4.0 oz	
	Beleaf 50SG	—	2.8 oz	
Strawberry leafroller	Sevin XLR	—	2.0 qt	Strawberry leafroller is seldom a problem. Entrust is for organic management. Use of Radiant should be delayed if spotted-wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Dipel DF	—	0.5-1.0 lb	
	Entrust 80WP	—	1.25-1.5 oz	
	Radiant 1SC	—	6.0-10.0 fl oz	
	Assail 30SG	—	4.0-6.9 oz	
	Coragen 1.67SC	—	3.5-5.0 fl oz	
	Intrepid 2F	—	6-12 fl oz	

Table 2.2 - Strawberry Insects (continued)

Crop and Pest	Chemical and Formulation	Rate per 100 Gal Dilute	Rate per Acre	Spray Timing and Remarks
Second Cover				
Thrips	Aza-Direct	—	12.5-42.0 fl oz	
	Entrust 80WP	—	1.25-1.5 oz	
	Exirel 10.2EC	—	13.5-20.5 fl oz	
	Radiant 1SC	—	6.0-10.0 fl oz	
	Assail 30SG	—	4.0-6.9 oz	
Strawberry clipper	See First Cover	—	—	—
Third Cover				
No insecticides at this time	—	—	—	At 10% bloom.
Fourth Cover				
No insecticides at this time	—	—	—	At 50% bloom.
Fifth Cover				
Tarnished plant bug	See Second Cover	—	—	Berries half-grown, 7 to 10 days after fourth cover. This second TPB spray may be needed. See note in Second Cover.
Spittlebugs	See First Cover	—	—	—
Leafroller	See Second Cover	—	—	—
Spider mites	See First Cover	—	—	—
Strawberry aphid	Actara 25WG	—	1.5-3.0 oz	Use virus-free plants.
	Assail 30SG	—	1.9-4.0 oz	
	M-Pede	—	2% solution	
	Aza-Direct	—	11.5-42.0 fl oz	
	Beleaf 50SG	—	2.8 oz	
Preharvest				
Sap beetles	Assail 30SG	—	4.0-6.9 oz	Harvest ripe fruit promptly and completely and remove from field. Pesticides not as effective as cultural methods. See Table 2.7 on REI and PHI.
	Malathion 5EC	—	1.5 pt	
	Danitol 2.4EC	16.0-21.3 fl oz	—	
	Rimon 0.83EC	12.0 fl oz	—	
	Bait Buckets	Not a spray		Sap beetles are sometimes called picnic beetles, and are strongly attracted to ripening fruit. Sanitation, in the form of conscientiously picking all ripe fruit on a daily basis, is the most important management option for controlling sap beetles. Bait buckets filled with overripe fruit may be used on the perimeter of fields to attract sap beetles and other ripe fruit pests. If several days of rain preclude picking, it may be necessary to send laborers into fields in advance of pick-your-own customers to remove overripe fruit.
Spotted-wing Drosophila	Entrust 80 WP	—	1.25–2.0 oz	Harvest fruit promptly and completely. Rotate among available modes of action to slow development of pesticide resistance. Use of malathion or Brigade should be delayed if spotted-wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Entrust 2SC	—	4.6 fl oz	
	Brigade WSB	—	16.0 oz	
	PyGanic 1.4 EC	—	64.0 fl oz	
	Azera	—	2.0–3.0 pt	
	Exirel 10.2EC	—	17.5-20.5 fl oz	
	Malathion 5EC	—	1.5 pt	
	Radiant 1SC	—	6-10 fl oz	
Post-Harvest				
Strawberry root weevil	Brigade WSB	8.0-16.0 oz	16.0-32.0 oz	Where root weevil has been a problem, spray when leaf feeding appears.
	Malathion 5EC	—	1.5-2.5 pt	
Strawberry leafrollers	See Second Cover	—	—	Leafrollers and aphids may need to be controlled to ensure continued growth, especially in young plantings.
Strawberry aphid	See Fifth Cover			
White grubs	Admire Pro	—	7.0-10.5 fl oz	Apply at renovation; incorporate into soil and furrow with 0.25 inches of water (irrigation or rain).

[1]Predatory mites *(Amblyseius fallacis)* are available commercially; these have been used effectively. Avoid use of Sevin, Brigade, and Danitol if predatory mites are used.

■ Caneberries

Table 2.3 - Blackberry and Raspberry Diseases

Crop and Pest	Chemical and Formulation	Rate per 100 Gal Dilute	Rate per Acre	Spray Timing and Remarks
Anthracnose (Elsinoe veneta) Cane Blight *(Leptosphaeria coniothyrium)* Spur Blight *(Didymella applanata)*	**See fungicide use comments and Table 2.7 for specifics on fungicide use and for REI's, PHI's & maximum use rates for each fungicide.** **Dormant or late dormant sprays** Liquid lime sulfur (24-31% solution)	—	See specific product label	**Dormant or late dormant sprays:** Spray in late winter or early spring when new growth is less than ¾ inch long. Lime-sulfur will likely burn any exposed green tissue, and will burn applicators as well as plants. At least 200 gallons of dilute spray per acre is recommended. Sulfur = FRAC-M2.
	Copper-based products	—	See specific product label	Copper products should only be applied as dormant or delayed dormant sprays. Copper can cause phytotoxicity on black raspberry and occasionally on red raspberry if used with formulated phosphorus acid products (Aliette – FRAC-33 for example). Be sure to thoroughly clean equipment after using a copper product or lime sulfur.
	Shoots 6" long to After-Harvest:			**Shoots 6" long to After-Harvest:** No more than 2 sequential applications are allowed for any of these products before alternating to a fungicide with a different mode of action. No more than 3-4 total applications are allowed per season for any of these products, depending upon the specific product label. Cabrio & Abound are FRAC-11 only. Pristine contains FRAC-11 & FRAC-7 fungicides, while Quilt Xcel contains a FRAC-11 & a FRAC-3 fungicide.
	Cabrio	—	14.0 oz	
	Abound	—	6.2-15.5 fl oz	
	Pristine	—	18.5-23 oz	
	Quilt Xcel	—	14.0-21.0 fl oz	
	Captan products		see specific product label	Captan products are FRAC-M4. Apply at bloom (shoots 8" -10" long), 2 weeks later, & in the fall after old canes have been removed.
	OSO	—	13.0 fl oz	OSO & Ph-D are FRAC-19 fungicides.
	Ph-D	—	6.2 oz	
Gray mold *(Botrytis cinerea)*	Pristine 38WDG	—	18.5-23.0 oz	**Resistance to the active ingredients in Elevate (FRAC-17) and Pristine is increasingly common, and may become an issue with the Luna fungicides.** Therefore, a protectant fungicide (Captan, for example) should always be mixed with Elevate. Make no more than 2 sequential applications of Pristine or Luna Tranquility before alternating to a product with a different mode of action (FRAC Group). Switch contains a FRAC-9 and a FRAC-12 fungicide. Rovral, Nevado, and Iprodione are FRAC-2 products.
	Luna Tranquility	16-27 fl oz		
	Elevate 50WDG		1.5 lb	
	Switch 62.5WG		11.0-14.0 oz	
	Rovral 4F, Nevado 4F, Iprodione 4L AG	0.5-1.0 pt	1.0-2.0 pt	For raspberry only; begin applications at 10% bloom and continue every 7-14 days or when conditions favor disease development, through harvest.
	Captevate 69WGD		3.5 lbs	
	Captan products		See labels	For use in rotating other fungicides for resistance management. No more than 6 applications at the maximum rate.
	OSO		13.0 fl oz	
	Ph-D		6.2 oz	
	Abound 2.08F		fl oz	**Caution: Abound (FRAC-11) is extremely phytotoxic to some apple cultivars.** Prevent spray drift and leftover residue in the spray tank which may come in contact with apples.

Table 2.3 - Blackberry and Raspberry Diseases (continued)

Crop and Pest	Chemical and Formulation	Rate per 100 Gal Dilute	Rate per Acre	Spray Timing and Remarks
Cane and Leaf Rust *(Kuehneola uredines)* Orange Rust (*Arthuriomyces peckianus, Gymnoconia nitens)* Yellow Rust *(Phragmidium rubi-idaei)*	Rally 40WSP	—	1.25-2.5 oz	Applications should be initiated as early as bud break and repeated at 10- to 14-day intervals, depending on the diseases to be controlled. Orange rust: April-June; cane and leaf rust: green tip and just before bloom; yellow leaf rust: April-May; late leaf rust: June-Sept.; powdery mildew: early white bud to full bloom; leaf spot: June-Aug. Rally is a FRAC-3 fungicide, while Cabrio is a FRAC-11 product. Pristine and Quilt Xcel both also contain a FRAC-11 fungicide, but Pristine also includes a FRAC-7 compound while Quilt Xcel also includes a FRAC-3 fungicide.
	Tilt 3.6EC	—	6.0 fl oz	
	Cabrio	—	14 oz	
	Abound FL	—	6.0-15.5 fl oz	
	Pristine WG	—	18.5-23.0 oz	
	Quilt Xcel	—	14.0-21.0 fl oz	
Rosette or Double Blossom *(Cercosporella rubi)*	Abound FL	—	6.0-15.5 fl oz	Pristine and Quilt Xcel both contain a FRAC-11 fungicide, but Pristine also includes a FRAC-7 compound while Quilt Xcel also includes a FRAC-3 fungicide. Switch contains a FRAC-9 and a FRAC-12 fungicide.
	Pristine W	—	18.5-23 oz	
	Quilt Xcel	—	14.0-21.0 fl oz	
	Switch 62.5WG		11.0-14.0 oz	
	Bordeaux mixture	8 lb Copper sulfate + 8 lb Calcium hydroxide		
Powdery mildew *(Sphaerotheca macularis)*	Rally 40WSP	—	1.25-2.5 oz	Rally, Orbit, and Tilt are FRAC-3 fungicides. Do not apply more than 10 oz per acre per season. Cabrio and Abound are FRAC-11 fungicides, while Pristine is a FRAC-11 + FRAC-7 product and Quilt Xcel contains a FRAC-11 and a FRAC-3 fungicide. OSO and Ph-D are FRAC-19 fungicides, while sulfur products are FRAC-M2. Use sulfur products only as dormant or late dormant sprays in late winter or early spring when new growth is less than ¾ inch long. Lime-sulfur will likely burn any exposed green tissue, and will burn applicators as well as plants. At least 200 gallons of dilute spray per acre is recommended.
	Cabrio EG	—	14.0 oz	
	Abound FL	—	6.2-15.5 fl oz	
	Azaka	—	6.0--15.5 fl oz	
	Pristine WG	—	18.5-23 oz	
	Sulfur-based products	—	See product label	
	Tilt 3.6EC	—	6.0 fl oz	
	Quilt Xcel	—	14.0-21.0 fl oz	
	OSO	—	13.0 fl oz	
	PhD	—	6.2 oz	
Leaf spots *(Sphaerulina westendorpii)*	Quilt Xcel	—	14.0-21.0 fl oz	Sprays for anthracnose, Botrytis gray mold, double blossom, and fruit rots should prevent Septoria infections. Quilt Xcel contains both a FRAC-11 fungicide and a FRAC-3 fungicide. Cabrio is a FRAC-11 fungicide. Pristine contains a FRAC-11 fungicide and a FRAC-7 fungicide, while Luna Tranquility combines a FRAC-7 and a FRAC-9 fungicide. Captan products are FRAC-M4 fungicides.
	Tilt 3.6EC	—	6 fl oz	
	Cabrio	—	14 oz	
	Abound FL	—	6.2-15.4 fl oz	
	Pristine WG	—	18.5-23 oz	
	Luna Tranquility	16-27 fl oz		
	Captan Products		See specific product label	

FUNGICIDE USE FOR CANEBERRY DISEASES

See fungicide use comments and Table 2.7 for specifics on fungicide use and for REI's, PHI's & maximum use rates for each fungicide.

"Bordeaux mixture" can be prepared using the following procedure:1-Fill spray tank to ½ the desired water volume; 2-Turn-on agitator; 3-dissolve powdered bluestone (copper sulfate)in spray tank at a rate of 4 lb bluestone/50 gallons of water; 4-make a "milk of lime" suspension by dissolving 4 lb of hydrated lime (calcium hydroxide) in 5 gallons of water in a container, for a rate of 4 lb hydrated lime/50 gallons water; 5-Slowly add "milk of lime" suspension into spray tank; 6-Fill spray tank to desired water volume; 7-maintain constant agitation and apply immediately. Do not mix with Topsin-M or Sevin. Bordeaux mixture will severely burn leaves if applied on very hot days or if combined with insecticides. Slight phytotoxicity will have relatively minor impact.

If used, Quilt Xcel sprays should begin before disease develops. Because resistance to the active ingredients in QoI (FRAC Group 11) fungicides is increasingly common, Cabrio, Abound, Luna Tranquility, Pristine, and Quilt Xcel should be applied no more than twice in a single growing season. Resistance to Elevate (FRAC = 17) is also a rising issue, and is a possibility with polyoxin-D products like Ph-D. Therefore, Ph-D should be applied in no more than 4 sprays per season, while no more than 6 applications of OSO are

allowed. Do not make more than 4 applications of Elevate, or of iprodione products like Rovral or Nevado, per season. **Caution: Fungicides containing azoxystrobin (Abound, for example) may be extremely phytotoxic to some apple cultivars. Prevent spray drift and leftover residue in the spray tank which may come in contact with apples.**

Pre-Harvest Spray Intervals: Abound, Agri-Fos, Cabrio, Elevate, Lime Sulfur, Luna Tranquility, Nevado, OSO, Ph-D, Phostrol, Pristine, Rally, Rovral, and Switch may be applied the day of harvest. The preharvest interval for Captan, Captec and Captevate is 3 days. Preharvest intervals for most copper products are 2 days, but check the product label to be sure. Bumper, PropiMax, Tilt, and Quilt Excel must be applied at least 30 days before harvest, while MetaStar, Ridomil Gold, and Ultra Flourish have a preharvest interval of 45 days. Aliette can be applied no closer than 60 days before harvest.

Maximum Fungicide Uses per year: Abound – 92.3 fl oz; Aliette – 4 applications; Cabrio – 56.0 oz; Captan 80WDG – 12.5 lb; Captevate – 21.0 lb; Elevate – 6.0 lb; MetaStar – 2 applications; Luna Tranquility – 54.7 fl oz; OSO – 78 fl oz; Ph-D – 18.6 oz; Pristine – 92.0 oz; PropiMax – 30.0 fl oz; Quilt Xcel – 105 fl oz; Rally – 10.0 oz; Ridomil Gold – 3.6 pt; Switch – 56.0 oz; Tilt – 30.0 fl oz; Ultra Flourish – 2 applications.

CANE BLIGHTS

Spray from Delayed Dormant to After Harvest.

Cane blights can cause significant losses to brambles, but in Virginia are often associated with winter injury. However, pruning wounds can also be a primary site of cane blight infection, especially during wet weather. Avoid pruning unless at least four days of dry weather are expected. Pinching off or "tipping" primocanes when they are at the desired height (and narrower) will reduce the size of pruning wounds, reducing the frequency of infections. Weed-free zones below the caneberry canopy will also help reduce infections. Fungicides should be applied immediately after pruning in order to be effective. Fungicide FRAC Groups should also be alternated to deter development of fungicide resistance. See https://smallfruits.org/2021/04/cane-blight-and-cane-dieback-of-blackberry-causal-organisms-and-management-recommendations/ for additional information.

ANTHRACNOSE

Nearby wild blackberries (within 500-1,000 ft) can be a source of infection and should be destroyed. Floricanes should be removed as soon as possible after harvest; new canes with signs of disease or insect injury should also be removed and burned or buried prior to budbreak. Good weed control below the canopy and proper thinning and sucker control will help reduce infection by allowing faster drying of canes and foliage. Cultivars that are thornless or procumbent blackberries are generally less susceptible than those that are thorny or erect. Liquid lime sulfur sprays should start before 3/4 inches of green tissue has formed. Additional liquid lime sulfur sprays may be applied after primocanes become 6 inches tall and thereafter at 14-day intervals through harvest.

ORANGE RUST

Orange rust systemically infects black raspberry, blackberry, and wild dewberry. Blackberry varieties Cherokee, Cheyenne, Comanche, Choctaw (erect, thornless), Arapaho (erect, thornless), and Shawnee are considered resistant, although some disease has been observed on all varieties. Wild blackberries within 0.25 mile of planting should be eradicated. Preventative fungicide (Rally, etc.) applications can be effective, but new canes 12-18 inches tall should be inspected thoroughly, early in the season. Note spindly emerging canes with fluorescent orange rust lesions on the underside of leaves. Uproot the entire plant, place it in a plastic bag, and remove it from the planting as soon as possible to reduce spread to healthy plants.

LEAF AND CANE RUST

Nearby wild blackberries (within 500-1,000 feet) can be a source of infection and should be destroyed. Floricanes should be removed as soon as possible after harvest; new canes with signs of disease or insect injury should also be removed and burned or buried prior to budbreak. Good weed control below the canopy and proper thinning and sucker control will help reduce infection by allowing faster drying of canes and foliage. Fungicide sprays should be applied at green tip and prior to bloom, and then resumed after harvest until floricanes are removed. Further sprays after primocane removal should be delayed until new infections are observed on primocanes.

PHYTOPHTHORA ROOT ROT

Phytophthora root rot is generally a problem in low, poorly-drained sites, so site selection and/or proper bedding operations are essential cultural practices for control of this disease. Fungicide treatment usually can't reverse root rot damage on plants with severe symptoms. However, Orondis Gold 200 is a highly-effective new fungicide to control Phytophthora root rot on blackberry and red or black raspberry. First applications of 4.8-9.6 fl oz/acre should be made before plants start to grow in the spring, with a second application during a period favorable for root growth and at least 7 days after the first application. Orondis Gold 200 should be applied in at least 20 gal/acre of water and as a band directed to the soil along the side of each crop, near and under the lower leaves. The higher rate should be used for moderate to severe infections. Apply ¼ - ½ inch of water after each application, either by overhead sprinkler irrigation or as a drench on the row. No more than two applications are allowed per year, for a total of 19.2 fl oz/acre/year. When more than 3 applications of a *Phytophthora* fungicides are made, Orondis should be used in no more than 33% of the sprays, or a maximum of 4 applications, whichever is fewer.

Ridomil Gold GR and MetaStar 2E are labeled for control of Phytophthora root rot on raspberries only, but Ridomil Gold SL and Ultra Flourish are registered for this use both on blackberries and red or black raspberries. On a broadcast basis, Ridomil Gold SL is applied at 3.6 pt/A (0.25 pt/1,000 row feet) while Ultra Flourish sprays use 7.2 pt/A (0.5 pt/1,000 row feet). Raspberry rates for Ridomil Gold GR are 5.0 lb/1,000 linear feet, while 1.0 pt of Meta Stare 2E may be applied per 1,000 linear feet of row. Use the formula in the general information section of the appropriate label to calculate the amount of fungicide needed per acre. Ridomil Gold GR is applied at 72.0 lb/A on a broadcast basis, but use the formula in the general information section of the label to calculate the correct amount of fungicide needed per acre for band application. Consult the labels for each of these products concerning the details of correct application timing and methods. Do not apply any of these fungicides within 45 days before harvest or possibly illegal residues may result.

Aliette 80WDG (FRAC = 33) is registered for control of *Phytophthora* on all caneberries. Apply as a foliar spray at the rate of 5 lb/A in new plantings. Applications should begin when plants produce 1-3 inches

of new growth. Applications in established plantings should begin when conditions favor disease development. Begin foliar sprays in the spring after bud break (1-3 inches of new growth) and continue spraying on a 45-60 day schedule, up to a maximum of 4 sprays during the growing season. The last fall application should be applied at least 30 days prior to leaf drop. Do not mix Aliette with surfactants or foliar fertilizers. Do not apply Aliette within 60 days of harvest. Several other phosphorous acid products (FRAC = 33) are labeled as foliar sprays for Phytophthora root rot control, including Agri-Fos, Phostrol, and ProPhyt. Do not use adjuvants or acidifying type compatibility agents with any phosphorus acid products in order to avoid phytotoxicity. Damage could also occur if these products are mixed in water with a low pH (below 6). Apply 4 fl oz of Ridomil Gold EC, 5.0 lb of Ridomil Gold GR and MetaStar 2E/1,000 linear feet of row to the soil surface in a three-foot band over the row.

BOTRYTIS GRAY MOLD

Blossom blight and disease spread to ripening fruit can be controlled by sprays starting at early bloom and continuing through full bloom to near harvest. However, the pathogen has developed resistance to multiple fungicides. Growers should follow fungicide resistance management recommendations closely to avoid crop losses. Pre-harvest sprays are usually not necessary for blackberry unless weather is cool and wet.

ROSETTE (DOUBLE BLOSSOM)

Blackberry varieties can vary in resistance to rosette or double blossom: Apache, Navaho, and Humble are largely resistant, while Shawnee, Choctaw, Chickasaw and Black Satin are highly susceptible. Sprays should start when rosettes are blooming and primocanes begin to grow. Witches-brooms should be clipped-out as they develop and before they flower. Prompt removal and destruction of floricanes after final harvest will help prevent or limit this disease. If disease pressure is high, cut all canes after harvest to 12-18 inches tall, fertilize heavily, and irrigate regularly to increase cane production for the following year.

POWDERY MILDEW

Powdery mildew is usually not a problem, but some western cultivars are very susceptible. Fungicide treatments should begin at the first sign of disease and continue at 10-14 day intervals.

CROWN GALL

All caneberries can be affected by crown gall, which causes canker-like growths on roots and stems. Galls look greenish-white at first, but then turn tan-to-brown, and then black. Planting tissue-cultured stock will help avoid introducing the disease to a field. This is particularly important because the bacterial pathogen can persist in soil once introduced. Wounds in roots and lower stems are required for infection. Allow wounded root pieces to heal before planting; prune above-ground plant parts when several days of dry weather are expected, and avoid wounding plants during cultivation or from herbicides. Dips for root cuttings at planting can provide additional insurance against this disease.

VIRUSES

A number of viruses are common and can be significant problems in bramble production. However, apparent symptoms don't always reliably indicate their presence. Specific tissue tests must be conducted to verify a virus diagnosis. No control measures are available for bramble viruses, other than rapid removal of symptomatic plants in order to slow plant-to-plant spread. Since viruses can be introduced through propagation, clean planting stock is essential. Although tissue-cultured plants can't be guaranteed to be virus-free, they are more likely to be free of viruses and crown gall, and are highly recommended. Destruction of wild blackberries within 100-200 yards of a commercial planting may help reduce possible spread. Avoiding or minimizing dagger nematodes in the soil can also be important, as these nematodes can be virus vectors.

COMMENTS ABOUT THE USE OF COPPER FUNGICIDES ON CANEBERRIES

Copper fungicides have been used for caneberry disease control (rusts, for example), even though these materials can be phytotoxic to caneberries and cause damage. However, other products of different chemical classes are now registered that are highly effective on targeted diseases. For example, Rally, and PropiMax should be effective for managing rust diseases. These products do not have the broad phytotoxicity concerns of the copper materials, but they do have potential fungicide-resistance concerns. Phytotoxicity can also occur when copper products are applied and phosphorus acid-based products (FRAC-33) are used to control *Phytophthora* root rot. Always use a product only in accordance with the label for that particular formulation, as application timing and target diseases may vary with the formulation. Again, caution is advised in using any copper product.

Table 2.4 - Caneberry Insects				
Crop and Pest	**Chemical and Formulation**	**Rate Per 100 Gal Dilute**	**Rate per Acre**	**Spray Timing and Remarks**
Dormant				
Raspberry crown borer and rednecked cane borer	—	—	—	Removal of infested canes during winter pruning is an effective cultural control for these borers.
Prebloom				
Leafrollers	Confirm 2F	—	16.0 fl oz	When buds are breaking or new canes are 6 to 8 inches long. See label for timing Confirm sprays. See Table 2.7 for REI and PHI. Use of Delegate, Brigade or Sniper should be delayed if spotted-wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Delegate 25WG	—	3.0-6.0 oz	
	Dipel ES	—	1.0-4.0 pt	
	M-Pede	2.0 gal	2% solution	
	Brigade 10WSB	—	8.0-16.0 oz	
	Entrust 80WP	—	1.25-2.0 oz	
	Sniper	—	3.2-6.4 fl oz	
	Intrepid 2F	—	10-16 fl oz	
Raspberry sawfly	M-Pede	2.0 gal	2% solution	Use of Delegate should be delayed if spotted-wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Delegate 25WG	—	3.0-6.0 oz	
	Entrust 80WP	—	1.25-2.0 oz	
Blackberry psyllid	Malathion 57EC	—	3.0 pt	Spray for psyllid when adults appear on plants. Surround provides suppression. Use of malathion should be delayed if spotted-wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Surround 95WP	—	12.5-50.0 lb	
Raspberry cane borer	Malathion 57EC	—	3.0 pt	For cane borer remove all infested canes; prune within a few days after wilted tips appear to minimize tissue removed. Spray just before blossoms open.
	M-Pede	2.0 gal	2% solution	
Raspberry fruitworm	Delegate 25WG	—	3.0-6.0 oz	Use of Delegate should be delayed if spotted-wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Entrust 80WP	—	1.25-2.0 oz	
Stink bug (inc. Brown marmorated stink bug) and Tarnished plant bug	Brigade 10WSB	—	8.0-16.0 oz	Apply when one TPB (Tarnished plant bug) in every two flower clusters. Do not apply more than 6.0 oz/A of Actara per session. After an Actara application, wait at least five days before placing beehives in treated fields.
	Actara 25WDG	—	3.0 oz	
	Sniper	—	3.2-6.4 fl oz	
Thrips	Aza-Direct	—	12.5-42.0 fl oz	Just before blossoms open. Admire Pro soil-applied.
	Assail 30SG		4.5-5.3 oz	
	Malathion 57EC		1.5 pt	
	Admire Pro	—	2.8 fl oz	
	Entrust 80WP	—	1.25-2.0 oz	
	Delegate 25WG	—	3.0-6.0 oz	
Clipper	Brigade 10WSB	—	16.0 oz	Use of Brigade or Danitol should be delayed if spotted-wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Danitol	—	10.66-16.0 fl oz	
Raspberry crown borer	Brigade 10WSB	—	16.0 oz	Apply as a drench in at least 200 gal of water/A, either prebloom or post harvest but not both. Use of Brigade or Sniper should be delayed if spotted-wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Sniper	—	6.4 fl oz	
	Altacor 35 WDG	4.0-5.3 oz		OMRI approved
	Heterorhabditis	—		see label
First Cover: at petal fall				
Aphids	Malathion 57EC	—	3.0 pt	Admire Pro soil-applied. Use of malathion should be delayed if spotted-wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Asana XL		4.8-9.6 fl oz	
	Sevin XLR Plus	—	2.0 qt	
	M-Pede	2.0 gal	2% solution	
	Assail 30SG	—	2.5-5.3 oz	
	Actara 25WG	—	2.0-3.0 oz	
	Admire Pro	—	2.8 fl oz	
	Sivanto Prime	—	7-14 fl oz	

Table 2.4 - Caneberry Insects (continued)

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Rate per Acre	Spray Timing and Remarks
First Cover: at petal fall				
Red-necked cane borer	Malathion 57EC	—	3.0 pt	Spray every 7 to 12 days from early May to early June if this pest has been a problem. Remove galled canes in early spring. This cultural control can contribute significantly to RNCB management. Use of malathion or Bridage should be delayed if spotted-wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Brigade 10WSB	—	8.0-16.0 oz	
Thrips	See Prebloom Spray Admire Pro		2.8 fl oz	
Leafrollers	See Prebloom Spray			
Blackberry psyllid	See Prebloom Spray			
Leafhoppers	Malathion 57EC	—	1.5 pt	Use of malathion should be delayed if spotted-wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	M-Pede	2.0 gal	2% solution	
	Assail 30SG	—	2.5-5.3 oz	
	Admire Pro	—	2.8 fl oz	
Rose scale	Admire Pro	—	2.8 fl oz	Use of Brigade should be delayed if spotted-wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Assail 30SG	—	4.0 - 5.3 oz	
	Brigade 2EC	—	3.2-6.4 fl oz	
	Tri-Tek	—	2% solution	
	Esteem 35W	—	5 oz	
Second Cover: ten days after petal fall				
Aphids	See First Cover			
Brown marmorated stink bug	Actara 25WDG	—	3.0 oz	Do not apply more than 6 oz/A of Actara per season. After an Actara application, wait at least 5 days before moving bee hives into treated fields. Use of malathion, Brigade or Sniper should be delayed if spotted-wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Brigade 10WSB	—	8.0-16.0 oz	
	Malathion 57EC	—	3.0 pt	
	Sniper	—	3.2-6.4 fl oz	
Spider mites	Agri-Mek 8SC	—	1.75-3.5 fl oz	Savey is highly effective against mite eggs. If many active mites are present, an adulticide should be applied. PHI is 3 days.
	Savey 50DF	—	6.0 oz	
	Stylet Oil	3.0-6.0 qt	—	
	Acramite 50WS	—	0.75-1.0 lb	
	Zeal 72WSB	—	2-3 oz	
	Kanemite 15SC	—	31 fl oz	
Broad mites	Agri-Mek 8SC	—	3.5 fl oz	Broad mites are very small and will require a 20x hand lens to see. Agri-Mek must be combined with a non-ionic wetting/spreading/ penetrating adjuvant.
Third Cover				
Japanese beetle	Sevin 80S	1.0 lb	2.0 lb	Twenty days after petal fall.
	Sevin XLR Plus	—	2.0 qt	
	Admire Pro	—	7.0 - 14.0 fl oz (soil) 2.8 fl oz (foliar	
	Aza-Direct	—	12.5-42.0 fl oz	
	Assail 30SG	—	4.5-5.3 oz	
	Actara 25WG	—	3.0 oz	
	Neemix 4.5 plus	—	7.0-16.0 fl oz +	Neemix/Trilogy mix every 7-10 days. See label for Trilogy mixing instructions. Neemix and Trilogy are OMRI-certified.
	Trilogy 70	—	2% solution	
	Surround 95WP	—	12.5-50.0 lb	Surround provides suppression. Recommended only for 1st three weeks following fruit set in fresh market berries because of visible residues.

Table 2.4 - Caneberry Insects (continued)

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Rate per Acre	Spray Timing and Remarks
Third Cover				
Spotted-Wing Drosophila	Entrust 80WP	—	1.25-2.0 oz	Open pruning will aid in SWD management, as will prompt harvest of ripe berries. Keep berries as cool as possible after harvest. Spray timing must be at least every 7 days in many cases. Rotate modes of action in order to delay the development of pesticide resistance. Observe seasonal maximum number of applications: Danitol 2 applications, malathion 4 applications, bifenthrin 2 applications, Entrust and Delegate 6 applications. Season limits to product applied may also apply; check the label. Addition of table sugar at the rate of 30 oz per 100 gal will aid in efficacy of chemical control of SWD.
	Entrust 2SC	—	4.0-6.0 fl oz	
	Exirel 10.2EC	—	13.5-20.5 fl oz	
	Delegate 25WDG	—	3.0-6.0 oz	
	Malathion 57EC	—	3.0 pt	
	Mustang Maxx	—	4.0 oz	
	Asana	—	4.8-9.6 fl oz	
	Brigade 10WSB	—	16.0 oz	
	PyGanic 1.4EC	—	64.0 fl oz	
	Azera	—	2.0-3.0 pt	
Broad mites	Agri-Mek	—	3.5 fl oz	+ 0.1-0.5% v/v non-ionic surfactant (NIS)
Brown marmorated stink bug	Actara 25WDG	—	3.0 oz	
	Assail 30SG	—	5.3 oz	
	Azera	—	2.0-3.0 pt	
	Brigade 10WSB	—	8.0-16.0 oz	
	Malathion 57EC	—	3.0 pt	
	PyGanic 1.4EC	—	64.0 fl oz	
	Sniper	—	3.2-6.4 fl oz	
Click beetles	Malathion 57EC	—	2.0 pt	Spray for pests as needed. Do not apply within 1 day of harvest.
Aphids	See First Cover			
Mites	See Second Cover			
Post Harvest				
Raspberry crown borer	Sevin XLR Plus	—	2.0 qt	Sevin may be applied as foliar spray. Apply Brigade as drench in at least 50 gal of water either postharvest or prebloom but not both. Rogue out infested plants after harvest.
	Brigade 10WSB	—	16.0 oz	
	Altacor 35WDG	—	4.0 - 5.3 oz	
	Verdepryn	—	8.2-11 fl oz	To be applied as foliar spray, before larvae reach the crown. Provides suppression.
	Heterorhabditis	—	See label	
Aphids	See First Cover			Spray for pests if needed.
Mites	See Second Cover			
Leafhoppers	See First Cover Spray			
Rose Scale	Admire Pro	—	2.8 fl oz	
	Brigade 2EC	—	3.2-6.4 fl oz	
	Tri-Tek	—	2% solution	

■ Blueberries

Table 2.5 - Blueberry Diseases

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Rate per Acre	Spray Timing and Remarks
Mummy Berry Cups *(Monilinia vaccinii-corymbosi)*	50% urea mix	—	200.0 lb	Apply when cups appear (usually). Delayed Dormant Urea mix is 50% Urea sprills plus 50% inert materials. It supplies 45 lbs/A nitrogen. Cups may also be covered with 1 to 2 inches soil by discing or raking.
Phomopsis Twig Blight *(Phomopsis* spp.)	Indar 2F	—	6.0 fl oz	Begin applications before disease development and continue on a 7-to-14-day schedule, following resistance management guidelines. For Phomopsis twig blight control, make the first Indar application at early green tip and make subsequent applications at 8-to-14 day intervals. Applying Indar alone during bloom can increase fruit rots, so tank-mix Captan with Indar for bloom sprays to alleviate this problem. Apply Ziram at loose bud scale stage and 7 days later. Do not apply more than two sequential applications of FRAC-3 or FRAC-11 fungicides before alternating with a fungicide that has a different mode of action. Caution: Abound is extremely phytotoxic to some apple cultivars including 'Gala.' Prevent spray drift and leftover residue in the spray tank which may come in contact with apples.
	Quash	—	2.5 oz	
	Ziram 76DF	—	30.0 lb	
	Pristine 38WG	—	18.5-23.0 oz	
	Luna	—	13.6-27.0 fl oz	
	Switch 62.5WG	—	11.0-14.0 oz	
	Omega 500F	—	1.25 pt	
	Abound 2.08F	—	.2-15.4 fl oz	
	Captan products	—	See product labels	

Table 2.5 - Blueberry Diseases (continued)

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Rate per Acre	Spray Timing and Remarks
Mummy Berry Twig/fruit infection, *(Monilinia vaccinii-corymbosi)*	Indar 2F	—	6.0 fl oz	Begin applications before disease development and continue on a 7-to-14-day schedule, following resistance management guidelines. Start applications of FRAC-3 fungicides (Indar, Tilt, Bumper, Propimax, or Quilt Xcel (FRAC-3 and FRAC-11), at early green tip and make subsequent applications at 7-to-14 day intervals. Do not make more than two sequential applications any fungicide within the same FRAC group before alternating with a fungicide that has a different mode of action. Caution: Abound is extremely phytotoxic to some apple cultivars, including 'Gala'. Prevent spray drift and leftover residue in the spray tank which may come in contact with apples.
	Tilt 3.6E	—	6.0 fl oz	
	Propimax 3.6E	—	6.0 fl oz	
	Bumper 41.8EC	—	6.0 fl oz	
	Quash 50WDG	—	2.5 oz	
	Quilt Xcel	—	14.0-21.0 fl oz	
	Proline 480SC	—	5.7 fl oz	
	Pristine 38WG	—	18.5-23.0 oz	
	Luna Tranquility	—	13.6-27 fl oz	
	Switch 62.5WG	—	11.0-14.0 oz	
	Abound 2.08F	—	6.2-16.5 fl oz	
Fruit Rots (Anthracnose, Alternaria rot, *Glomerella cingulata*)	Pristine 38WDG		18.5-23.0 oz	Early Bloom to Post Bloom: Begin applications before disease development and continue on a 7-to-10-day interval, following resistance management guidelines. Observe pre-harvest and re-entry restrictions. Do not make more than two sequential applications of any fungicides within the same FRAC group before alternating with a fungicide that has a different mode of action. Caution: Abound is extremely phytotoxic to some apple cultivars, including 'Gala'. Prevent spray drift and leftover residue in the spray tank which may come in contact with apples.
	Luna Tranquility	—	13.6-27 fl oz	
	Switch 62.5 WG	—	11.0-14.0 oz	
	Abound 2.08F	—	6.2-15.4 fl oz	
	Captevate 68WDG		4.7 lb	
	Captan products	—	See product labels	
	Omega 500F	—	1.25 pt	
	Ziram	—	3.0 lb	
Leaf Spots (*Gloeosporium minus*, *Gloeocercospora inconspicua*, *Septoria albopunctata*, *Dothichiza caroliniana*, *Alternaria tenissima* and *Glomerella cingulata*)	Pristine WG	—	18.5-23.0 oz	Post Bloom to August at 7-to-10 day intervals. Observe pre-harvest and re-entry regulations. For leaf spot control after harvest, resume spray schedule 1 to 2 times. Arrange season-long schedule to include no more than two sequential sprays of Pristine, Abound or Azaka (FRAC-11), Quash (FRAC-3), Switch (FRAC-9 or FRAC-12), Luna Tranquility (FRAC-7 and FRAC-9). Caution: Abound is extremely phytotoxic to some apple cultivars, including 'Gala'. Prevent spray drift and leftover residue in the spray tank which may come in contact with apples. Apply a minimum of 16 fl oz of Luna Tranquility for Mycosphaerella or Septoria leaf spots. Tilt, Bumper, Propimax and Proline (all FRAC-3 fungicides) have good activity against Septoria and anthracnose leaf spots, but activity against other leaf spots is unknown. Captan is more effective against anthracnose leaf spot than against Septoria.
	Luna Tranquility	—	13.6-27 fl oz	
	Quilt Xcel	—	14.0-21.0 fl oz	
	Abound	—	6.0-15.5 fl oz	
	Indar	—	6.0 fl oz	
	Quash	—	2.5 oz	
	Tilt 3.6EC	—	6 fl oz	
	Bumper	—	6 fl oz	
	Propimax	—	6 fl oz	
	Proline	—	5.7 fl oz	
	Switch	—	11-14 oz	
	Captan products	—	See product labels	

PHYTOPHTHORA ROOT ROT CONTROL

Ridomil Gold EC and Ultra Flourish are labeled for control of Phytophthora root rot of blueberries. **Established plantings:** Apply 4 fl oz of Ridomil Gold EC or 0.5 pt (8.0 fl oz) of Ultra Flourish per 1000 linear feet of rot (3.6 pt per acre of Ridomil Gold EC or 7.2 pt of Ultra Flourish on a broadcast basis) in a three-foot band over the row before the plants start growth in the spring. One additional application may be made to coincide with periods most favorable for root rot development. **New plantings:** Broadcast apply 3.6 pt per acre of Ridomil Gold or 7.2 pt of Ultra Flourish to the soil at or after planting. Supplemental applications of Ridomil Gold should be made at 2- to 3-month intervals or to coincide with periods most favorable for root rot development. An 18-inch width is recommended for banded applications. Use the formula in the general sections of the labels to calculate the amount of fungicide needed per acre. On new plantings, do not broadcast apply more than 0.9 gal per acre of Ridomil Gold EC or 7.2 pt per acre of Ultra Flourish broadcast during the 12 months before bearing harvestable fruit or illegal residues may result.

Aliette 80WDG is registered on blueberries at 5.0 lb per acre for control of Phytophthora root rot and suppression of some fruit rots. Begin foliar sprays at approximately the pink bud stage and continue on a 14- to 21-day interval. Do not exceed four applications or 20 lbs per acre per year. Do not apply in less than 10 gal per acre of water or closer than 12 hours to harvest. Several other phosphorous acid products are labeled as foliar sprays for Phytophthora root rot

control, including Agri-Fos, Phostrol, and ProPhyt. See labels for specific use instructions and rates.

Pre-Harvest Spray Intervals: Do not apply Bumper, Indar, Orbit, Propimax, Quilt Xcel, or Tilt within 30 days of harvest. Abound, Azaka, Captan, Captevate, Luna Tranquility, Omega 500, Pristine, Proline, Quash, Switch, and Tavano may be applied the day of harvest. Ziram must be applied within 3 weeks of full bloom.

Maximum Fungicide Uses per year: Do not apply more than 1.44 qt of Abound, 30 fl oz of Bumper, 43.7 lb of Captan, 21.0 lb of Captevate, 24 fl oz (4 applications) of Indar, 54.7 fl oz of Luna Tranquility, 7.5 pt Omega 500, 92 oz of Pristine, 11.4 fl oz of Proline, 30 fl oz of Propimax EC, 7.5 oz of Quash, 82 fl oz of Quilt Xcel, 56 oz of Switch, 30 fl oz of Tilt, or 20 lb of Ziram 76F per acre per year.

Caution: Fungicides containing azoxystrobin (Abound, Azaka, and Quilt Xcel, for example) may be extremely phytotoxic to some apple cultivars. Prevent spray drift and leftover residue in the spray tank which may come in contact with apples.

Table 2.6 - Blueberry Insects

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Rate per Acre	Spray Timing and Remarks
Dormant				
Scales	Horticultural oil	1-3% solution	—	
	Esteem	—	16 fl oz	Since Esteem is an Insect Growth Regulator, evidence of activity may take longer than with contact insecticides. In dormant spray, combine with oil. May be applied as a foliar spray as well, when crawlers are active.
First Cover: at petal fall. (Petal fall spray is the single most important spray for blueberry insects)				
Blueberry tip borer	Sevin XLR Plus	—	2.0 qt	Removing dead canes at pruning aids in control of tip borer. Use of Malathion should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Malathion 57EC	—	1.5 pt	
Plum curculio	Sevin XLR Plus	—	2.0 qts	Two applications may be required for plum curculio. Surround provides suppression. Recommended only for 1st three weeks following fruit set for fresh berries because of visible residues. Use of Malathion or Exirel should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Surround 95WP	—	12.5-50.0 lb	
	Imidan 70W	—	1.5 lb	
	Malathion 57EC	—	2.0 pt	
	Exirel 10.2EC	—	13.5-20.5 fl oz	
Cranberry fruitworm and cherry fruitworm	Altacor	—	3.0-4.5 oz	Use of Delegate, Malathion or Mustang Maxx should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications. Use of Exirel should be delayed if spotted wing drosophila will be a target later.
	Intrepid 2F	—	10.0-16.0 fl oz	
	Entrust 80W	—	1.25-2.0 oz	
	Entrust 2SC	—	4.0-6;0 fl oz	
	Diazinon 50W	—	1.0 lb	
	Sevin XLR Plus	—	1.0-2.0 qt	
	Dipel ES	—	1.0-4.0 pt	
	Esteem 0.86EC	—	16 fl oz	
	Delegate 25WG	—	3.0-6.0 oz	
	Malathion 8F	—	1.25 pt	
	Assail 30SG	—	4.5-5.3 oz	
	Asana XL	—	4.8-9.6 fl oz	
	Rimon 0.83EC	—	20.0-30.0 fl oz	
	Mustang Maxx 1.5EC	—	4.3 fl oz	
	Avaunt	—	3.5 - 6.0 oz	
	Exirel 10.2EC	—	10-13.5 fl oz	
	Verdepryn 100SL	—	8.8-11 fl oz	

Table 2.6 - Blueberry Insects (continued)

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Rate per Acre	Spray Timing and Remarks
First Cover: at petal fall. (Petal fall spray is the single most important spray for blueberry insects)				
Gall midge	Diazinon AG500	—	1 pt	Use of Exirel, Delegate or Entrust should be delayed if spotted wing drosophila will be a target later.
	Delegate 25WG	—	3.0 - 6.0 oz	
	Entrust 80W	—	1.25 - 2.0 oz	
	Entrust 2SC	—	4.0-6.0 fl oz	
	Malathion 57EC	—	1.5 fl oz	
	Exirel 0.83EC	—	13.5-20.5 fl oz	
Periodical cicada	Asana XL	—	9.6 fl oz	Comment for Cicada: Brood 14 of periodical cicada will appear in 2025, mainly in southwestern Virginia. Egg-laying results in injured branches. Bird netting with a mesh no larger than 1 cm will provide effective control of injury.
	Danitol 2.4EC	—	16 fl oz	
	Surround WP	—	25 to 50 lb	
Thrips	Sivanto Prime	—	10.5-14.0 fl oz	
Second Cover: ten days after first cover				
Cranberry fruitworm and cherry fruitworm	See First Cover			
Brown marmorated stink bug	Actara 25WDG	—	4.0 oz	After an Actara application, wait at least 5 days before placing beehives in treated fields. If flowering plants are present in the ground cover, mow before applying Actara. Use of Malathion should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Lannate SP	—	1.0 lb	
	Malathion 57EC	—	1.5 pt	
Leafrollers	Intrepid 2F	—	10.0-16.0 fl oz	See label for timing Confirm sprays. Use of Delegate should be delayed if spotted wing drosophila will be a target later, in order to comply with the seasonal maximum number of applications.
	Delegate 25WG	—	3.0-6.0 oz	
Aphids	M-Pede	2.0 gal	—	Repeated sprays of M-Pede may be needed. Do not apply M-Pede within 3 days of sulfur. Use of Exirel should be delayed if spotted wing drosophila will be a target later.
	Admire Pro	—	1.0-1.4 fl oz	
	Actara 25WG	—	3.0-4.0 oz	
	Assail 30SG	—	4.5-5.3 oz	
	Exirel 0.83EC	—	13.5-20.5 fl oz	
	Sivanto 200SL	—	7.0-10.5 fl oz	
Blueberry tip borer	See First Cover			
Plum curculio	See First Cover			
Preharvest				
Yellow-necked caterpillar and other defoliating caterpillars	Delegate 25WG	—	3.0-6.0 oz	
	Altacor	—	3.0-4.5 oz	
	Entrust 80W	—	1.25-2.0 oz	
	Entrust 2SC	—	4.0-6.0 oz	
	Dipel ES	—	1.0-4.0 pt	
Blueberry maggot	Entrust 80W	—	1.25-2.07 oz	Spray if flies trapped for two consecutive weeks, or three flies/week. Delegate provides suppression. See Table 2.7 for PHI. See footnote petal fall spray. GF-120 NF Naturalyte fruit fly bait. Spot or strip spray several areas of inner canopy (1.0-3.0 fl oz/tree). OMRI-approved
	Entrust 2SC	—	4.0-6.0 fl oz	
	Imidan 70W	—	1.5 lb	
	Surround 95WP	—	12.5-50.0 lb	
	Danitol 2.4EC	—	10.7-18.0 fl oz	
	Delegate 25WG	—	3.0-6.0 oz	
	Malathion 57EC	—	1.5 pt	
	Admire Pro	—	2.1 - 2.8 fl oz	
	Assail 30SG	—	4.5-5.3 oz	
	Asana XL	—	9.6 fl oz	
	Sevin XLR	—	1.0-2.0 q	
	Rimon 0.83EC	—	20.0-30.0 fl oz	
	GF-120	—	10.0-20.0 fl oz	
	Exirel 0.83EC	—	13.5-20.5 fl oz	
	Sivanto 200SL	—	12.0-14.0 fl oz	

Table 2.6 - Blueberry Insects (continued)

Crop and Pest	Chemical and Formulation	Rate Per 100 Gal Dilute	Rate per Acre	Spray Timing and Remarks
Preharvest				
Brown marmorated stink bug	Actara 25WDG	—	4.0 oz	After an Actara application, wait at least 5 days before placing beehives in treated fields. If flowering plants are present in the ground cover, mow before applying Actara. No more than 5 applications per season of Assail. Residual activity of Azera will be short.
	Assail 30SG	—	4.5-5.3 oz	
	Azera	—	2.0-3.0 pt	
	Lannate SP	—	1.0 lb	
	Malathion 57EC	—	1.5 pt	
Spotted-Wing Drosophila	Entrust 80WP	—	1.25-2.0 oz	Open pruning will aid in SWD management, as will prompt harvest of ripe berries. Spray timing must be at least every 7 days in many cases. Rotate modes of action in order to delay the development of pesticide resistance. There is a 24(c) label for malathion 8F allowing 2.5 pt for SWD. Addition of table sugar at the rate of 30 oz per 100 gal will aid in efficacy of chemical control of SWD.
	Entrust 2SC	—	4.0-6.0 fl oz	
	Malathion 57EC	—	2.0 pt	
	Imidan 70W	—	1.5 lb	
	Lannate SP	—	0.25-0.5 lb	
	Delegate 25WG	—	3.0-6.0 oz	
	Mustang Maxx	—	4.0 oz	
	Danitol 2.4EC	—	10.7-18.0 fl oz	
	Asana XL	—	9.6 fl oz	
	Brigade 10WSB	—	16.0 oz	
	PyGanic 1.4EC	—	64.0 fl oz	
	Azera	—	2.0-3.0 pt	
	Exirel 0.83EC	—	13.5-20.5 fl oz	
Mites	Stylet oil	3.0-6.0 qt	—	Acramite non-bearing only. Spray Stylet oil every 7 to 10 days while mite eggs persist.
	Acramite 50WS	—	0.75-1.0 lb	
	Kanemite 15SC	—	21.0-31.0 fl oz	
	Oberon 2SC	—	12.0-16.0 fl oz	
Japanese beetle	Admire Pro	—	1.0-1.4 fl oz	Apply Neemix/Trilogy over 7-10 days. See Trilogy label for mixing instructions. Neemix and Trilogy are OMRI-certified.
	Danitol 2.4EC	—	10.7-18.0 fl oz	
	Malathion 57EC	—	1.5 pt	
	Assail 30SG	—	4.5-5.3 oz	
	Asana XL	—	4.8-9.6 fl oz	
	Sevin XLR Plus	—	1.0-2.0 qt	
	Actara 25WG	—	4.0 oz	
	Neemix 4.5 plus Trilogy 70	—	7.0-16.0 fl oz + 2% solution	
Special Soil Treatment				
Japanese beetle	Admire Pro	—	7.0 - 14.0 fl oz	Apply as chemigation or in band followed by irrigation.

■ Small Fruit Pesticides

Table 2.7 - Chemical Names, Re-entry Intervals (REI) and Preharvest Intervals (PHI)

Chemical	Manufacturer	Re-entry Interval	Preharvest Interval		
			Strawberry	Caneberries	Blueberry
Fungicides					
Abound (azoxystrobin)	Syngenta	4 hours	0 days	0 days	0 days
Actigard (acibenzolar-S-methyl)	Syngenta	12 hours	0 days	—	0 days
Agri-Fos (phosphite)	Monterey	4 hours	0 days	0 days	0 days
Aliette (fosetyl Al)	Bayer CropScience	12 hours	12 hours	60 days	12 hours
Bordeaux mixture (coppers)	various	24 hours	—	(see label)	—
Bumper	ADAMA	12 hours REI (blueberries)	0 days	30 days	30 days
Cabrio (pyraclostrobin)	BASF	24 hours 12 hours (strawberries)	0 days	0 days	0 days
Captan	Micro Flo, etc.	see label	0 days (see label)	3 days (Captan 80WDG)	0 days (see label)
Elevate (fenhexamid)	Arysta	12 hours	0 days	0 days	0 days
Flint (trifloxystrobin)	Syngenta	12 hours	0 days	—	—
Fontelis (penthiopyrad)	DuPont	12 hours	0 days	—	0 days
Gatten (flutianil)	Nichino America	12 hours	0 days	—	—
Indar (fenbuconazole)	Dow AgroSciences	12 hours	—	30 days	30 days
Intuity (mandestrobin)	Valent	12 hours	0 days	—	—
Kenja 400SC (isofetamid)	Summit Agro USA	12 hours	0 days	—	0 days
Lime sulfur	various	48 hours	—	0 days	—
Luna Sensation (fluopyram & trifloxystrobin)	Bayer CropScience	12 hours	0	—	0
Luna Tranquility (fluopyram & pyrimethanil)	Bayer CropScience	12 hours	1	0	1
Merivon (pyraclostrobin & fluxapyroxad)	BASF	12 hours	0 day PHI for strawberry	not labelled	not labelled
MetaStar (metalaxyl)	LG life Science	48 hours	0 days	45 days	—
Mettle (tetraconazole)	Isagro USA	12 hours	0 days	—	0 days
Miravis Prime	Syngenta	12 hours REI	0 days PHI for strawberry	—	—
Nevado (iprodione)	ADAMA	24 hours REI	—	7 days	—
Omega 500F (fluazinam)	Syngenta	12 hours REI	—	—	30 days
Orondis Gold 200 (oxathiapiprolin)	Syngenta	4 hours REI &	0 days	1 day	0 days
OSO 5SC (polyoxin D zinc salt)	Certis U.S.A.	4 hours	0 days	0 days	0 days
Ph-D (polyoxin D zinc salt)	Arysta LifeScience	4 hours	0 days	0 days	0 days
Phostrol (phosphorus acid)	Nufarm Americas	4 hours	0 days	0 days	0 days
Procure (triflumizole)	Chemtura	12 hours	1 day	—	—
Proline (prothioconazole)	Bayer CropScience	12 hours REI			7 days
Protocol	Loveland Products	24 hours	1 day	—	—
Pristine (pyraclostrobin & boscalid)	BASF	24 hours 12 hours (strawberries)	0 days	0 days	0 days

Table 2.7 - Chemical Names, Re-entry Intervals (REI) and Preharvest Intervals (PHI) (continued)

Chemical	Manufacturer	Re-entry Interval	Preharvest Interval		
			Strawberry	Caneberries	Blueberry
Fungicides					
ProPhyt (potassium phosphite)	Helena	4 hours	0 days	0 days	0 days
Quash (metconazole)	Valent	12 hours REI	—	—	7 days
Quadris Top (azoxystrobin & difenoconazole)	Syngenta	12 hours	0 days	—	—
Quilt Xcel (azoxystrobin & difenoconazole)	Syngenta	12 hours	0 days	30 days	30 days
Rally (myclobutanil)	Dow AgroSciences	24 hours	0 days	0 days	—
Rhyme (flutriafol)	FMC	12 hours	0 day PHI	—	—
Ridomil Gold (mefenoxam)	Syngenta	0 hours (soil-injected or incorporated applications) 48 hours (soil-directed or foliar sprays)	0 days 0 days	— 45 days	— 45 days
Rovral (iprodione)	Bayer CropScience	24 hours	prebloom	0 days	—
Scala (pyrimethanil)	Bayer CropScience	12 hours	1 day	—	—
Switch (cyprodinil & fludioxonil)	Syngenta	12 hours	0 days	0 days	0 days
Thiram (thiram)	Taminco	24 hours	3 days	—	—
Tilt (propiconazole)	Syngenta	12 hours	0 days	30 days	30 days
Topsin-M (thiophanate methyl)	UPL NA, Inc	12 hours	1 day	—	—
Torino (cyflufenamid)	Gowan	4 hours	0 days	—	0 days
Ultra Flourish (mefenoxam)	New Farm Americas	48 hours	0 days	45 days	0 days
Ziram (ziram)	UPL NA, Inc, Taminco	48 hours	—	(see label)	(see label)
Insecticides					
Acramite (bifenazate)	Chemtur	12 hours	1 day	1 day	—
Acramite (bifenazate)	Chemtura	12 hours	1 day	1 day	—
Actara (thiamethoxam)	Sygenta	12 hours	3 days	3 days	3 days
Admire Pro (imidacloprid)	Bayer CropScience	12 hours	14 days (soil) 7 days (foliar)	7 days (soil) 3 days (foliar)	7 days (soil) 3 days (foliar)
Agri-Mek (abamectin)	Syngenta	12 hours	3 days	7 days	—
Altacor (chlorantraniliprole)	DuPont	4 hours	—	3 days	1 day
Asana (esfenvalerate)	DuPont	12 hours	—	7 days	14 days
Assail (acetamiprid)	UPL NA, Inc	12 hours	1 day	1 day	1 day
Avaunt (indoxacarb)	DuPont	12 hours	—	—	7 days
Aza-Direct (azadirachtin)	Gowan	4 hours	0 days	0 days	0 days
Azera (azadirachtin and pyrethrins)	MGK	12 hours	0 days	0 days	0 days
Beleaf (flonicamid)	ISK Biosciences	12 hours	0 days	—	—
Brigade (bifenthrin)	FMC	12 hours	0 days	3 days	1 day
Confirm (tebufenozide)	Gowan	4 hours	—	14 days	14 days
Coragen (chlorantraniliprole)	DuPont	4 hours	1 day	—	—
Danitol (fenpropathrin)	Valent	24 hours	2 days	3 days	3 days
Delegate (spinetoram)	Dow AgroSciences	4 hours	—	1 day	3 days
Diazinon (diazinon)	Helena	5 days	7 days	—	5 days
Dipel	Valent	4 hours	0 days	0 days	0 days
Entrust (spinosad)	Dow AgroSciences	4 hours	1 day	1 day	3 days

Table 2.7 - Chemical Names, Re-entry Intervals (REI) and Preharvest Intervals (PHI) (continued)

Chemical	Manufacturer	Re-entry Interval	Preharvest Interval		
			Strawberry	Caneberries	Blueberry
Insecticides					
Esteem (pyriproxyfen)	Valent	12 hours	—	7 days	7 days
Exirel (cyantraniliprole)	DuPont	12 hours	1 day	1 day	3 days
Imidan (phosmet)	Gowan	3 days	—	—	3 days
Intrepid (methoxyfenozide)	Dow AgroSciences	4 hours	3 days	3 days	7 days
Lannate (methomyl)	DuPont	48 hours	—	—	3 days
Lorsban (chlorpyrifos)	Dow AgroSciences	24 hours	21 days	—	—
Malathion (malathion)	Gowan, UAP	12 hours	3 days	1 day	1 day
M-Pede (insecticidal soap)	Dow AgroSciences	12 hours	0 days	0 days	0 days
Mustang Maxx (zeta cypermethrin)	FMC	12 hours	—	1 day	1 day
Neemix (azadirachtin)	Certis	4 hours	0 days	0 days	0 days
PyGanic (pyrethrin)	MGK	12 hours	0 days	0 days	0 days
Radiant (spinetoram)	Dow AgroSciences	4 hours	1 day	—	—
Rimon (novaluron)	Makhteshim Agan	12 hours	1 day	—	8 days
Seduce (spinosad bait)	Certis	4 hours	1 day	1 day	1 day
Sevin (carbaryl)	Bayer CropScience	12 hours	7 days	7 days	7 days
Sivanto Prime (flupyradifurone)	Bayer	4 hours	0 days	0 days	3 days
Sniper (bifenthrin)	Loveland Products	12 hours	—	3 days	1 day
Surround (kaolin)	Engelhard	4 hours	—	0 days	0 days
Trilogy (clarified neem extract)	Certis	4 hours	0 days	0 days	0 days
Tri-Tek (oil)	Brandt	4 hours	0 days	0 days	0 days
Verdepryn (cyclaniliprole)	SummitAgro	4 hours	1 day	1 day	1 day
Acaricides					
Acramite (bifenazate)	Chemtura	12 hours	1 day	7 day	1 day
Brigade (bifenthrin)	FMC	12 hours	0 days	3 days	1 day
Kanemite (acequinocyl)	Arysta LifeScience	12 hours	1 day	1 day	1 day
Nealta (cyflumetofen)	BASF	12 hours	1 day	—	—
Oberon (spiromesifen)	Bayer CropScience	12 hours	3 days	—	3 days
Savey (hexythiazox)	Gowan	12 hours	3 days	3 days	3 days
Stylet Oil	JMS Flower Farms	4 hours	0 days	0 days	0 days
Vendex (fenbutatin oxide)	UPL NA, Inc	48 hours	1 day	—	—
Zeal (etoxazole)	Valent	12 hours	1 day	0 days	1 day
Nematicides					
Majestene (heat-killed Burkhoderia A396)	Marrone Bio Innovations	4 hours	0 days	0 days	0 days
Nimitz or Fluensulfone 480EC (fluensulfone)	ADAMA	12 hours	0 days	—	—
Velum Prime (fluopyram)	Bayer CropScience	12 hours	—	0 days	—

Commercial Small Fruit: Nematodes

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Table 2.8 - Plant-Parasitic Nematodes on Blackberries, Blueberries, Raspberries, and Strawberries

Pests/Pathogens Controlled	Nematicide Product	Rate	Remarks
Plant parasitic nematodes only	1,3-dichloropropene 94% (Telone II)	15-27 gal or 153-275 lb per treated acre	Follow detailed label instructions carefully. Shank-applied soil fumigant.
	1,3-dichloropropene 94% (Telone EC)	9-24 gal (91-242 lb) per treated acre	Follow detailed label instructions carefully. Soil fumigant formulated for drip-application under plastic mulch. Efficacy dependent on good distribution through soil profile.
	Fluensulfone 40% (Nimitz)	3.5-7 pt per treated acre	Apply via drip or incorporated spray at least 7 days before planting; only 1 application per year. Soil temperature must be 60˚ or above. Soil incorporation in the top 6-8 inches is critical. Irrigating (0.5-1 inches) 2-5 days after application is recommended. **Strawberries and blueberries only. Not labeled for caneberries. Application to perennial crops may be split between spring and fall, but spring applications must be made at least 30 days prior to bloom. Fall applications to perennial crops must be made after harvest.**
	Heat-killed *Burkholderia* spp. strain A396, 94% (Majestene)	4-8 qt/acre	Can be applied as a preplant-incorporated, in-furrow or banded spray as long as spray volume is sufficient to thoroughly soak the root zone. Can also be drip-applied prior to planting, at or shortly after planting, and again later in the growing season. Higher rates likely more effective, and repeated applications also increase the extent and duration of control. Another product may also be necessary when nematode populations are high. Nematode suppression only for blackberries and raspberries.
Certain soil fungi only	Chloropicrin products	11-26 gal (150-350 lb) per treated acre	Shank-injected uses. Follow detailed label instructions carefully.
	Tri-Pic EC	9-11 gal (125-150 lb) per treated acre	Special formulation for drip application under plastic mulch. Follow detailed label instructions carefully.
Plant parasitic nematodes and certain soil fungi **Shank Application**	1,3-dichloropropene, 20% + chloropicrin, 80% (PicClor 80)	34 gal (440 lb) per treated acre	Lower rates with VIF tarps have been associated with losses in weed control.
	1,3-dichloropropene, 40% + chloropicrin, 60% (PicClor 60)	48.6 gal (588 lb) per treated acre	Lower rates with VIF tarps have been associated with losses in weed control.
	1,3-dichloropropene, 65% + chloropicrin, 35% (Telone C-35)	39-50 gal (437-560 lb) per treated acre	Also moderate nutsedge control when Telone C-35 is tarped with VIF.
	Metam potassium (K-Pam HL)	30-62 gal (318-657 lb) per treated acre	
	Allyl isothiocyanate or AITC (Dominus)	25-40 gal (213-340 lb) per broadcast equivalent acre	Limited experience with this recently registered product; 10-day plant back interval. AITC is chemically-related to metam products, so may perform similarly against a similar range of target pests.
Plant-parasitic nematodes and certain soil fungi. **Drip Application**	1,3-dichloropropene, 60.8% + chloropicrin, 33.3% (InLine)	29-58 gal (325-645 lb) per treated acre (See Label)	Drip Application: Products for drip-application are specially formulated for use under plastic mulch. Efficacy dependent on good distribution through soil profile.
	1,3-dichloropropene, 40% + chloropicrin, 60% (Pic Clor 60EC)	42.6 gal (503 lb) per treated acre	
	Chloropicrin, 99% (Tri Pic 100EC)	8-24 gal (100-300 lb) per treated acre	
Plant-parasitic nematodes and certain foliar fungi	Fluopyram 41.5% (Velum Prime)	6.0-6.5 fl oz per acre (Blueberry and Strawberry); 6.5-6.84 fl oz per acre (Caneberries)	Chemigate into root zone via low pressure drip, trickle, micro-sprinkler or equivalent equipment. Fluopyram is also a FRAC-7 fungicide, and Velum Prime is registered for powdery mildew control as well as for nematodes on strawberry and blueberry, but not caneberries. Fluopyram is also present in Luna Sensation and Luna Experience. To avoid fungicide resistance development, the first foliar fungicide product applied after use of Velum Prime should NOT include a FRAC-7 component. No more than 0.446 lbs of fluopyram may be applied per acre per year, regardless of formulation or application method (soil or foliar). For caneberries, soil should be pre-wetted to break surface tension prior to application, and for optimum results, apply to new plantings or to those previously trained to drip, trickle, or micro-sprinkler irrigation

CAUTION: Fumigant vapors are toxic. Read the label completely and follow directions strictly.

Small fruit growers should select a nematode management option based on the types of soil pathogens and pests present in their field(s). Soil assays for plant-parasitic nematode populations should indicate the need for a nematode control product. Typical actions include doing nothing, applying a pre-plant nematicide or a soil fumigant, or doing nothing. If some type of nematode control action is needed, soil fumigation remains the most effective in terms of reducing nematode populations in field soils. Products containing 1,3-dichloropropene do so in order to control nematodes, while the chloropicrin, metam sodium, metam potassium, or AITC are included primarily to control fungal pathogens and weed seeds. All soil fumigants are restricted use pesticides, with all the associated requirements, including respirator fit-testing, mandated use of full-face respirators for many soil fumigants, written "fumigant management plans" (FMPs), restrictions on cutting and removal of tarps, air monitoring in special circumstances, posting of treated fields and buffer zones surrounding treated fields, and 3-day "entry restricted periods (ERPs)". FMPs must be completed *before* application, and include documenting the site(s) to be fumigated, handler information, compliance with mandatory good agricultural practices (GAPs), as well as weather conditions surrounding soil fumigation. A "post-application summary" must also be completed for each fumigation. FMPs and post-application summaries must be maintained for 2 years. Most soil fumigant labels also now include minimum distances between treated fields and sites that would be difficult to evacuate (schools, etc.) and official notification requirements.

Growers who fumigate soil or contract with others to fumigate their fields need to familiarize themselves with all requirements. Fumigant applicators must be certified by the Virginia Department of Agriculture and Consumer Services in order to purchase soil fumigants from their dealer. Certifications are valid for a 3 year period.

The mandatory GAPs included in soil fumigant labels document practices long recommended for soil fumigant application. Prior to fumigation, soil should be cultivated deeply and thoroughly, breaking up all clods and crop debris so that the area to be gassed is in good "seed bed" condition and as free as possible of un-decayed organic matter. *Adequate soil moisture and soil temperatures between 50° and 80°F at the depth of injection are critical to effective soil fumigation.* Fumigation characteristics vary significantly among soil fumigants, so check product labels for specific directions regarding shank spacing and outlet depth for specific products and target pests. For example, shank spacing is often narrower and outlet depth shallower for application of metam sodium products. Soil should be smoothed and compacted and/or covered with plastic mulch immediately after application of all soil fumigants in order to minimize gas escape.

Broadcast fumigation may provide more lengthy nematode control when the crop to be planted will be maintained for multiple years, but the "in-row" fumigation common in annual strawberry plasticulture typically provides excellent control over a single growing season using less total fumigant, because less soil is actually treated. The amount of product needed for in-row fumigation is calculated based upon the area treated relative to the total area of land devoted to the crop. *Important note: the area to be fumigated is based on the width of the "bed" at the bottom versus the top.* VIF (virtually impermeable film) and TIF (totally impermeable film) plastic mulches increase fumigant activity and reduce fumigant emissions into the atmosphere. Using VIF or TIF mulches may enable applicators to reduce the fumigant rates, sometimes reducing the size of buffer zones, but these reductions can also reduce fumigant effectiveness for some products and target pests. Formulations of soil fumigants are also now available that enable application of these products through drip-lines, similar to in-row fumigation. Be sure to read, understand, and follow instructions in these labels carefully.

Because fumigant residues can severely damage new plantings, a waiting period is required for all soil fumigants, but broadcast soil fumigation for perennial crops is typically timed in the fall to allow at least a 4 to 8 week "waiting period" to allow the fumigant to dissipate from treated soil. Waiting periods vary for different fumigants and are also highly influenced by environmental conditions. Check fumigant labels for recommended procedures to ensure fumigant residues have dissipated sufficiently to avoid crop injury.

Small fruit producers have more options to manage nematodes now than in the past, particularly where preplant populations are low to moderate. While generally not as effective as soil fumigants, several nematicides are now available that offer some advantages. The labels for both Nimitz and Velum contain 'Caution' signal words, indicating that they are far less toxic than soil fumigants. Both can be drip-applied, although Nimitz must be used at least 7 days before transplanting. Supplemental after-planting applications are possible with Velum Prime. Nimitz applications may be split between fall and spring, but fall applications must be made after harvest. Spring applications must be made at least 30 days before bloom. Majestene is a biological product that may also fit growers who want to avoid traditional pesticides. Some cover crops have been demonstrated to help minimize damage from plant-parasitic nematodes and soilborne pathogens, particularly brassicaceous cover crops. Cover crop benefits often increase depending on a number of factors, such as increased biomass, that is extensively incorporated into soil, under prolonged soil moisture conditions, and well before intended transplanting. Mustard seed meals involve a similar mode of action to brassicaceous cover crops, but have required high rates in university research in order to provide significant benefits. Finally, anaerobic soil disinfestation (ASD) is currently being investigated extensively as an alternative to soil fumigation. While results so far have been positive, ASD requires incorporating an extremely high volume of some carbon source material into soil, that must remain saturated for approximately 21 days. Work is on-going to identify the most effective and economically practical carbon source materials for use on a large scale. Some growers in other states are also experimenting on their own with products like Melocon, azadiractin-based products, essential oils (thyme oil, for example), and even crab meal, for nematode control in small fruit crops. Unfortunately, very little formal research has been conducted with these materials for small fruits, and in general, results from this research has been disappointing.

Commercial Small Fruit: Weeds

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Table 2.9 - Herbicides

Crop	Weeds Controlled	Chemical Rate/A (Product/A)	Remarks
Preemergence directed			
Blueberries, Blackberries, and Raspberries	Most annuals, fescue, quackgrass, dandelions, dock, and other herbaceous perennials	dichlobenil 4.0-6.0 lb (Casoron 4G 100.0-150.0 lb or 2.3-3.4 lb/1000 sq ft)	Apply dry granules in late winter or early spring. Shallow incorporation may improve weed control. Do not apply within 4 weeks after transplanting. Short residual activity; regrowth usually occurs in late summer. Do not graze livestock in treated areas. Do not make application within one month of harvest. Do not apply over 4.0 lb of dichlobenil to blackberries or raspberries and do not apply during new shoot emergence.
	Annual grasses and broadleaf weeds	flumioxazin 0.19-0.375 lb (Chateau EZ 6.0-12.0 fl oz in blueberry, a maximum of 6 fl oz in caneberries)	Do not apply to blueberries established less than 2 years unless stems are protected by grow tubes, wraps, or waxed containers. Do not apply after budbreak through final harvest. Avoid contact with foliage and green bark. The preharvest interval is 7 days.
	Annual broadleaf weeds	isoxaben 0.52-1.0 lb (Trellis SC 16-31 fl oz)	Do not apply within 60 days of harvest. Combine with a herbicide such as napropamide, norflurazon or oryzalin for improved control of annual grassy weeds. Include a postemergence herbicide if emerged weeds are present.
	Annual broadleaf and certain annual grassy weeds	mesotrione 0.09-0.18 lb (Callisto 3.0-6.0 fl oz)	Blueberries only. Apply preemergence or early postemergence. For improved postemergence control, apply 3.0 fl oz Callisto followed 3 weeks later by a second application at that rate. Apply prior to bloom. Include a crop oil concentrate tolerated by blueberries if applied postemergence to weeds.
	Annual grasses and certain broadleaf weeds	napropamide 4.0 lb (Devrinol 2-XT 2 gal or Devrinol DF-XT 8.0 lb)	Apply to a weed-free surface or include an appropriate postemergence herbicide. May be applied to newly planted and established crop. Must be incorporated by rainfall or irrigation within 24 hours of application for optimum results. May be tank-mixed with other herbicides for broader-spectrum weed control.
	Annual grasses, certain broadleaf weeds, and suppression of perennial grasses and nutsedge	norflurazon 2.0-4.0 lb (Solicam DF 2.5-5.0 lb)	Apply only to blueberries established at least 6 months and to raspberries and blackberries established at least 12 months. Apply when crop is dormant. Apply to weed-free soil or include an appropriate postemergence herbicide. Combine with simazine for improved broadleaf control.
	Annual grasses and certain broadleaf weeds	oryzalin 2.0-6.0 lb (Surflan 4AS 2.0-6.0 qt, Oryzalin 4AS 2.0-6.0 qt)	May be used immediately after planting or in established plantings. Apply to weed-free soil or include an appropriate postemergence herbicide. Use lowest rate for short-term control, 4.0 lb for full-season control, and the highest rate for long-term (8–12 months) control. May be tank-mixed with such herbicides as simazine or terbacil to control a broader spectrum of weeds in established plantings. However, oryzalin is currently unavailable so consider alternative products.
	Annual grasses and broadleaf weeds	simazine 2.0-4.0 lb (Princep 4L 2.0-4.0 qt)	Apply to weed-free soil or include an appropriate postemergence herbicide. Split application possible with 1/2 rate in fall and 1/2 rate in spring. On plantings less than 6 months old use 1/2 the total rate of application.
	Certain annual weeds plus yellow nutsedge	sulfentrazone 0.25-0.375 lb (Zeus XC 8-12 fl oz)	Apply as a directed spray avoiding crop foliage. Crop needs to be established at least 3 years. Do not apply more than 12 fl oz/A/year. Preemergence control of annual broadleaf weeds and certain annual grasses. Provides postemergence control of yellow nutsedge.
	Certain annual weeds plus yellow nutsedge	carfentrazone + sulfentrazone 0.21-0.41 lb (Zeus Prime XC 7.7-15.2 fl oz)	Apply to blueberry and caneberry established at least 2 years. Avoid contact with crop foliage or stems. Application after budbreak requires use of a hooded sprayer. Combine with a nonselective postemergence herbicide for broader spectrum weed control. Preemergence and early postemergence control of annual broadleaf weeds. Provides postemergence control of yellow nutsedge.
	Annual grasses and broadleaf weeds plus some perennial broadleaf weeds	terbacil 0.8-1.6 lb (Sinbar WDG 1.0-2.0 lb)	Only treat plantings established for one year or more. Use higher rate on heavy (clay) soils with high organic matter (3% +). May be applied in early spring or late fall.
	Yellow nutsedge and certain broadleaf weeds	bentazon 0.75-1.0 lb (Basagran 1.2-2 pt/A + 1 qt/A crop oil concentrate)	Nonbearing only - allow at least one year between application and harvest. Apply when yellow nutsedge and annual broadleaf weeds are small and actively growing.

Table 2.9 - Herbicides (continued)

Crop	Weeds Controlled	Chemical Rate/A (Product/A)	Remarks
Postemergence directed			
Blueberries, Blackberries, and Raspberries (continued)	Annual broadleaf weeds	carfentrazone-ethyl 0.016-0.031 lb (Aim 2EC 1.0-2.0 fl oz/A)	Apply post-directed using a hooded sprayer for control of small annual broadleaf weeds less than 4 inches tall. Add a crop-oil concentrate or nonionic surfactant. Can be tank mixed with other herbicides for broader-spectrum weed control. Can also be used for control of primocanes – see label rates and directions for this use.
	Annual and perennial grasses	clethodim 0.09-0.12 lb Select Max 9.0-16.0 fl oz + 0.25% v/v nonionic surfactant)	Apply to actively growing grasses. Will control annual bluegrass. For spot treatment, use 0.44-0.88 fl oz Select Max per gallon plus 0.33 fl oz nonionic surfactant. A repeat application may be required for perennial grass control. Select Max can be applied to bearing plantings. The preharvest interval is 14 days for highbush blueberry and 7 days for both raspberry and blackberry.
	Annual and perennial grasses	fluazifop-P-butyl 0.25- 0.375 lb (Fusilade DX 16.0-24.0 fl oz + 2 pt crop oil concentrate or 1/2 pt nonionic surfactant/25.0 gal)	Use a directed spray on actively growing grasses. Treat annual grasses before tillering for optimum results. Perennial grasses may need repeat treatment for total control. Do not harvest within one day after appliication for caneberries and blueberry. For spot treatment use 0.75 oz Fusilade DX plus 1.5 fl oz crop-oil concentrate or 0.5 fl oz nonionic surfactant/gal.
	Annual and perennial weeds	glufosinate 0.88-1.5 lb (Rely 280 48.0-82.0 fl oz)	Blueberries only. Apply as a directed spray, keeping droplets off blueberry foliage and stems. Repeat application may be needed for perennial weed control. Do not apply within 14 days of harvest. For spot application apply 1.7 fl oz Rely 280/gal.
	Annual and perennial grasses and broadleaf weeds	glyphosate (various formulations, see label for application rates)	Can be applied prior to planting or to control emerged weeds after planting. Can be applied as a wiper application.
	Annual weeds, contact activity only, will not control established perennial weeds	paraquat 0.5-1.0 lb (Gramoxone SL 2.0-4.0 pt/A + 1.0-2.0 pt nonionic surfactant/100 gal water)	Apply as coarse directed spray to thoroughly wet emerged weeds. Apply before emergence of new crop shoots. Do not allow spray to contact new shoots or green stems, otherwise injury is likely. RESTRICTED USE PESTICIDE
	Annual and perennial grasses	sethoxydim 0.28-0.47 lb ai (Poast 1.5-2.5 pt + 1.0 qt crop-oil concentrate)	Do not apply within 45 days of harvest in raspberries and blackberries or within 30 days of harvesting blueberries. Apply in a minimum of 10 gal/A of water. Apply the lower rate to annual grasses up to 6 inches tall and apply higher rate to annual grasses up to 12 inches tall and to perennial grasses. For spot treatment, use 1.25 fl oz Poast plus 1.25 fl oz crop-oil concentrate/gal.
	Yellow nutsedge and certain broadleaf weeds	halosulfuron 0.024-0.047 lb (Sandea 0.5-1.0 oz/A plus a nonionic surfactant at 0.25-0.5% V/V in highbush blueberry, Sandea 0.75-1.5 oz/A plus a nonionic surfactant at 0.25-0.5% V/V in blacksberry and raspberry)	Do not allow spray to contact crop foliage. 14-day preharvest interval. Use the lower rate on highbush blueberry plants less than 4 years old. Can also be applied to raspberry and blackberry. Highbush blueberry, raspberry, and blackberry must be established at least 1 year. Do not allow spray to contact crop foliage. Treat when yellow nutsedge is actively growing under good soil moisture.
Strawberries	Annual and perennial grasses	clethodim 0.09-0.125 lb (Select Max 9.0-16.0 fl oz + 0.25% nonionic surfactant)	Apply to actively growing grasses. Will control annual bluegrass. For spot treatment, use 0.44-0.88 fl oz Select Max per gallon plus 0.33 fl oz nonionic surfactant. A repeat application may be required for perennial grass control. Allow at least 4 days between application and harvest.
	Certain annual and perennial broadleaves	clopyralid 0.12-0.25 lb (Stinger 0.33-0.67 pt/A)	Apply to actively-growing broadleaf weeds. Primarily controls weeds in the legume and composite families. Stinger can be applied to strawberries at 0.33 pt/A in spring. Do not apply within 30 days of harvest. Up to 0.67 pt/A can be used after harvest. Growers who intend to use the product in strawberries must sign a waiver of liability.

Table 2.9 - Herbicides (continued)

Crop	Weeds Controlled	Chemical Rate/A (Product/A)	Remarks
Postemergence directed			
Strawberries (continued)	Annual broadleaf weeds	carfentrazone-ethyl 0.006-0.025 lb (Aim EC 0.5-1.6 fl oz)	Apply post-directed using a hooded sprayer for control of small annual broadleaf weeds less than 4 inches tall. Add a crop-oil concentrate or nonionic surfactant between the rows in plasticulture. Can be tank mixed with other herbicides for broader-spectrum weed control.
	Annual grasses and broadleaf weeds	flumioxazin 0.09 lb (Chateau WDG 3.0 oz/A)	Apply before laying plastic to formed beds at least 30 days before transplanting. Addition of a crop-oil concentrate or nonionic surfactant may improve postemergence weed control. Can be applied using a hooded or shielded spray to row middles prior to fruit set. Do not apply overtop of strawberries. Dormant applications can be made to plants in the matted row production system.
	Annual grasses and certain broadleaf weeds	napropamide 4.0 lb (Devrinol 50 DF 8.0 lb)	Use on established strawberries. Delay application until daughter plants in the desired number have become established in the matted row production system. Do not apply from bloom to harvest. Make only one application/season. Does not control established weeds. Apply in fall through early winter. Early spring applications may also be made, but rainfall or irrigation will be needed for optimum weed control. Can also be applied to row middles in plasticulture production systems.
	Annual broadleaf weeds	oxyfluorfen 0.25-0.5 lb (Goal 2XL 1.0-2.0 pt, GoalTender 0.5-1.0 pt)	Apply to the surface of preformed fallow beds at least 30 days prior to transplanting strawberries. Incorporation prior to planting reduces the potential for crop injury. Plastic mulch can be applied anytime after application but, ideally, soon after the Goal was applied.
	Annual weeds	acifluorfen 0.25-0.375 lb (UltraBlazer 1.0-1.5 pt)	Apply prior to laying plastic and transplanting. Can also be applied to row middles as a shielded directed spray. Do not allow spray to contact strawberry plants. Apply after last harvest or following bed renovation in matted row production. Can also be applied in late fall or winter when plants are dormant in matted row production. Do not apply the last application within 120 days before harvest.
	Yellow nutsedge and certain broadleaf weeds	sulfentrazone 0.125-0.25 (Spartan 4F 4-8 fl oz)	Apply before laying plastic and transplanting. See label - rate based on soil type.
	Annual weeds and suppression of perennials	paraquat 0.5 lbs (Gramoxone SL 2.0 pt)	Directed spray to row middles using a shielded spray. Do not allow spray to contact strawberry plants. Do not apply within 21 days of harvest.
	Annual and perennial grasses	sethoxydim 0.28-0.47 lb ai (Poast 1.5-2.5 pt + 1.0 qt crop-oil concentrate)	Do not apply within 7 days of harvest. Apply the lower rate to annual grasses up to 6 inches tall. Apply higher rate to taller annual grasses and perennial grasses. For spot treatment use 1.25 fl oz Poast plus 1.25 fl oz crop-oil concentrate/gal. Do not tank mix with other pesticides.
	Annual broadleaf weeds	2,4-D amine 1.0-1.5 lb (Formula 40 1.0-1.5 qt)	Apply to established beds in late winter when the strawberries are dormant or immediately after last picking 7 to 10 days before renovation in matted row production. Do not apply during bud, flower, or fruit stage, or during runner formation. Do not apply unless some injury is acceptable.
	Annual grasses and broadleaf weeds	terbacil 0.1-0.3 lb (Sinbar WDG 2-6 ounces/A)	Use only on plants established at least 6 months in a matted row production system. Apply after postharvest renovation before new growth begins or in late fall to control winter annuals. Do not apply more than 8.0 oz of Sinbar/A/ growing season. Do not use on soils less than 2% organic matter.

Table 2.10 - Relative Effectiveness of Preemergence Herbicides in Small Fruit									
	Dichlobenil	Flumioxazin	Mesotrione	Napropamide	Norflurazon	Oryzalin	Oxyfluorfen	Simazine	Terbacil
Annual Grasses									
Barnyardgrass	G	F	P	G	E	G	F	F-G	G
Cheat	G	—	—	G	G	G	—	G	G
Crabgrass	G	F-G	F	E	E	E	F	F-G	F-G
Fall panicum	F	F	P	G	E	G	—	F-G	G
Foxtails	G	F-G	P	E	E	E	F	G	G
Goosegrass	F	F-G	P-F	E	G	E	F	E	—
Johnsongrass (seedling)	F	P-F	N	P	G	F-G	—	N	—
Annual Broadleaf Weeds									
Annual fleabane	E	—	—	G	F	G	G	G	E
Annual morningglory	G	F-G	F	N	F	P-F	F	E	G
Black nightshade	G	G	P	N	F-G	P-F	G	E	—
Carpetweed	G	G	—	G	G	G	G	E	E
Common chickweed	G	—	—	G	G	G	G	E	G
Common lambsquarter	G	F-G	G	F-G	G-E	G	G	E	G
Common ragweed	G	G	P	F	F	P	F	E	G
Hairy galinsoga	G	—	G	G	—	P	G	E	E
Henbit	G	G	G	F	—	G	G	E	G
Horseweed	G	G	—	P	G	F	F	E	G
Knotweed	G	—	—	G	F	G	G	E	G
Mustards	G	—	—	P	F	P-F	G	G	E
Pennsylvania smartweed	G	—	—	P	—	P-F	G	E	G
Pigweeds	G	G	F-G	G	F	G	G	E	G
Prickly lettuce	G	—	—	G	—	F	G	E	G
Prickly sida	F-G	G	—	N	P	P-F	G	G	—
Purslane	G	—	—	G	G	G	G	E	E
Shepherds' purse	G	—	—	F	G	G	G	E	G
Speedwells	—	—	G	—	—	—	—	—	
Velvetleaf	—	G	—	N	F	P-F	F	G	G
Virginia pepperweed	G	—	—	F	G	G	—	E	—
Perennial Grasses And Sedges									
Bermudagrass	N	N	P	N	P	N	N	N	F
Dallisgrass	—	N	P	N	P	N	N	N	F-G
Fescues	G	N	N	N	F	N	N	P	F
Johnsongrass (rhizome)	—	N	N	N	P	N	N	N	P
Nimblewill	—	N	F-G	N	F	N	N	P	P
Orchardgrass	G	N	—	N	F	N	N	P-F	G-E
Purpletop, Redtop	—	N	—	N	F-G	N	N	N	F-G
Quackgrass	G	N	—	N	P	N	N	P-F	G
Yellow nutsedge	P-F	N	F	P	P-F	N	N	N	F-G
Perennial Broadleaf Weeds									
Broadleaf plantain	G	—	—	N	P	N	N	G	F
Buckhorn plantain	G	—	—	N	P	N	N	G	F
Canada thistle	P-F	—	—	N	N	N	N	N	N

Table 2.10 - Relative Effectiveness of Preemergence Herbicides in Small Fruit

	Dichlobenil	Flumioxazin	Mesotrione	Napropamide	Norflurazon	Oryzalin	Oxyfluorfen	Simazine	Terbacil
Perennial Broadleaf Weeds									
Chicory	G	—	—	N	N	N	N	P-F	G
Common dandelion	E	—	—	N	N	N	N	P-F	G-E
Common mallow	G	—	—	N	N	N	N	N	—
Common milkweed	—	—	—	N	N	N	N	N	N
Common yarrow	—	—	—	N	N	N	N	—	N
Docks (broadleaf, curly)	G	—	—	N	N	N	N	N	F
Goldenrod	F-G	—	—	N	N	N	N	N	P-F
Ground ivy	E	—	—	N	N	N	N	N	N
Hemp dogbane	N	—	—	N	N	N	N	N	N
Horsenettle	N	—	—	N	N	N	N	P	F-G
Mugwort	G-E	—	—	N	N	N	N	N	P
Red sorrel	G	—	—	N	N	N	N	N	P
Thistles (bull, musk, curly)	F	—	—	N	N	—	N	—	—
White flowered aster	G	—	—	N	N	N	N	N	N
Wild carrot	G	—	—	N	F	N	N	N	F
Wild strawberry	G	—	—	N	P	N	N	N	N
Yellow rocket	G	—	—	N	F	N	N	P	G
Yellow woodsorrel (from seed)	G	—	—	P	F	F	N	F	G
Special Perennial Weed Problems									
Bigroot morningglory	N	—	—	N	N	N	N	N	N
Brambles (Rubus spp.)	N	—	—	N	N	N	N	N	N
Common greenbriar	N	—	—	N	N	N	N	N	N
Japanese honeysuckle	N	—	—	N	N	N	N	N	N
Poison ivy	N	—	—	N	N	N	N	N	N
Virginia creeper	N	—	—	N	N	N	N	N	N
Wild garlic	F	—	—	N	N	N	N	N	N

(E=Excellent; G=Good; F=Fair; P=Poor; N=None; –=Unknown)

Table 2.11 - Relative Effectiveness of Postemergence Herbicides in Small Fruit										
	Acifluorfen	Bentazon	Carfentrazone	Fluazifopbutyl	Glyphosate	Sethoxydim	2,4-D	Clopyralid	Paraquat	Clethodim
Annual Grasses										
Barnyardgrass	N	N	N	E	E	E	N	N	G	E
Cheat	—	N	—	G	E	G	N	N	G	-
Crabgrass	N	N	N	E	E	E	N	N	G	E
Fall panicum	P	N	N	E	E	E	N	N	G	E
Foxtails	P	N	N	E	E	E	N	N	G	E
Goosegrass	N	N	N	E	E	E	N	N	G	E
Johnsongrass (seedling)	P	N	N	E	E	E	N	N	G	E
Annual Broadleaf Weeds										
Annual fleabane	—	—	—	N	E	N	G	—	E	N
Annual morningglory	G-E	P	F	N	E	N	E	N	G	N
Black nightshade	F-G	N	G	N	E	N	F-G	F	G	N
Carpetweed	—	—	G	N	E	N	E	—	E	N
Common chickweed	—	—	F	N	E	N	P	—	E	N
Common lambsquarter	P-F	G	G	N	E	N	G	P	E	N
Common ragweed	E	G	P	N	E	N	G	E	E	N
Hairy galinsoga	—	—	—	N	E	N	G	—	E	N
Henbit	—	—	G	N	E	N	G	—	E	N
Horseweed	—	N	—	N	E	N	G	G	G	N
Knotweed	—	—	—	N	E	N	F	—	F	N
Mustards	—	—	—	N	E	N	G	—	F	N
Pennsylvania smartweed	G	G	—	N	E	N	P	F	G	N
Pigweeds	G-E	—	G	N	E	N	G	P	G	N
Prickly lettuce	—	—	—	N	E	N	P	—	G	N
Prickly sida	N	—	—	N	E	N	G	—	E	N
Purslane	—	—	—	N	E	N	F	—	G	N
Shepherds' purse	—	—	—	N	E	N	G	—	G	N
Speedwells	—	—	G	N	E	N	P	—	P	N
Velvetleaf	P	G	E	N	E	N	G	P	E	N
Virginia pepperweed	—	—	—	N	E	N	G	—	G	N
Perennial Grasses And Sedges										
Bermudagrass	—	—	N	G	G	G	N	N	P	G
Dallisgrass	—	—	N	G	E	G	N	N	P	—
Fescues	—	N	N	P-F	E	P-F	N	N	F	F
Johnsongrass (rhizome)	—	N	N	G	E	G	N	N	P	G
Nimblewill	—	N	N	G	G-E	F-G	N	N	P	—
Orchardgrass	—	N	N	F	E	F	N	N	F	F
Purpletop, Redtop	—	N	N	G	E	G	N	N	P	—
Quackgrass	—	N	N	G	G	G	N	N	P	G
Yellow nutsedge	—	F-G	N	N	G	N	N	N	P	N
Perennial Broadleaf Weeds										
Broadleaf plantain	—	—	—	N	E	N	G	—	P	N
Buckhorn plantain	—	—	P	N	E	N	G	P	P	N
Canada thistle	—	—	—	N	F-G	N	F-G	G	P	N

Table 2.11 - Relative Effectiveness of Postemergence Herbicides in Small Fruit (continued)

	Acifluorfen	Bentazon	Carfentrazone	Fluazifopbutyl	Glyphosate	Sethoxydim	2,4-D	Clopyralid	Paraquat	Clethodim
Perennial Broadleaf Weeds										
Chicory	—	—	—	N	E	N	G	—	P	N
Common dandelion	—	—	P	N	E	N	G	F	P	N
Common mallow	—	—	—	N	E	N	—	—	P	N
Common milkweed	—	—	—	N	G	N	P-F	—	P	N
Common yarrow	—	—	—	N	G	N	F	—	P	N
Docks (broadleaf, curly)	—	—	P	N	G	N	G	—	P	N
Goldenrod	—	—	—	N	E	N	P-F	—	P	N
Ground ivy	—	—	—	N	G	N	P-F	—	P	N
Hemp dogbane	—	—	—	N	F	N	P-F	—	P	N
Horsenettle	—	—	—	N	F-G	N	P	—	P	N
Mugwort	—	—	—	N	F	N	P	P-F	P	N
Red sorrel	—	—	—	N	G	N	P	—	P	N
Thistles (bull, musk, curly)	—	—	—	N	G	N	F-G	G	P	N
White flowered aster	—	—	—	N	E	N	N	—	P	N
Wild carrot	—	—	—	N	E	N	P-F	—	P	N
Wild strawberry	—	—	—	N	E	N	P-F	—	P	N
Yellow rocket	—	—	—	N	E	N	P-F	—	P	N
Yellow woodsorrel	—	—	—	N	E	N	F	N	P	N
Special Perennial Weed Problems										
Bigroot morningglory	—		—	N	F-G	N	F-G	—	P	N
Brambles (Rubus spp.)	—		—	N	G	N	P	—	P	N
Common greenbriar	—		—	N	P	N	N	—	P	N
Japanese honeysuckle	—		—	N	F-G	N	P-F	—	P	N
Poison ivy	—		—	N	G	N	F	—	P	N
Virginia creeper	—		—	N	F-G	N	F	—	P	N
Wild garlic	—		—	N	F	N	F	—	P	N

(E=Excellent; G=Good; F=Fair; P=Poor; N=None; –=Unknown)

Grapes: Diseases and Insects in Vineyards

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Additional information on pest and beneficial species identification is available online at https://www.virginiafruit.ento.vt.edu/. Disease updates and management information is available at https://ext.grapepathology.org/.

In January 2018, a new invasive insect was found in Virginia. Spotted lanternfly came to Virginia from southeastern Pennsylvania, and spread through the Shenandoah Valley and parts of the Piedmont. Isolated counties to the south are also infested. SLF feeds on more than 70 different hosts, and can cause significant injury on some. Some of our important fruit crops are on the host list: grape, caneberry, blueberry, stone and pome fruits, and hops; grape is the most vulnerable commercial crop. Populations can build to create a severe nuisance in residential areas as well. An eradication effort has been implemented in 2018, and a quarantine was established by VDACS in May 2019. More information on the **quarantine program** is posted (https://www.pubs.ext.vt.edu/ENTO/ENTO-319/ENTO-319.html). An online training is available too allow certification as part of the quarantine effort (https://register.ext.vt.edu/search/publicCourseSearchDetails.do;jsessionid=E3FEE1B1C1921BA6848B382063FC0BDE?method=load&courseId=1066947). Fruit growers should be aware of the pest's appearance, and how to handle finds you may make in your operations. For information on **SLF appearance and management in vineyards,** refer to our fact sheet (https://www.pubs.ext.vt.edu/ENTO/ENTO-323/ENTO-323.html). For updated information, visit the spotted lanternfly page in the Virginia Cooperative Extension web site (https:ext.vt.edu). For updated control information, visit the SLF page in Virginia Fruit (https://www.virginiafruit.ento.vt.edu/SLF.html). To report suspected discoveries, please contact your county Extension Agent (https://ext.vt.edu/offices.html).

Application rates: The rate per acre column gives rates for low-volume or concentrate applications. Sprays may be applied as semiconcentrate (40-100 gal/A) or concentrate (10-40 gal/A) sprays. Use caution with more concentrated sprays; the smaller droplet sizes associated with low-volume application are more prone to drift. Amount of pesticide to be applied for dilute applications (usually 100 gal/A early in early season, 200 gal/A in mid season, and 300 gal/acre in late season. In training systems that don't result in extensive canopies, use 100 gal/acre throughout the season.) is usually given on the label.

Table 3.1 - Disease and Insect Control

Pest	Chemical and Formulation	Rate/Acre	Spray Timing and Remarks
Dormant			
Anthracnose (Bird's eye rot) Powdery Mildew Phomopsis	lime sulfur solution Sulforix	10.0 gal, or see label	Only necessary where anthracnose, Phomopsis, or powdery mildew have been a serious problem. Lime sulfur can reduce overwintering inoculum of these diseases.
Botryosphaeria canker, Eutypa dieback, ESC	Topsin-M	1 lb per 5 gal of water	Obtain either a section 24c label for VA or the newest (2020) label for paint application information.
	Rally 40WSP	5 oz	Obtain the newest label for paint application information.
	Mettle 125 ME	5 fl oz	Obtain the newest label for paint application information.
	B-lock	n/a	B-lock is a latex paint with boron for pruning wound protection, and shown to be effective against a number of trunk diseases.
Mealybugs	Applaud 70DF	24 oz	If a problem at harvest in the previous year. If a delayed dormant spray does not provide adequate control, a summer application may be made. Baythroid targets only crawlers, present in May. Mealybug materials may be applied in May, contact materials mainly effective at that time. Movento prebloom only in table grapes. The use of Baythroid should be delayed until fourth cover in blocks where Spotted-wing drosophila must be controlled, in order to observe maximum applications per season.
	Belay Insecticide	6.0 fl oz	
	Venom 70	1.0-3.0 oz (foliar) 5.0-6.0 oz (soil)	
	Scorpion 35SL	2.0-5.0 fl oz (foliar) 9.0-13.25 fl oz (soil)	
	Assail 30SG	2.5-5.3 oz	
	Admire Pro	1.0-1.4 fl oz (foliar) 7.0-14.0 fl oz (soil)	
	Movento 2SC	6.0-8.0 fl oz	
	Actara 25WDG	1.5-3.5 oz	

Table 3.1 - Disease and Insect Control (continued)			
Pest	**Chemical and Formulation**	**Rate/Acre**	**Spray Timing and Remarks**
Grape scale	Dormant oil	2% solution	Apply in high volume (dilute) application. Loose bark on vines makes coverage of scale difficult.
	Knack	16 fl oz	Since Knack is an Insect Growth Regular, evidence of activity may take longer than with a contact insecticide. In dormant application, combine with a spray oil. May also be applied in foliar spray when crawlers are active.
Bud Swell			
Grape flea beetle	Danitol 2.4EC	8.0 fl oz	If adult beetles are present in damaging numbers. See Table 3.4 for Restricted Entry Intervals. The REI for Imidan may render it impractical for most growers. The use of Baythroid, Mustang Maxx, and Tombstone should be delayed until fourth cover in blocks where spotted-wing drosophila must be controlled, in order to observe maximum applications per season.
	Sevin XLR Plus	1.0-2.0 qt	
	Imidan 70WP	2.0 lb	
	Baythroid XL 1EC	2.4-3.2 fl oz	
	Mustang Maxx	4.0 fl oz	
European red mite (ERM)	superior oil (70 sec)	2.0 gal	Only where ERM is a problem. Apply as a dilute spray.
Climbing cutworms	*Bacillus thuringiensis (Bt)*	Rates vary	Spray in evening if possible. Various preparations of *Bt* available. Check label for rates. **See Table 3.4 for Restricted Entry Intervals.** The use of Delegate, Baythroid, Brigade and Sniper 2 should be delayed until fourth cover in blocks where spotted-wing drosophila must be controlled, in order to observe maximum applications per season. Seduce spinosad bait may be applied at a rate of 20-44 lb/A (0.5-1 lb/1000 sq ft, or a 6" circular band around the base of the trunk)
	Sevin XLR Plus	1.0-2.0 qt	
	Danitol 2.4EC	15.0 fl oz.	
	Intrepid 2F	12.0-16.0 fl oz	
	Entrust 2SC	4.0-8.0 fl oz	
	Seduce bait 25WG	See label and comments	
	Delegate	3.0-5.0 oz	
	Baythroid XL 1EC	2.4-3.2 fl oz	
	Brigade 10WSB	8.0-16.0 oz	
	Altacor 35WDG	3.0-4.5 oz	
	Sniper 25EC	3.2-6.4 fl oz	
Spotted lanternfly (eggs)	Malathion 5EC	3 pt	Malathion has ovicidal activity if applied in the two weeks before hatch. Apply in volume sufficient to provide soaking of egg masses.
New Shoots: at weekly intervals or according to label until pre-bloom			
Black rot, Phomopsis cane and leaf spot, Downy mildew	captan 50WP or equivalent	2.0-4.0 lb	Important to maintain protection starting at 1/2 inch to 1 inch shoot length where black rot or Phomopsis has been a problem. Add a surfactant to improve wetting of pubescent young growth. Captan has only fair efficacy against black rot. At high disease pressure, it should be tank-mixed with a more efficaceous material. Do not make captan applications within two weeks of an oil spray.
	mancozeb 75DF	2.0-4.0 lb	
	Ziram 76DF See Table 3.2	2.0-4.0 lb	
Powdery mildew	wettable sulfur (81.25% or 92%) See Table 3.2	2.0-5.0 lb (See label)	Where powdery mildew is a severe problem. Do not make sulfur applications within two weeks of an oil spray. Do not use sulfur prior to or during periods of excessively high temperatures (with risk increasing near 90F and above), as sulfur injury can occur even on sulfur-tolerant varieties. Do not apply sulfur to Concord, red-fruited French-American hybrids, and other sulfur sensitive varieties. See prebloom powdery mildew options for such situations.
Anthracnose	captan 50WP or equivalent See Table 3.2	2.0-4.0 lb	Apply at 4- to 10-inch shoot length. Repeat at 10- to 14-day intervals. Only necessary where anthracnose has been a problem.
	copper fungicides with lime	see label	
	Aprovia	8.6-10.5 fl oz	
	Aprovia Top	8.5-13.3 fl oz	
	Inspire Super	16.0-20.0 fl oz	
	Kenja	20.0-22.0 fl oz	
	Mettle 125ME	3.0-5.0 fl oz	
	Miravis Prime	9.2-13.4 fl oz	
	Pristine	8.0-12.5 oz	

Table 3.1 - Disease and Insect Control (continued)			
Pest	**Chemical and Formulation**	**Rate/Acre**	**Spray Timing and Remarks**
Grape cane girdler	Danitol 2.4EC	10.6 fl oz	When shoots are 4- to 6-inches long, where infesting more than 10% of shoots. Mainly a problem when training young vines. See Table 3.4 for Restricted Entry Intervals.
	Imidan 70WP	2.0 lb	
	Baythroid XL 1EC	2.4-3.2 fl oz	
Redbanded leafroller	Altacor 35WDG	3.0 oz	Where pest has been a problem in past. Various preparations of *Bt* available. Check rates. See Table 3.4 for Restricted Entry Intervals.
	Entrust 2SC	4.0-8.0 fl oz	
	Delegate 25WG	5.0 oz	
	Intrepid 2F	12.0-16.0 fl oz	
	Imidan 70WP	2.0 lb	
	Sevin XLR Plus	2.0 qt	
	Bacillus thuringiensis (Bt)	See label	
Climbing cutworms	*Bacillus thuringiensis (Bt)*	See label	Spray in evening if possible. Various preparations of *Bt* are available. Check rates. See Table 3.4 for Restricted Entry Intervals. The use of Delegate, Baythroid, Brigade and Sniper 2 should be delayed until fourth cover in blocks where Spotted-wing drosophila must be controlled, in order to observe maximum applications per season. Seduce spinosad bait may be applied at a rate of 20-44 lb/A (0.5-1 lb/1000 sq ft, or a 6" circular band around the base of the trunk)
	Sevin XLR Plus	1.0-2.0 qt	
	Danitol 2.4EC	15.0 fl oz	
	Intrepid 2F	12.0-16.0 fl oz	
	Entrust 2SC	4.0-8.0 fl oz	
	Seduce bait		
	Delegate 25WG	5.0 oz	
	Baythroid XL 1EC	2.4-3.2 fl oz	
	Brigade 10WSB	3.2-6.4 oz	
	Altacor 35WDG	3.0 oz	
	Sniper 25EC	3.2-6.4 fl oz	
Spotted lanternfly	Sevin XLR Plus	1.0-2.0 qt	Assess SLF nymphs in the first two weeks of May. A provisional action threshold is 15-20 nymphs per vine. Nymphs are less injurious than adults. Watch for secondary pests (e.g. mealybug) infestations following pyrethroid applications. BoteGHA is organically approved, but limited efficacy.
	Malathion 5EC	3.0 pt	
	Danitol 2.4EC	16-21 fl oz	
	BoteGHA ES	3 qt	
	Aza-Direct	1.0-3.5 pf	
	Pounce	7.87 oz	
Pre-Bloom - Just before blossoms open, critical spray for black rot, powdery, and downy mildew			
Black rot	mancozeb (various)	2.0-4.0 lb	Infection occurs at 7 or more hours of leaf wetness (dew, fog, and/ or rain), depending on temperature. Apply all fungicides before or between these wet periods. Spray every 10-14 days throughout the growing season according to label. Do not use sterol inhibitors (group 3, Rally, Orius, Procure, Inspire Super, Mettle, Revus Top, Topguard EQ) or strobilurins (group 11, Abound, Sovran, Flint, Topguard EQ, Rhyme, Quadris Top or Pristine) continuously; rotate with other groups of fungicides.
	Ziram 76DF	2.0-4.0 lb	
	Abound	10.0-15.5 fl oz	
	Aprovia	8.6-10.5 fl oz	
	Aprovia Top	8.5-13.3 fl oz	
	Cevya	4.0 fl oz	
	Flint Extra	3.5-3.8 fl oz	
	Inspire Super	16.0-20.0 fl oz	
	Luna Experience	8.0-8.6 fl oz	
	Luna Sensation	7.0 fl oz	
	Mettle 125ME	3.0-5.0 fl oz	
	Miravis Prime	9.2-13.4 fl oz	
	Pristine	8.0-12.5 oz	
	Quadris Top	12.0-14.0 fl oz	
	Rally 40WSP	3.0-5.0 oz	
	Revus Top	7.0 fl oz	
	Rhyme	4.0-5.0 fl oz	
	Sovran	3.2-4.8 oz	
	tebuconazole 45% (Orius 20AQ, formerly Elite, various fomulations available)	8.6 oz	
	Topguard EQ.	5.0-6.0 fl oz	
	Viathon	2.0-4.0 pt	

Table 3.1 - Disease and Insect Control (continued)

Pest	Chemical and Formulation	Rate/Acre	Spray Timing and Remarks
Downy mildew	captan (various)	2.0-4.0 lb	Apply 2 weeks before blossom caps begin to drop on very susceptible varieties. Downy mildew strains with resistance to Abound, Pristine, and other Group 11 fungicides are present in many Virginia locations. Rotating or tank mixing with a different anti-downy-mildew material is recommended. Downy mildew isolates that are resistant to group 40 (Revus, Revus Top, Forum, and a part of Zampro) were found in several vineyards in Virginia.
	copper (with lime or various formulations)	see label	
	mancozeb (various)	2.0-4.0 lb	
	Gavel 75DF	2.0-2.5 lb	
	Ziram 76DF	3.0-4.0 lb	
	Forum	6.0 fl oz	
	phosphorous acid (various)	See label	
	Ranman 400SC	2.1-2.75 fl oz	
	Revus	8.0 fl oz	
	Revus Top	7.0 fl oz	
	Ridomil Gold MZ	1.5-2.0 lb	
	Ridmil Gold Copper	2.0 lb	
	Viathon	2.0-4.0 pt	
	Zampro	11.0-14.0 fl oz	
Powdery mildew	wettable sulfur (81.25% or 92%), or other sulfur products (e.g., Microthiol Disperrs)	2.0-4.0 lb	Do not use sterol inhibitors (Group 3, see above under black rot) or strobilurins continuously; rotate with other groups of fungicides. Powdery mildew strains with resistance to the strobilurins (Abound, Sovran, and Flint) are very common in Virginia and can cause control failure! It is recommended that strobilurins be tank mixed with sulfur or another anti-mildew material. Pristine contains a strobilurin, but also a different active chemical (group 7) and does not need to be tank mixed. Quintec resistance has been observed in Virginia, but appears as yet uncommon and its impact limited. Rates for sulfur can be increased to as high as 5.0 lb/100 gallons. Severe disease pressure may warrant this, but beware of possible plant injury at higher rates. Be aware of label restrictions of Merivon (no mixing) that may make it impractical in many vineyards. There are many generic tebuconazole materials with various concentrations (e.g., Sonoma). Please refer to your label for specific application rate. If you have experienced an outbreak of powdery mildew on clusters in the past, a pre-bloom application of a powdery mildew material plus sulfur at 7 to 10 days before bloom is effective. (i.e., do not wait until bloom.)
	Aprovia	10.5 fl oz	
	Aprovia Top	8.6-13.3 fl oz	
	Cevya	4.0 fl oz	
	Endura	4.5 oz	
	Gatten	6.4 fl oz	
	Inspire Super	16.0-20.0 fl oz	
	Kenja	20.0-22.0 fl oz	
	Luna Experience	6.0-8.6 fl oz	
	Luna Sensation	7.0 fl oz	
	Merivon	4.0-5.5 fl oz	
	Mettle 125ME	3.0-5.0 fl oz	
	Miravis Prime	9.2-13.4 fl oz	
	Pristine	8.0-12.5 oz	
	Procure 480SC	4.0-8.0 oz	
	Quadris Top	12.0-14.0 fl oz	
	Quintec	4.0-6.6 fl oz	
	Rally 40WSP	3.0-5.0 oz	
	Revus Top	7.0 fl oz	
	Rhyme	4.0-5.0 fl oz	
	tebuconazole 45% (Orius 20AQ)	8.6 fl oz	
	Topguard EQ	5.0-6.0 fl oz	
	Trionic 4SC	4-8 fl oz	
	Viathon	2.0-4.0 pt	
	Vivando	10.3-15.4 fl oz	
Grape berry moth	Intrepid 2F	12.0-16.0 fl oz	Use higher rate of Entrust for more intensive infestations and larger larvae, where pest has been a problem in past. See Table 3.4 for Restricted Entry Intervals. The use of Delegate should be delayed until fourth cover in blocks where spotted-wing drosophila must be controlled, in order to observe maximum applications per season.
	Entrust 2SC	4.0-8.0 fl oz	
	Delegate 25WG	3.0-5.0 oz	
	Altacor 35WDG	2.0-4.5 oz	
	Imidan 70WP	2.0 lb	
	Belay 50WDG	6.0 fl oz	
	Avaunt 30DG	5.0-6.0 oz	
	Sevin XLR	1.0-2.0 qt	
	Bacillus thuringiensis (BT)	Rates vary	

Table 3.1 - Disease and Insect Control (continued)			
Pest	**Chemical and Formulation**	**Rate/Acre**	**Spray Timing and Remarks**
Grape leafhopper	Assail 30SG	2.5-5.3 oz	Use a treatment threshold of 5 nymphs/leaf before July 15, 10/ leaf thereafter. Apply Surround at least 2 or 3 times at 7- to 14-day intervals throughout infestation; not recommended for table grapes because of visible residues. Nexter may be applied up to twice per season. Use 8.8-10.67 oz/A in vineyards with dense foliage. See Table 3.4 for Restricted Entry Intervals. The use of malathion should be delayed until fourth cover in blocks where spotted-wing drosophila must be controlled, in order to observe maximum applications per season. When available, flowable (F) formulations pose less risk of phytotoxicity that emulsifiable (EC; oil-based) formulations. Avoid using captan and oil-based pesticides within 14 days of each other.
	Actara 25WDG	1.5-3.5 oz	
	Admire Pro	1.0-1.4 fl oz	
	Imidan 70WP	2.0 lb	
	malathion 5EC	3.0 pt	
	Surround 95WP	12.5-50.0 lb	
	Sevin XLR Plus	1.0-2.0 qt	
	Nexter 75WP	4.4-10.67 oz	
	Applaud 70DG	9-12 oz	
Grape scale	Applaud 70DF	12.0 oz	Apply when crawlers are active, or at 493 and 990 degree-days above 50˚F starting at April 1 (early and peak activity of first generation).
	Movento 2SC	6.0-8.0 fl oz	
	Admire Pro	1.0-1.4 fl oz	
	Assail 30SG	2.5-5.3 oz	
	Knack	16 fl oz	
Mealybugs	Applaud 70DF	24 oz	If a problem at harvest in the previous year. If a delayed dormant spray does not provide adequate control, a summer application may be made. Baythroid targets only crawlers. Movento prebloom only in table grapes. The use of Baythroid should be delayed until fourth cover in blocks where spotted-wing drosophila must be controlled, in order to observe maximum applications per season.
	Belay Insecticide	6.0 fl oz	
	Venom 70	1.0-3.0 oz (foliar) 5.0-6.0 oz (soil)	
	Scorpion 35SL	2.0-5.0 fl oz (foliar) 9.0-13.25 fl oz (soil)	
	Assail 30SG	2.5-5.3 oz	
	Admire Pro	1.0-1.4 fl oz (foliar) 7.0-14.0 fl oz (soil)	
	Baythroid XL 1EC	2.4-3.2 fl oz	
	Movento 2SC	6.0-8.0 fl oz	
	Actara 25WDG	1.5-3.5 oz	
Grape tumid gallmaker	Movento 2SC	6.0-8.0 fl oz	Apply when galls first appear in blocks with a history of high populations of grape tumid gallmaker. Traminette and Niagara are notably sensitive to grape tumid gall.
Periodical cicada	Sevin XLR	1-2 qt	The next appearances of periodical cicada in Virginia will be in 2025 (Brood XIV, a 17-year brood mainly in southwestern Virginia). Egg-laying results in injured shoots and trunks. Bird netting with a mesh no larger than 1 cm will provide effective control of injury. Pyrethoid sprays may induce outbreaks of mealybugs or mites.
	Danitol 2.4ECin	5.33-10.66 fl oz	
	Baythroid XL	1.6-3.2 fl oz	
	Surround WP	25-50 lb	

Table 3.1 - Disease and Insect Control (continued)			
Pest	**Chemical and Formulation**	**Rate/Acre**	**Spray Timing and Remarks**
Bloom			
Botrytis	Elevate 50 WDG	1.0 lb	Materials may be applied at early mid-bloom and again before bunch closing, if needed. Botrytis strains with resistance to strobilurins, Endura, Pristine, and Topsin M, and with reduced sensitivity to Rovral/Meteor are widespread in Virginia. Isolates with reduced sensitivity to Vangard and Scala as well as Elevate, Kenja, Luna, Miravis, and Merivon have also been observed in some locations. Use 10 oz/A of Vangard or 18 fl oz/A of Scala when it is applied by itself. You can use lower rates when you tank-mix it with another Botrytis fungicide.
	Inspire Super	16-20 fl oz	
	Kenja	20-22 fl oz	
	Luna Experience	6.0-8.6 fl oz	
	Luna Sensation	5.0-7.6 fl oz	
	Miravis Prime	10.3-13.4 fl oz	
	Rovral 4F or Meteor	0.67-1.33 lb or 1.5-2.0 pt	
	Scala	9.0-18.0 fl oz	
	Switch	11.0-14.0 oz	
	Vangard	5.0-10.0 oz	
Post-Bloom: Immediately after bloom			
Black rot	Same fungicides and rates as pre-bloom spray		This is a very important spray. Do not delay more than 12-14 days after last pre-bloom spray. Note: Rally, Inspire Super, or Revus Top at the higher rates using 200 gal/A dilute sprays in combination with black rot predictor models provide excellent curative control. There are many generic tebuconazole materials with various concentrations. Please refer to your label for specific application rate. Note 5-day REI for cane work for Luna Experience and Topguard EQ
Downy mildew	Same fungicides and rates as pre-bloom spray		Do not apply mancozeb or Gavel within 66 days of harvest. Copper fungicides may be mixed with hydrated lime to reduce risk of phytotoxicity, especially in cool, wet conditions, when copper fungicides may cause injury on certain varieties.
Powdery mildew	Same fungicides and rates as pre-bloom spray		Very important spray. Use at 12-14 day intervals as needed. Use higher rates and/or shorter intervals (see label) under severe disease pressure. See notes for prebloom.
Grape berry moth	Intrepid 2F	12.0-16.0 fl oz	See Table 3.4 for Restricted Entry Intervals. The REI for Imidan may render it impractical for most growers.
	Entrust 2SC	4.0-8.0 fl oz	
	Delegate 25WG	3.0-5.0 oz	
	Altacor 35WDG	2.0-4.5 oz	
	Bacillus thuringiensis (Bt)	Rates vary	
	Imidan 70WP	2.0 lb	
	Sevin XLR	1.0-2.0 qt	
	Avaunt 30DG	5.0-6.0 oz	
	Knack	16 fl oz	
Grape rootworm	Sevin XLR PLUS	1.0-2.0 qt	Apply when beetles appear, usually in mid June or early July. Second application may be necessary 10 days later. beetleGone is OMRI-approved.
	beetleGone	1-17.5 lb	
	Heterorhabditis bacteriophora, NemaSeek	See comments	*Heterorhabditis bacteriophora* is an entomopathogenic nematode. Recommended use rate ranges from 5 million for 1600 sq ft to 50 million per treated acre (https://www.arbico-organics.com/category/beneficial-nematodes-faqs).

Table 3.1 - Disease and Insect Control (continued)			
Pest	**Chemical and Formulation**	**Rate/Acre**	**Spray Timing and Remarks**
Grape leafhopper	Admire Pro	1.0-1.4 fl oz	Apply if more than 5 leafhopper nymphs/leaf before August 1, and 10/leaf thereafter. Portal on nonbearing vines only. See Table 3.4 for Restricted Entry Intervals. The use of malathion should be delayed until fourth cover in blocks where spotted-wing drosophila must be controlled, in order to observe maximum applications per season. When available, flowable (F) formulations pose less risk of phytotoxicity that emulsifiable (EC; oil-based) formulations. Avoid using captan and oil-based pesticides within 14 days of each other.
	Nexter 75WP	4.4-5.2 oz	
	Assail 30SG	2.5-5.3 oz	
	Actara 25WDG	1.5-3.5 oz	
	Belay Insecticide	2.0-4.0 fl oz	
	Imidan 70WP	2.0 lb	
	Malathion 8F	1.88 pt	
	Malathion 5EC	3.0 pt	
	Sevin XLR PLUS	1.0-2.0 qt	
	Applaud 70DF	12.0 oz	
	Portal 5EC	1.0-2.0 pt	
Phylloxera	Assail 30SG	2.5-5.3 oz	Spray when yellow crawlers first detected with hand lens or when galls first appear. Repeat 10-12 days after first spray if foliar form was a problem the previous year. Movento for prebloom use only on table grapes. Movento provides control of root infestations.
	Movento 2SC	6.0-8.0 fl oz	
European red mite	Vendex 50WP	1.0-2.5 lb	Only if mites exceed 10/leaf (20/leaf on labrusca types), and more than minor bronzing occurs. Rotate acaricides. Use 8.8-10.67 oz of Nexter if twospotted spider mite is the predominant mite, or in vineyards with dense foliage. Vendex is available in water-soluble bags (1-2.5 bags/A). Acramite may only be applied once per year. Use 8.0 oz of Agri-Mek for low populations, 16.0 oz for severe; Agri-Mek should include a non-ionic surfactant. Stylet Oil should be applied at 1.0-2.0 gal/A, every 10 to 14 days against mite eggs. Nealta should be applied at first sign of infestation; do not make more that one application of Nealta before using an acaricide of differing mode of action.
	Nexter 75WP	4.4-10.67 oz	
	Acramite 50WS	0.75-1.0 lb	
	Agri-Mek 0.15EC	8.0-16.0 fl oz	
	JMS Stylet Oil	1.0-2.0 gal	
	Envidor 2SC	16.0-34.0 fl oz	
	Zeal WP	2.0-3.0 oz	
	Onager 11.8EC	12.0-24.0 fl oz	
	Portal 5EC	2.0 pt	
	Tri-Tek	1.0-2.0% solution	
	Nealta 1.67WSP	13.7 fl oz	
First Cover: 7 to 10 days after post-bloom spray			
Black rot, downy mildew, powdery mildew	Same fungicides and rates as pre-bloom spray.		Do not apply ferbam more than twice after pre-bloom spray. Copper fungicides with hydrated lime may be used for control of downy mildew. Observe per season limits on pesticide amounts and pre-harvest intervals.
Grape berry moth, grape leafhopper, phylloxera, European red mite, grape rootworm	Same insecticides and rates as post-bloom spray.		Do not apply Imidan within 14 days of harvest.
Second Cover: 7-10 days after first cover spray (when berries are about pea size, but before they touch in cluster)			
Japanese beetle, June beetle, wasps	Sevin XLR PLUS	1.0-2.0 qt	Apply when beetles are common. Sevin may not be applied within 7 days of harvest. See Table 3.4 for Restricted Entry Intervals. beetleGone *(Bacillus thuringiensis galleriae)* is OMRI approved; it should be applied in up to 30 gallons of water per acre. Neemix and Trilogy are to be combined.
	Surround 95WP	12.5-50.0 lb	
	Imidan 70WP	2.0 lb	
	Belay Insecticide	2.0-4.0 fl oz	
	Actara 25WDG	1.5-3.5 oz	
	Assail 30SG	2.5-5.3 oz	
	Avaunt 30DG	3.5-6.0 oz	
	Neemix 4.5 + Trilogy	7.0-16.0 fl oz, 2% solution	
	beetleGone	2.5-17.5 lb	
Third Cover: before bunch closing			
Botrytis	Same fungicides and rates as pre-bloom spray		Polyoxin D materials such as Ph-D and Oso (group 19) are also labeled for Botrytis management. It tends to be less effective than others, thus, it would be a nice tank-mix or alternation partner.
Downy mildew	Same pesticides and rates as pre-bloom spray		When night time temperature drops, dark, warm, and high relative humidity conditions promote downy mildew to produce spores.

Table 3.1 - Disease and Insect Control (continued)			
Pest	**Chemical and Formulation**	**Rate/Acre**	**Spray Timing and Remarks**
Veraison: berry ripening, sugar building up			
Botrytis	Same fungicides and rates as pre-bloom spray		Anti-Botrytis materials can be applied at beginning of ripening and again prior to harvest if needed. Fruit rot can be caused by a variety of organisms. Many anti-Botrytis fungicides have little effect on organisms other than Botrytis. Botrytis strains with resistance to strobilurins, Endura, Pristine, and Topsin M, and with reduced sensitivity to Rovral/ Meteor are widespread in Virginia. Isolates with reduced sensitivity to Vangard and Scala, and to Elevate have also been observed in some locations. Rotating Vangard or Scala (same group), Elevate, Rovral or Meteor, Switch, and/ or Luna Experience is recommended. Carefully observe per season limits on number of sprays.
Sour rot			To improve sour rot control, add a drosophila material plus Oxidate, 1:200-1:400, Use a combination of an insecticide to reduce SWD (see below) and Oxidate. Apply at ~15 Brix and one more time at 10-14 days after the first application. If possible, rotate modes of action of insecticide.
Spotted-wing drosophila	Entrust 2SC	4.0-8.0 fl oz	Spotted-wing drosophila is more important in some varieties than others; growers should incorporate block history. Berries become most vulnerable at about 15 degrees Brix. It is critical to rotate among differing modes of action in order to delay the development of resistance. PyGanic has a short residual life which limits its efficacy. Surround, Entrust and PyGanic are organic alternatives. Be watchful for flare-ups of secondary pests (mealybugs, spider mites) following application of pyrethroids. When available, flowable (F) formulations pose less risk of phytotoxicity that emulsifiable (EC; oil-based) formulations. Avoid using captan and oil-based pesticides within 14 days of each other. Removing foliage from the fruit zone will reduce habitat suitability for SWD. For more information on SWD, visit www.virginiafruit.ento.vt.edu/SWD.html.
	Delegate 25WG	3.0-5.0 oz	
	Malathion 8F	1.88 pt	
	Malathion 5EC	3.0 pt	
	Mustang Maxx 0.8EC	4.0 fl oz	
	Tombstone 2EC	2.4-3.2 fl oz	
	PyGanic 1.4EC	64.0 fl oz	
	Surround WP	25.0-50.0 lb	
	Sevin XLR Plus	1.0-2.0 qt	
Grape scale	Applaud 70DF	9.0-12.0 oz	Second generation crawlers can be targeted at first and peak activity (1100 and 2000 degree-days above 50˚F after April 1) (mid-July and mid-August).
	Movento 2SC	6.0-8.0 fl oz	
	Admire Pro	1.0-1.4 fl oz	
	Assail 30SG	2.5-5.3 oz	
Fourth Cover: mid-August or 10 days after third cover spray			
Same diseases and insects as above plus:	Same fungicides and insecticides as Post-bloom spray, except ferbam, plus the following:		Do not apply copper within 30 days of harvest or sulfur within 10- to 14-days of harvest to minimize enological problems **if berries are to be used for wine.**
Drosophila flies (vinegar flies)	Malathion 8EC or 8F	1.88 pt	Apply if drosophila are abundant. See separate comments below on Spotted-wing drosophlia
Brown marmorated stink bug	Scorpion 35SL	1.25-5.0 fl oz (foliar) 9.0-10.5 fl oz (soil)	When available, flowable (F) formulations pose less risk of phytotoxicity than emulsifiable (EC; oil-based) formulations. Avoid using captan and oil-based pesticides within 14 days of each other. Use an action threshold of 3 BMSB/cluster.
	Belay Insecticide	4.0-6.0 fl oz	
	Venom	3.0 oz	
	Malathion 5EC	3.0 pt	
	Actara 25WDG	1.5-3.5 oz	
	Azera	2.0-3.0 pt	
Spotted-wing Drosophlia	Azera	1.0-2.0 p	Spotted-wing drosophila is more important in some varieties than others; growers should incorporate block history. Berries become most vulnerable at about 15 degrees Brix. It is critical to rotate among differing modes of action in order to delay the development of resistance. PyGanic has a short residual life which limits its efficacy. Surround, Entrust and PyGanic are organic alternatives. Be watchful for flare-ups of secondary pests (mealybugs, spider mites) following application of pyrethroids. When available, flowable (F) formulations pose less risk of phytotoxicity that emulsifiable (EC; oil-based) formulations. Avoid using captan and oil-based pesticides within 14 days of each other. For more information on SWD, visit www.virginiafruit.ento.vt.edu/SWD.html.
	Entrust 2SC	4.0-8.0 fl oz	
	Baythroid XL 1EC	2.4-3.2 fl oz	
	Delegate 25WG	3.0-5.0 oz	
	Malathion 8F	1.88 pt	
	Malathion 5EC	3.0 pt	
	Mustang Maxx	4 fl oz	
	PyGanic 1.4EC	64.0 fl oz	
	Tombstone 25EC	2.4-3.2 fl oz	
	Surround WP	25.0-50.0 lb	
	Sevin XLR Plus	1.0-2.0 qt	
Yellow jackets	Sevin XLR Plus	1.0-2.0 qt	Chemical control is not very effective because short PHI materials provide limited control and only current workers are killed. Try to find the nest and spot treat, especially if located in vineyard. Yellow jacket traps placed early in spring to trap overwintered queens may be helpful.

Table 3.1 - Disease and Insect Control (continued)

Pest	Chemical and Formulation	Rate/Acre	Spray Timing and Remarks
Spotted lanternfly	Brigade 10WSB	3.2-6.4 oz	Adults begin to appear in mid-July, and will be present through most of the fall. A provisional action threshold is 5-10 adults per vine. Assess frequently; continued re-immigration is a problem with SLF. Adults may develop high numbers on surrounding Ailanthus before moving into vineyard blocks. Pay close to attention to PHI and season maximum applications or amount of material per season.
	Actara 25WDG	1.5-3.5 oz	
	Scorpion 35SL	1.25-5.0 fl oz	
	Admire Pro (G)	1.0-1.4 fl oz	
	Mustang Maxx (G)	4 fl oz	
	Sevin XLR Plus	1.0-2.0 qt	
	BoteGHA ES	3 qt	
	PFR-97 20WDG	1-2 lb	
Harvest: Day before or day of harvest			
Brown marmorated stink bug	Belay 50WDG PyGanic 1.4EC	6.0 fl oz 64.0 fl oz	This spray is timed to knock down of stink bugs in the clusters at harvest in case of high BMSB populations (>3/cluster). Not intended for residual control.
Postharvest: vines only			
Mealybugs	Applaud 70DF	24.0 oz	Apply if control is not achieved by delayed dormant spray. Rotate modes of action is multiple applications are made.
	Venom 70	1.0-3.0 oz	
	Assail 30SG	2.5-5.3 oz	
	Actara 25WDG	1.5-3.5 oz	
	Admire Pro	1.0-1.4 fl oz	
	Belay Insecticide	6.0 fl oz	
	Movento 2SC	6.0-8.0 fl oz	
Leaves of vines should be protected up until frost to maintain healthy plants. This is especially important for control of powdery and downy mildew. Maintain green functioning leaves as long as possible. Follow sprays for powdery and downy mildew under post-bloom.			
Special Borer Treatment			
Grape root borer	Isomate GRB	100 dispensers	Good weed control may help prevent GRB populations from reaching high levels. In problem infestations, consider soil mounding, 8-12 inches high, around July 1. Pull down mound before following season. This approach is not suitable for sites with shallow soils. Mating disruption is the most effective means of controlling GRB. It was unavailable in 2024, but is expected back in the marketplace, likely too late for our field season. We are seeking a Section 18 Emergency Registration for 2025; watch Extension outlets for updates. Apply pheromone dispenser at 100/A, at the beginning of flight, around the first of July.
Special Sharpshooter Sprays			
In some vineyards in the eastern part of the state, sharpshooter leafhoppers, the vectors of Pierce's disease are of concern. The risk of Pierce's disease is greatest when there are fewer than 3 winter nights below 15 degrees F (9.4 degrees C). While research is needed on the vector relationships and timing in Virginia, the neonicotinoids Admire Pro (1.0 fl oz). Assail 70WSP (1.1-2.3 oz/A), Assail 30SG (2.5-5.3 oz/A), Belay Insecticide (4.0-6.0 fl oz), Scorpion 35SL (2.0-5.0 fl oz), Venom 70SG (1.0-3.0 oz/A), and Venom 20SG (0.44-0.66 lb/A) are registered for control of sharpshooters. Use the higher rates for higher pressure. In addition, Scorpion and Venom are registered for soil application (9.0-10.5 fl oz; 5.0-6.0 oz/A respectively), as is Admire Pro (7.0-14.0 fl oz/A). Soil applications should be applied between bud-break and pea-berry stage and should be considered when there are three or fewer nights below 15°F during the preceding winter. The neonicotinoids share a common mode of action; avoid overuse to avoid resistance. Besides neonicotinoids, the following pyrethroids are registered for sharpshooter control: the insect growth regulator Knack (16 fl oz/A) and the pyrethoids Danitol 2.4EC (10.67-21.33 fl oz/A), Brigade 2EC (6.4 fl oz/A), and Baythroid 2EC (1.6-3.2 fl oz/A). Danitol is limited to two applications, Baythoid to four applications, and Brigade to two applications at the low rate, one at the high. In blocks where spotted-wing drosophila will need to be controlled, early use of pyrethroids will decrease the number of applications available in late season. Consult https://www.virginiafruit.ento.vt.edu/PDsharpshooters.html for updated information.			

■ Effectiveness of Grape Pesticides

Effectiveness ratings of grape pesticides for disease, insect, mite, and weed control are based on research from Virginia and surrounding states. Although the ratings are compiled from the results of 5-10 years of research, they may not hold true for all vineyard conditions within Virginia. Results can vary from location to location depending on the weather conditions, how well the vines were sprayed the previous year, inoculum density, pest populations, canopy size, age of vines, formulation of a given pesticide, and how the pesticide was applied (low or high volume). Under certain environmental conditions and cultural practices, the effectiveness ratings could change from good to fair or vice versa. The ratings given are intended as general guides to assist the grower in pesticide selection for disease, insect, mite, and weed control.

Fungicide resistance is a pressing issue. Prolonged use of a particular at-risk mode of action can lead to the selection of resistant fungal populations. While some resistant populations may not survive for long due to associated fitness costs, many persist. Once resistance is found in a vineyard, it tends to persist for an extended period.

The mode of action is conveniently summarized by FRAC group codes (Fungicide Resistance Action Committee, "https://www.frac.info/" FRAC | Home), which you can find on the fungicide label and in this guide. Codes that start with “M” indicate multi-site compounds with a low risk of resistance development. If the FRAC code lacks the "M," it likely represents a single-site mode of action and the FRAC group code will just be a number or start with the letter “U” (mode of action unknown). It's important to note that some fungicide products combine two different modes of action (two FRAC codes) and that several different chemicals may share the same mode of action and thus have the same FRAC code. Therefore, rotating the mode of action (FRAC group), rather than just the chemical, is crucial. For example, rotating Rally (myclobutanil) with Orius (tebuconazole) isn't a rotation as both belong to FRAC group 3. The same applies to rotating Flint and Pristine, both containing FRAC group 11. When using materials with single-site mode of action, it is essential to **rotate** them, **limit their use** (ideally, no more than twice per year), and also **tank-mix** them with materials with FRAC code starting with “M”, such as sulfur, copper, mancozeb, ziram, captan, etc. to minimize the risk of fungicide resistance.

Instances of resistance against certain mode of action groups have been found in Virginia:

Powdery mildew

benzimidazoles (FRAC = 1) and QoIs (FRAC = 11) are usually no longer effective.

DMIs (FRAC = 3) are still effective, but you may see a decline in its efficacy, which may depend on the product and spray history.

Quintec (FRAC = 13): resistant strains of powdery mildew have been reported in VA, but only one case so far, not known to be widespread as of 2023.

Downy mildew

QoIs (FRAC = 11) are usually no longer effective.

Revus (FRAC = 40) resistance to downy mildew has been reported in several VA vineyards across the state.

Botrytis gray mold

benzimidazoles (FRAC = 1) and QoIs (FRAC = 11) are usually no longer effective.

Reduced sensitivity to iprodione (FRAC = 2), Vangard (FRAC = 17), and SDHI (FRAC = 7, e.g., Endura, Luna, Kenja, Merivon, etc.) have been reported. FRAC group 7 is complicated because some common mutations cause resistance to some members of the group (e.g., boscalid=Endura), but not others.

Ripe rot

Several QoI (FRAC =11) resistant isolates have been reported in VA

In general, SDHI (FRAC = 7) fungicides are not effective, except Aprovia

In some cases, efficacy is product-dependent (i.e., you may see big differences in efficacy among products); however, if they belong to the same FRAC group, the risk of fungicide resistance development is often similar. Thus, please rotate and mix when it comes to fungal disease management.

Table 3.2 - Relative Effectiveness of Selected Fungicides in Grapes

(E=excellent; G=good; F=fair; P=poor; N=none; – =information lacking or not registered; Var=variable depending on presence of resistance)

Fungicides Trade Name	Fungicides Common Name	Resistance Risk	Mode of Action Group	Anthracnose	Black rot	Botrytis bunch rot	Downy Mildew	Phomopsis cane/leaf spot	Powdery Mildew
Abound[1]	azoxystrobin[1]	H	11	G	E	Var	Var	F-G	Var
Aprovia	benzovindiflupyr	M	7	G	G	–	–	–	G-E
Aprovia Top	benzovindiflupyr plus difenoconazole	M	3 + 7	labeled	G	–	–	labeled	G-E
Aliette	fosetyl-Al	L	P07	–	–	–	E	–	–
Armicarb, Kaligreen, Agricure	potassium bicarbonate	L	M	–	–	–	–	–	F-G
Captan, Captec, etc	captan	L	M4	G	F	F	G-E	G–E	N
Cevya	mefentrifluconazole	M	3	–	E	–	–	labeled	G-E
Coppers[3]	Bordeaux[3], fixed coppers[8]	L	M1	F-G	F	P-F	G-E	F	F-G
Elevate[5]	fenhexamid	M	17	–	–	G-E	–	–	P-F
Endura	boscalid	M	7	G	–	Var	–	–	G-E
Ferbam	ferbam	L	M3	–	G	N	F	F	N
Flint[1]	trifloxystrobin[1]	H	11	–	E	Var	Var	F-G	Var
Fracture, ProBlad Verde	BLAD	Unknown	NC	–	–	labeled	–	–	labeled
Forum	dimethomorph	M	40	–	–	–	G-E[11]	–	–
Gatten	flutianil	Unknown	U13	–	–	–	–	–	labeled
Gavel	zoxamide + mancozeb	M for zoxamide	22+M3	F	F	–	G	G	–
Inspire Super	difenoconazole + cyprodinil	M	3+9	–	E	G-E	–	–	E
Intuity	mandestrobin	H	11	–	–	Var	–	–	P
Kenja	isofetamid	M	7	G	–	G-E	–	–	G-E
LifeGard	Bacillus mycoides	Unknown		–	–	–	labeled	–	
Luna Experience	fluopyram + tebuconazole	M	7+3	–	E	E	–	–	E
Luna Sensation	fluopyram + trifloxystrobin	M for flu H for tri	7+11	–	E	G	–	G	G
Manzate, various[4]	mancozeb[4]	L	M3	G	G	N	E	G-E	N
Miravis Prime	pydiflumetofen + fludioxonil	M for pyd M for flu	7+12	–	E	E	–	labeled	E
Merivon	fluxapyroxad + pyraclostrobin	M for flu H for pyr	7+11	–	–	–	–	–	labeled
Mettle	tetraconazole	M	3	–	E	–	–	–	G-E
Nutrol	mono potassium phosphate	L	M	–	–	–	–	–	F
Oils: Sun Ultra-Fine Oil JMS Stylet-Oil, Pure Spray Green, Safe-T-Side, etc.		L	M	–	–	–	–	–	G
Oxidate	hydrogen peroxide	L	M	–	–	–	–	–	F
Ph-D, OSO	polyoxin D	M	19	–	–	labeled	–	–	labeled
Pristine[1]	boscalid plus pyraclostrobin[1]	H+H	11+7	G	G-E	Var	Var	labeled	E
Procure, Viticure	triflumizole	M	3	–	–	–	–	–	G
Prolivo	pyriofenone	M	50	–	–	–	–	–	labeled
ProPhyt, Phostrol, Agri-Fos, Fosphite, Fungi-Phite	phosphorous acid (phosphite)	L	P07	–	–	–	G	F	–
Quadris Top	azoxystrobin + difenoconazole	M-H	3+11	G	E	Var	Var	F-G	G-E
Quintec	quinoxyfen	M	13	–	P	–	–	–	G-E (var)
Rally[2]	myclobutanil[2]	M	3	G	E	–	N	P	G[10]
Ranman 400SC	cyazofamid	M-H	21	–	–	–	G-E	–	–
Reason[1]	fenamidone	H	11	–	–	–	P-E (var)	–	–

Table 3.2 - Relative Effectiveness of Selected Fungicides in Grapes (continued)

(E=excellent; G=good; F=fair; P=poor; N=none; – =information lacking or not registered; Var=variable depending on presence of resistance)

Fungicides Trade Name	Fungicides Common Name	Resistance Risk	Mode of Action Group	Anthracnose	Black rot	Botrytis bunch rot	Downy Mildew	Phomopsis cane/leaf spot	Powdery Mildew
Revus[11]	mandipropamid	M	40	–	–	–	G-E[11]	–	–
Revus Top[11]	difenoconazole + mandipropamid	M	3+40	–	E	–	G-E[11]	–	E
Ridomil Gold MZ[6]	mefenoxam + mancozeb[6]	H for mefenoxam	4+M3	F	F	–	E	F	–
Ridomil Gold/Copper[6]	mefenoxam + copper[6]	H for mefenoxam	4+M1	–	F	P	E	F	F
Rovral[5], Meteor[5]	iprodione[5]	M	2	–	P	G-Var	–	N	N
Rhyme	flutriafol	M	3	–	E	–	–	–	G[10]
Scala	pyrimethanil	M	9	–	–	G-E	–	–	P?
Sovran[1]	kresoxim methyl[1]	H	11	G	E	Var	F-Var	F-G	Var
Sulfur, Various[7]	sulfur[7]	L	M2	–	N	N	N	–	G
Switch	cyprodinil + fludioxonil	M	9+12	–	–	E	–	–	–
Tanos	cymoxanil + famoxadone	M	11+27	–	–	–	Var	–	–
tebuconazole (Orius, Tebuzol, etc.)	tebuconazole	M	3	–	E	–	–	–	G[10]
TopGuard EQ	flutriafol + azoxystrobin	M for flu H for azo	3+11		G	E	Var	Var	F-G
Topsin MWSB	thiophanate methyl	H	1	F-G	F	P-G[9]	N	F	P-G[9]
Torino	cyflufenamid	M	U6						E
Trionic 4SC	triflumizole	M	3	–	–	–	–	–	G-E
Vangard	cyprodinil	M	9	–	–	G-E	–	–	–
Viathon	potassium phosphite plus tebuconazole	3 plus P07	–	E	–	G	P	G	
Vivando	metrafenone	M	50	–	–	–	–	–	E
Ziram 76DF, XCEL	ziram	L	M3	G	G	–	F	G	–
Zampro	ametoctradin + dimethomorph	M	45+40	–	–	–	E[11]	–	–

[1] Do not use Abound (azoxystrobin), Sovran (kresoxim methyl), Flint (trifloxystrobin), Reason (fenamidone) or Pristine (pyraclostrobin plus boscalid) continuously. Rotate with other fungicide groups as per label. Powdery and downy mildew as well as Botrytis strains with resistance to these strobilurins have been found in many locations in Virginia, and can cause control failure! It is recommended that strobilurins be tank mixed with sulfur or another anti-powdery mildew material, and also with another anti-downy-mildew material. Pristine contains a strobilurin and also boscalid (group 7), which has separate activity against powdery mildew but not against downy mildew. Botrytis strains with resistance to both ingredients in Pristine are common in Virginia. Abound can cause serious injury to some apple cultivars. Avoid drift to apples and do not spray apples with equipment containing Abound residues. Pristine or Flint should not be used on Concord grapes. Sovran can injure some cherry cultivars.

[2] Rally, tebuconazole and other Group-3 materials can control black rot after infection has occurred. For effective control, infection periods must be monitored and fungicide applied within 3 days after the start of an infection period. Application of these materials and Mettle, Inspire Super, Revus Top, and Procure to sporulating lesions of powdery mildew is best avoided to prevent selection of resistant strains of the pathogen. Continuous heavy use of this group of fungicides may entail the risk of selecting resistant strains of disease-causing fungi.

[3] Bordeaux mixture is a mixture of copper sulfate and hydrated lime; it may be purchased prepacked or mixed fresh by the grower. See also note8 for fixed copper fungicides.

[4] Trade names for mancozeb include Manzate 200, Manzate 200 DF, Dithane M45, Dithane F45, Dithane DF,and Penncozeb. Gavel is mancozeb + zoxamide.

[5] Continuous use of Rovral or Meteor, Elevate, and Vangard or Scala entails the risk of selecting strains of Botrytis with resistance to these fungicides. Strains of Botrytis with reduced sensitivity to all these products have been found in some Virginia vineyards. Do not routinely apply more than two sprays of either of these groups per season.

[6] Ridomil Gold MZ contains 10% metalaxyl plus 48% mancozeb; Ridomil Gold/Copper contains 10% metalaxyl plus 60% copper hydroxide (see also note8).

[7] Sulfur is very phytotoxic on the foliage of Concord, red-fruited French-American hybrids and several other, mainly American (Labrusca-type), varieties. Even tolerant varieties may be injured when temperatures over 85°F occur during or immediately following an application.

[8] Fixed copper compounds that are registered for use on grapes include Kocide 101, BCS-Copper Fungicide, Ten-Cop 5E, copper oxychloride sulfate (C-O-C-S), and many other compounds and formulations. The main drawback of copper fungicides is the potential for severe injury to grape foliage, depending on variety and weather conditions, and for reduced vine vigor and yields even in the absence of visible foliar injury. Cool wet weather generally makes copper toxicity worse. Phytotoxicity can be lessened by adding spray lime. One should be very careful mixing other pesticides with preparations containing lime: many of these combinations are incompatible. Excessive use of copper within 30 days of harvest may interfere with wine making. On the plus side, copper fungicides are usually cheap and may provide longer-lasting activity than others such as ferbam and captan. If growers wish to use copper materials, they should try them first on a limited acreage of each variety before treating the entire planting.

[9] Continuous use of Topsin M entails the risk of selecting Topsin M-resistant strains of disease-causing fungi. Topsin M-resistant Botrytis and powdery mildew have been found in many Virginia vineyards.

[10] In some areas of the eastern U.S., including Virginia, Rally, Orius, Mettle, and tebuconazole, and to a lesser extent Procure, have lost some of their efficacy against grape powdery mildew.

[11] Downy mildew with resistance to mandipropamid (Revus and Revus Top) and dimethomorph (Forum) has been identified in several areas in Virginia.

Table 3.3 - Relative Effectiveness of Selected Insecticides/Acaricides in Grapes

Insects and mites	Insecticides/Acaricides and Ratings																																				
	Acramite	Actara	Admire Pro	Agri-Mek	Altacor	Applaud	Assail	Avaunt	Azera	Baythroid	*Bt galleriae*	*Bt kurstaki*	Belay	Brigade	Danitol	Delegate	Diazinon	Entrust	Envidor	Imidan	Intrepid	Isomate GRB	Lannate	Malathion	Movento	Neemix/Trilogy	Nexter	Onager	PyGanic	Sevin	Sytlet Oil	Surround	Vendex	Venom	Zeal
Brown Marmorated Stink bug	–	G	–	–	–	–	G	–	F	–	–	–	G	G	G	–	–	–	–	N	–	–	F	G	–	–	–	–	G	P	–	–	–	G	–
Cutworms	–	–	–	–	G	–	–	–	–	G	–	G	–	G	G	G	–	G	–	–	G	–	–	–	–	–	–	–	–	G	–	–	–	–	–
Drosophila flies	–	–	–	–	–	–	–	–	G	–	–	–	–	–	–	–	E	E	–	–	–	–	–	E	–	–	–	–	G	–	–	–	–	–	–
Grape berry moth	–	–	–	–	E	–	–	G	–	E	–	F	G	E	E	G	G	G	–	G	E	–	G	–	–	–	–	–	–	G	–	–	–	–	–
Grape cane girdler	–	–	–	–	–	–	–	–	–	E	–	–	–	–	E	–	–	–	–	G	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Grape flea beetle	–	–	–	–	–	–	–	–	–	E	–	–	–	–	E	–	–	–	–	G	–	–	–	–	–	–	–	–	–	E	–	–	–	–	–
Grape leafhopper	–	G	E	–	–	E	E	–	–	E	–	–	G	E	E	–	G	–	–	G	–	–	G	G	–	–	G	–	–	E	–	G	–	–	–
Grape rootworm	–	–	–	–	–	–	–	–	–	–	G	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	G	–	–	–	–	–
Grape root borer	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	E	–	–	–	–	–	–	–	–	–	–	–	–	–
Grape scale	–	–	G	–	–	E	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	G	–	–	–	–	–	–	–	–	–	–
Japanese beetle	–	G	–	–	–	–	G	G	–	–	G	–	G	–	E	–	–	–	–	–	–	–	–	G	–	G	–	–	–	G	–	E	–	–	–
June beetle	–	G	–	–	–	–	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–	G	–	–	–	–	–	G	–	–	–	–	–
Mealybugs	–	G	G	–	–	E	G	–	–	G	–	–	G	–	–	–	–	–	–	–	–	–	–	–	G	–	–	–	–	–	–	–	–	G	–
Phylloxera (Leaf form)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	E	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Redbanded leafroller	–	–	–	–	E	–	–	–	–	–	–	G	–	–	–	E	–	E	–	G	E	–	–	–	–	–	–	–	–	–	E	–	–	–	–
Rose chafer	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	G	–	–	–	–	–
Sharpshooter	–	–	G	–	–	–	G	–	–	–	–	–	G	G	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	G	–
Spider mites	G	–	–	G	–	–	–	–	–	–	–	–	–	–	–	–	F	–	E	–	–	–	–	F	–	–	E	E	–	–	G	–	G	–	G
Spotted lanternfly	–	E	G	–	–	–	–	–	–	E	–	–	–	E	E	–	–	–	–	G	–	–	–	G	–	–	–	–	–	G	–	–	–	E	–
Spotted-wing drosophila	–	–	–	–	–	–	–	–	F	E	–	–	–	–	E	E	–	G	–	E	–	–	–	G	–	–	–	–	F	G	–	–	–	–	–
Wasp	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	G	–	–	–	–	–

(E=excellent; G=good; F=fair; N=none; – = information lacking or not registered)

Table 3.4 - Chemical Names, Re-entry Times, and Days to Harvest[1]			
Chemical (Other name)	**Manufacturers**	**Restricted Entry Interval**	**Days to Harvest**
Abound (azoxystrobin)	Syngenta	4 hours	14
Acramite (bifenazate)	Uniroyal	5 days (cane turning, tying, girdling) 12 hours (other activities)	14
Actara (thiamethoxam)	Syngenta	12 hours	5
Admire Pro (imidacloprid)	Bayer CropScience	12 hours	30 (soil), 0 (foliar)
Agri-Mek (abamectin)	Syngenta	12 hours 4 days (grape girdling, cane turning and tying)	28
Aliette WDG (fosetyl Al)	Bayer CropScience	24 hours	15
Altacor (chlorantraniliprole)	DuPont	4 hours	14
Applaud (buprofezin)	Nichino America	12 hours	7 (12 oz), 30 (24 oz)
Aprovia (benzovindiflupyr)	Syngenta	12 hours	21
Aprovia Top (benzovindiflupyr plus difenoconazole)	Syngenta	12 hours	21
Assail (acetamiprid)	United Phosphorus	12 hours	7
Avaunt (indoxacarb)	DuPont	12 hours	7
Aza-Direct (azadirachtin)	Gowan	4 hours	0
Azera (azadirachtin, pyrethrins)	MGK	12 hours	0
Baythroid (cyfluthrin)	Bayer CropScience	12 hours	3
beetleGone *(B.t. galleriae)*	Phyllom Bioproducts	4 hours	0
Belay (clothianidin)	Valent	12 hours	0
BLAD (Fracture, ProBlad Verde, etc.)	FMC, SymAgro	4 hours	1
BoteGHA ES (*Beauveria bassiana*)	LAM Intermat	4 hours	0
Brigade (bifenthrin)	FMC	12 hours	30
Bordeaux mixture (copper sulfate + hydrated lime)	Instructions for making Bordeaux mix available at https://ipm.ucanr.edu/PMG/PESTNOTES/pn7481.html		0
Captan (Captan 4L, Captec, various)	various	2-4 days (see label)	0
Cevya	BSAF	12 hours	14
copper, fixed	various	4-28 hours	0
Danitol (fenpropathrin)	Valent	24 hours	21
Delegate (spinetoram)	Corteva Agriscience	4 hours	7
Dipel *(B.t. kurstaki)*	Abbott	4 hours	0
Elevate 50WDG (fenhexamid)	UPL	12 hours	0
Endura (boscalid)	BASF	12 hours	14
Entrust (spinosad)	Corteva Agriscience	4 hours	7
Envidor (spirodiclofen)	Bayer CropScience	12 hours	14
Flint Extra (trifloxystrobin)	Bayer CropScience	12 hours	14
Forum (dimethomorph)	BASF	12 hours	14
Gatten (flutainil)	Nichino-America	12 hours	14
Gavel (zoxamide + mancozeb)	Gowan	48 hours	66
Imidan (phosmet)	Gowan	14 days	14
Inspire Super (difenoconazole +cyprodinil)	Syngenta	12 hours	14
Intrepid (methoxyfenozide)	Corteva Agriscience	4 hours	30
Intuity (mandestrobin)	Valent	12 hours	10
JMS Stylet-Oil	JMS Flower Farms	4 hours	0
Kenja (isofetamid)	Summit Agro	12 hours	14
Knack (pyriproxyfen)	Valent	12 hours	21

Table 3.4 - Chemical Names, Re-entry Times, and Days to Harvest[1] (continued)

Chemical (Other name)	Manufacturers	Restricted Entry Interval	Days to Harvest
Leverage 360 (imidacloprid + beta-cyflutrin)	Bayer	12 hours	1
LifeGard (Bacillus mycoides)	Certis	4 hours	0
Luna Experience (fluopyram + tetraconazole)	Bayer	12 hours (5 days for cane work)	14
Luna Sensation (fluopyram + trifloxystrobin)	Bayer	12 hours	14
malathion (Malathion, Rainshield)	Gowan	24 hours (72 h for girdling and tying)	3
mancozeb (Dithane M45, Dithane DF, Rainshield, Manzate 200, Manzate Prostick, Penncozeb)	various	24 hours	66
Merivon (fluxapyroxad+pyraclostrobin)	BASF	12 hours (5 days for cane tying and leaf pulling in grapes)	14
Meteor (iprodione)	UPL	48 hours	7
Mettle 125ME (tetraconazole)	Gowan	12 hours	14
Miravis Prime (pydiflumetofen + fludioxonil)	Syngenta	12 hours	14
Movento (spirotetramat)	Bayer CropScience	24 hours	7
Mustang Max (zeta-cypermethrin)	FMC	12 hours	1
Nealta (cyflumetofen)	BASF	12 hours	14
Neemix (azadirachtin)	Certis	12 hours	0
Nexter (pyridaben)	Gowan	12 hours	7
Onager (hexythiazox)	Gowan	12 hours	7
Orius 20AQ (tebuconazole)	ADAMA	12 hours	14
Oxidate 5.0 (hydrogen peroxide)	BioSafe Systems	1 hour	0
PFR-97 (Isaria fumosoroasea Apopka 97)	Certis	4 hours	0
Phoshorous acid or phospite (Fosphite, K-phite, Phostrol, Prophyt, Rampart, etc.)	Nufarm, Loveland Products, JH Biotech, Helena and others	4 hours	0
Polyoxin D (Ph-D, Oso 5%SC)	UPL, Certis	4 hours	0
Portal (fenproximate)	Nichino America	12 hours	14
Potassium bicarbonate (Armicarb, Kaligreen, Milstop, etc.)	various	4 hours	0-1 (see label)
Pounce (permethrin)	FMC	12 hours	21
Pristine (boscalid + pyraclostrobin)	BASF	12 hours (5 days for cane work)	14
Procure 480SC, Viticure (triflumizole)	UPL	12 hours (24 h for girdling)	7
Prolivo 300SC (pyriofenone)	Summit-Agro USA	4 hours	0
Purespray Green (oil)	Petro-Canada	4 hours	0
PyGanic (pyrethrins)	MGK	12 hours	0
Quadris Top (azoxystrobin + difenoconazole)	Syngenta	12 hours	14
Quintec (quinoxyfen)	Gowan	12 hours	21
Rally 40WSP or 40W (myclobutanil)	Corteva Agriscience	24 hours	14
Ranman 400SC (cyazofamid)	SummitAgro USA	12 hours	30
Reason 500SC (fenamidone)	Bayer CropScience	12 hours	30
Rendition (peroxyacetic acid)	Certis	when dry	0
Revus (mandipropamid)	Syngenta	4 hours	14
Revus Top (difenoconazole + mandipropamid)	Syngenta	12 hours	14
Ridomil Gold Copper (mefenoxam & copper)	Syngenta	48 hours	42

Table 3.4 - Chemical Names, Re-entry Times, and Days to Harvest[1] (continued)

Chemical (Other name)	Manufacturers	Restricted Entry Interval	Days to Harvest
Ridomil Gold MZ WG (mefenoxam + manocozeb)	Syngenta	48 hours	66
Rhyme (flutriafol)	FMC	12 hours (5 days for girdling or turning)	14
Rovral (iprodione)	FMC	48 hours	7
Scala (pyrimethanil)	Bayer CropScience	12 hours	7
Scorpion (dinotefuran)	Gowan	12 hours	1 (foliar) 28 (soil)
Seduce (spinosad bait)	Certis	4 hours	7
Sevin (carbaryl)	Aventis	12 hours	7
Sniper (bifenthrin)	Loveland Products	12 hours	30
Sovran (kresoxim methyl)	BASF	12 hours	14
Sulfur (Kumulus, sulfur, Microthiol, liquid sulfur, wettable sulfur, etc.)	various	24 hours	0
Surround (Kaolin)	BASF	4 hours	02
Switch (cyprodinil + fludioxonil)	Syngenta	12 hours	7
Tanos (cymoxanil + famoxadone)	Corteva	12 hours	30
tebuconazole (various)	various	12 hours	14 (see label)
Tombstone (cyfluthrin)	Loveland	12 hours	3
TopGuard EQ (flutriafol+azoxystrobin)	FMC	12 hours (5 days for girdling or turning)	14
Topsin M WSB (thiophanate methyl)	UPL	2-7 days (see label)	7-14 (see label)
Torino (cyflufenamid)	Gowan	4 hours	3
Trilogy (clarified hydrophobic extract of neem oil)	Certis	4 hours	0
Trionic 4SC (triflumizole)	UPL	12 hours (24h for girdling)	7
Tri-Tek	Brandt	4 hours	0
Vangard (cyprodinil)	Syngenta	12 hours	7
Vendex (fenbutatin oxide)	DuPont	48 hours	28
Venom (dinotefuran)	Valent	12 hours	1 (foliar) 28 (soil)
Viathon (potassium phosphite + tebuconazole)	Helena Chemicals	12 hours	14
Vivando (metrafenone)	BASF	12 hours	14
Zampro (ametoctradin + dimethomorph)	BASF	12 hours	14
Zeal (etoxazole)	Valent	12 hours	14
Ziram 76DF	UPL	48 hours	21

[1]This information is given as a guideline only. Always read the label because there have been many changes in recent years, and more changes are expected in the future.

[2]See label cautions regarding potential effects on harvest parameters.

Grapes: Weed Control in Vineyards

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Table 3.5 - Herbicides Labeled for Use in Grapes

For preemergence herbicides, use lower rates on sandy soils and higher rates on clay soils. Do not disturb soil after a preemergence herbicide application. Tank mixes of certain preemergence and postemergence herbicides can be made to control existing vegetation and control weeds germinating from seed. Check compatibility of tank mixes prior to application.

Pest	Chemical and Formulation Rate per Acre	Timing and Remarks
Preemergence directed under vines		
Many annual weeds	indaziflam 0.045-0.065 lb (Alion 3.5-5.0 fl oz)	Vines must be established at least 3 years. Do not use in soils high in sand or gravel. Do not apply within 14 days of harvest.
Most annuals, fescue, quackgrass, dandelions, dock, and other herbaceous perennials	dichlobenil 4.0-6.0 lb (Casoron 4G 100.0-150.0 lb or 2.3-3.4 lb/1000 sq ft)	Apply dry granules in late winter or early spring. Shallow incorporation may improve weed control. Do not apply within 4 weeks after transplanting. Short residual activity, regrowth usually occurs in late summer. Do not graze livestock in treated areas. Do not make an application within 1 month of harvest.
Most annuals and some perennials	diuron 1.6-2.4 lb (Karmex 80DF 2.0-3.0 lb)	Apply a single application/year in early spring to a weed free surface or include an appropriate postemergence herbicide. Use in vineyards established at least 3 years. Do not replant to any crop within 2 years after application.
Annual grasses and broadleaf weeds	flumioxazin 0.19-0.375 lb (Chateau EZ 6.0-12.0 fl oz)	Preemergence and early postemergence action. Apply as a directed spray to dormant vines or use shields if applications are made after flowering to prevent spray contact with grape foliage or fruit. Do not apply to vines established less than 2 years unless protected from spray contact using nonporous wraps, grow tubes, or waxed containers. Apply prior to weed germination or to small emerged weed seedlings. Combine with a labeled postemergence herbicide such as glufosinate for control of larger annual weeds or perennials.
Annual broadleaf weeds	isoxaben 0.5-1.0 lb (Trellis SC 16-31 fl oz)	Do not apply within 60 days of harvest. Apply after soil has settled following transplanting. Combine with a preemergence herbicide for annual grass control, such as oryzalin. Add a postemergence herbicide to control emerged weeds.
Many annual weeds	simazine 2.0-4.0 lb (Princep Caliber 90 2.2-4.4 lb or 4L 2.0-4.0 qt)	Apply a single application per year in the fall or spring to a weed free surface or include an appropriate postemergence herbicide. Vineyards must be established at least 3 years.
Annual grasses and certain annual broadleaf weeds	oryzalin 2.0-6.0 lb (Orzalin 4AS, Surflan 4AS 2.0-6.0 qt	May be used in non-bearing and bearing vineyards. Areas to be treated should be free of weeds or include an appropriate postemergence herbicide. Remove or thoroughly mix trash into the soil before application. Use lower rate for short-term control (4 months) and higher rate for long-term control (6-8 months). Apply as a directed spray and avoid contact with leaves, branches, or trunks of vines. Do not apply to newly transplanted vineyards until soil has settled and there are no cracks present. Make only one application/growing season. May be tank-mixed with diuron or simazine to control many broadleaf weeds. Observe precautions and time limitations for diuron or simazine. Oryzalin is currently unavailable so consider other options.
Annual broadleaf weeds and certain annual grasses	oxyfluorfen 0.5-2.0 lb (Goal 2XL 2.0-8.0 pt, GoalTender 1.0-4.0 pt)	Dormant application only. Will control certain small seedling weeds plus provide soil residual control of annual broadleaf weeds and certain annual grasses. Combine with an annual grass herbicide for broader-spectrum control.
Annual broadleaf weeds and certain annual grasses	rimsulfuron 0.063 lb (Matrix FNV 4 oz/A)	Preemergence and postemergence control of certain annual weeds. Combine with other preemergence herbicides such as oryzalin or pendimethalin and with other postemergence herbicides (including glyphosate and glufosinate) for broader spectrum control. Grapevines need to be in the ground at least one year.
Annual and perennial grasses and certain broadleaf weeds	pronamide 1.0-4.0 lb (Kerb 50W 2.0-8.0 lb, Kerb SC 2.5-9.5 pt)	Apply in the fall after fruit harvest but prior to leaf drop and soil freeze-up. Do not apply to vines less than one year old. RESTRICTED USE PESTICIDE.

Table 3.5 - Herbicides Labeled for Use in Grapes (continued)

For preemergence herbicides, use lower rates on sandy soils and higher rates on clay soils. Do not disturb soil after a preemergence herbicide application. Tank mixes of certain preemergence and postemergence herbicides can be made to control existing vegetation and control weeds germinating from seed. Check compatibility of tank mixes prior to application.

Pest	Chemical and Formulation Rate per Acre	Timing and Remarks
Preemergence directed under vines		
Annual grasses and certain annual broadleaf weeds	pendimethalin 2.0-4.0 lb (Prowl 3.3EC 2.4-4.8 qt, Prowl H20 3.2-6.3 qt)	Prowl EC - use on nonbearing plantings only. Prowl H2O - do not apply within 21 days of harvest. Allow soil to settle around vines before application. Apply only to dormant plants. Do not apply after buds have started to swell. Do not apply overtop vines.
Annual grasses, certain annual broadleaf weeds and suppression of yellow nutsedge	norflurazon 1.0-4.0 lb (Solicam 1.25-5.0 lb)	Apply prior to budbreak. Vines must be established at least 2 years. Combine with simazine or diuron for improved broadleaf weed control in vineyards over 3 years old. Apply to weed-free areas or combine with an appropriate postemergence herbicide.
Annual grasses and certain annual broadleaf weeds	napropamide 4.0 lb (Devrinol 50DF 8.0 lb)	Apply to the soil surface in the fall through early spring prior to weed emergence. Do not apply to frozen ground. Does not control existing weeds, but may be used with an appropriate postemergence herbicide to kill existing vegetation or with simazine to broaden the spectrum of weeds controlled. Use as a directed spray and avoid contact with fruit or foliage. Do not apply when fruit is on the ground during the harvest period. Do not graze areas. Make only one application/season. Must be incorporated within 24 hours by rainfall, irrigation, or mechanical means for optimum results.
Certain annual broadleaf and grass weeds and yellow nutsedge	sulfentrazone 0.25-0.375 lb (Zeus XC 8-12 fl oz)	Vines must be established at least 3 years. Do not apply more than 12 fl oz Zeus XC per acre per year. Do not allow spray to contact grape vines. Use a shielded spray if applying after budbreak. Add a herbicide such as oryzalin for improved annual grass control and add a postemergence herbicide if weeds are present. Provides postemergence control of yellow nutsedge. Preharvest interval PHI is 3 days.
	sulfentrazone + carfentrazone (Zeus Prime XC 7.7-15.2 fl oz)	Vines must be established at least 2 years. Avoid contact with green bark by wrapping trunk with a grow tube or wax container. Apply using a hooded sprayer. Provides postemergence control of yellow nutsedge and small broadleaf seedlings. Can be applied with other preemergence or postemergence herbicides for broader spectrum control.
Postemergence directed under vines		
Yellow nutsedge and certain broadleaf weeds	bentazon 0.75-1.0 lb (Basagran 1.2-2 pt/A + 1 qt/A crop oil concentrate)	Nonbearing only - allow at least one year between application and harvest. Apply when yellow nutsedge and annual broadleaf weeds are small and actively growing.
Annual and perennial grasses	fluazifop-butyl 0.25-0.375 lb ai (Fusilade DX 16.0-24.0 fl oz + 2.0 pt crop oil concentrate or 1/2 pt nonionic surfactant/25 gal)	Do not apply within 50 days of harvest. Apply as directed spray to actively growing grasses. Treat annual grasses before tillering for optimum results. Perennial grasses may need repeat treatment for total control. For spot treatment use 0.75 fl oz Fusilade DX plus 1.5 oz crop oil concentrate or 0.5 fl oz nonionic substance/gal. Ensure thorough coverage of weed foliage.
	clethodim 0.09-0.12 lb ai (Select 2EC 6.0-8.0 fl oz or Select Max 9.0-16.0 fl oz + nonionic surfactant at 0.25% by volume)	Use on nonbearing plantings only (at least 1 yr before harvest). Postemergence control of actively-growing grasses. For spot treatment, apply 0.33-0.65 fl oz/gal Select 2EC solution or 0.44-0.88 fl oz Select Max with 0.33 fl oz nonionic surfactant.
	sethoxydim 0.28-0.47 lb ai (Poast 1.5E 1.5-2.5 pt + 1.0 qt crop oil concentrate)	Do not apply within 50 days of harvest. Apply in a minimum of 10 GPA of water. Apply the lower rate to annual grasses up to 6 inches tall and apply higher rate to annual grasses up to 12 inches tall and to perennial grasses. For spot treatment use 1.25-1.9 fl oz Poast plus 1.25 fl oz crop oil concentrate/gal. Provides postemergence grass control only.
Annual weeds and certain perennials	glufosinate 0.88-1.5 lb (Rely 280 48.0-82.0 fl oz)	Apply as a directed spray to emerged weeds. Do not allow spray to contact desired foliage or green bark. Do not apply within 14 days of harvest. For spot treatment, mix 1.7 fl oz Rely 280/gal of water. Glufosinate has also been sold under the trade names Cheetah, Forfeit 280, Glufosinate 280, and Reckon 280SL, among others, for use in grapes. Check the label to determine the current registration status.

Table 3.5 - Herbicides Labeled for Use in Grapes (continued)

For preemergence herbicides, use lower rates on sandy soils and higher rates on clay soils. Do not disturb soil after a preemergence herbicide application. Tank mixes of certain preemergence and postemergence herbicides can be made to control existing vegetation and control weeds germinating from seed. Check compatibility of tank mixes prior to application.

Pest	Chemical and Formulation Rate per Acre	Timing and Remarks
Postemergence directed under vines		
Annual and perennial grasses and broadleaf weeds	glyphosate (various formulations, see label for application rates)	Use as a directed spray in established vineyards or for site preparation prior to transplanting new vines. Do not apply when green shoots or canes or foliage are in the spray zone. Do not allow spray drift or mist to contact foilage, green bark, suckers, or vines. Spray contact, other than with mature bark on the main trunk, can result in serious localized or systemic injury. Do not treat within 14 days of harvest. Apply prior to the end of the bloom stage or apply with shielded eqiupment to avoid crop damage.
All weeds, general contact	paraquat 0.63-1.0 lb (Gramoxone SL 2.0 2.5-4.0 pt/A or Gramoxone SL 3.0 1.7-2.7 pt/A plus a nonionic surfactant at 2.0 pt/100 gallons)	Apply as a directed spray in at least 30 gal of water/A. Most effective on small, actively growing weeds. Repeat applications will be needed to control perennial weeds. Do not allow spray to contact foliage, fruit, or stems. Corrosive to aluminum. Do not mix or store in aluminum tanks or in systems with aluminum fittings. Paraquat is toxic and a restricted use pesticide - handle with caution. RESTRICTED USE PESTICIDE.
	diquat (Diquat 2L 1.5-2 pt/A plus a nonionic surfactant at at 0.25-0.5% V/V)	Apply as a directed spray, keeping the spray off the grape vines. Use only on nonbearing grapes. Do not harvest within 12 months of application. Contract control of annual weeds and suppression of perennials.
Annual broadleaf weeds	carfentrazone-ethyl 0.016-0.031 lb (Aim 2EC, 1.9EW 1.0-2.0 fl oz/A)	Apply post-directed using a hooded sprayer for control of small annual broadleaf weeds less than 4 inches tall. Add a crop-oil concentrate or nonionic surfactant. Can be tank mixed with other herbicides for broader-spectrum weed control. Can also be used for control of suckers—see label for rates and directions for this use.
	pyraflufen-ethyl 0.0027-0.0053 lb (Venue 2-4 fl oz/A + Crop oil concentrate at 1% v/v)	Nonselective contact control of small annual broadleaf weeds. Can be tank-mixed with other herbicides for broader-spectrum weed control. Can also be used for sucker management. Avoid contact with green bark or foliage of grapes. Use nonporous wraps, grow tubes or wax containers to keep Venue off vines less than 1 year in the ground.

Table 3.6 - Relative Effectiveness of Selected Preemergence Herbicides and Ratings in Grapes

Weeds	Indaziflam	Dichlobenil	Diuron	Flumioxazin	Isoxaben	Napropamide	Oryzalin	Oxyfluorfen	Pronamide1	Rimsulfuron	Simazine	Sulfentrazone	Pendimethalin	Norflurazon
Annual Grasses														
Barnyardgrass	-	G	G	-	-	G	G	F	F	G	F-G	F	G	E
Cheat	-	G	G	-	-	G	G	-	G	-	G	F	-	G
Crabgrasses	E	G	G	F-G	P	E	E	F	G	F	F-G	F	E	E
Fall panicum	-	F	F	-	-	G	G	-	F	F	F-G	F	G	E
Foxtails	G	G	G	F-G	-	E	E	F	G	G	G	F	G	F
Goosegrass	G	F	G	F-G	-	E	E	F	G	P	E	F	G	G
Johnsongrass (seedling)	-	F	G	P-F	-	P	F-G	-	-	-	N	F	G	G
Annual Broadleaf Weeds														
Annual fleabane	-	E	G	-	-	G	G	G	F	-	G	-	-	F
Annual morningglory	P	G	G	G	p	N	P-F	F	F	F	E	G	P	F
Black nightshade	-	G	G	G	-	N	P-F	G	F	P	E	G	P	F

Table 3.6 - Relative Effectiveness of Selected Preemergence Herbicides and Ratings in Grapes (continued)

Weeds	Indaziflam	Dichlobenil	Diuron	Flumioxazin	Isoxaben	Napropamide	Oryzalin	xyfluorfen	Pronamide1	Rimsulfuron	Simazine	Sulfentrazone	Pendimethalin	Norflurazon
Annual Broadleaf Weeds														
Carpetweed	E	G	E	-	-	G	G	G	G	-	E	G	G	G
Common chickweed	G	G	E	F-G	E	-	G	G	G	-	E	-	G	G
Common lambsquarters	F-G	G	E	E	F	F-G	G	G	F	F	E	G	F	G
Common ragweed	F-G	G	E	E	G	P	F	F	E	P	N	P	F	-
Hairy galinsoga	-	G	E	G	G	G	G	G	-	-	E	-	N	-
Henbit	E	G	E	-	G	F	P	G	G	-	E	F	G	-
Horseweed	-	G	G	G	F	P	F	F	P	G	E	-	P	G
Knotweed	-	G	G	-	-	G	G	G	E	G	E	-	-	F
Mustards	-	G	G	-	-	P	P-F	G	G	-	G	-	-	F
Pennsylvania smartweed	-	G	G	-	G	P	P-F	G	-	P	E	-	-	-
Pigweeds	-	G	E	E	G	G	G	G	N	G	E	G	F	F
Prickly lettuce	-	G	G	G	-	G	F	G	-	-	E	G	-	-
Prickly sida	-	F-G	G	E	-	N	P-F	G	N	-	G	-	-	P
Purslane	-	G	E	-	G	G	G	G	-	F	E	-	F	G
Shepherds' purse	-	G	G	-	-	F	G	G	G	-	E	G	N	G
Speedwells	-	-	-	-	-	-	-	-	P	-	-	-	-	-
Velvetleaf	-	-	F	G	F	N	P-F	G	P	F	G	-	G	-
Virginia pepperweed	-	G	G	-	-	F	G	-	P	-	E	-	-	G
Yellow rocket	-	G	P	-	-	N	N	-	P-F	-	P	-	N	F
Perennial Grasses And Sedges														
Fescues	-	G	F	-	N	N	N	N	G	-	P	N	N	F
Johnsongrass (rhizome)	-	-	P	N	N	N	N	N	P	-	N	-	N	P
Nimblewill	-	-	P	-	N	N	N	N	P	-	P	-	N	F
Orchardgrass	-	G	P-F	-	N	N	N	N	G	-	P	-	N	F
Quackgrass	-	G	G	-	N	N	N	N	G	-	P-F	-	N	P
Yellow nutsedge	N	P-F	P	N	N	N	N	N	N	F	N	F	N	P
Purpletop, redtop	-	-	P	-	N	N	N	N	-	-	N	-	N	F
Dallisgrass	-	-	F	-	N	N	N	N	-	-	N	N	N	P
Bermudagrass	N	N	N	N	N	N	N	N	P	N	N	N	N	P
Perennial Broadleaf Weeds														
Broadleaf plantain	-	G	P-F	-	N	N	N	N	F	-	G	-	N	P
Buckhorn plantain	-	G	P-F	-	N	N	N	N	F	-	G	-	N	P
Canada thistle	-	P-F	N	-	N	N	N	N	-	-	N	-	N	N
Chicory	-	G	G	-	N	N	N	N	-	-	P-F	-	N	N
Common dandelion	-	E	P-F	-	N	N	N	N	P	-	P-F	-	N	N
Common mallow	-	G	F	-	N	N	N	N	-	-	N	-	N	N
Common milkweed	-	-	N	-	N	N	N	N	-	-	N	-	N	N
Common yarrow	-	-	N	-	N	N	N	N	-	-	-	-	N	N
Docks (broadleaf, curly)	-	G	F	-	N	N	N	N	F	-	N	-	N	N
Goldenrod	-	F-G	-	-	N	N	N	N	-	-	N	-	N	N
Ground ivy	-	E	N	-	N	N	N	N	-	-	N	-	N	N

Table 3.6 - Relative Effectiveness of Selected Preemergence Herbicides and Ratings in Grapes (continued)

Weeds	Indaziflam	Dichlobenil	Diuron	Flumioxazin	Isoxaben	Napropamide	Oryzalin	Oxyfluorfen	Pronamide1	Rimsulfuron	Simazine	Sulfentrazone	Pendimethalin	Norflurazon
Perennial Broadleaf Weeds														
Hemp dogbane	-	N	N	-	N	N	N	N	-	-	N	-	N	N
Horsenettle	-	N	P-F	-	N	N	N	N	-	-	P	-	N	N
Mugwort	-	G-E	P	-	N	N	N	N	-	-	N	-	N	N
Red sorrel	-	G	N	-	N	N	-	N	F-G	-	N	-	N	N
Thistles (bull, musk, curl)	-	F	N	-	N	N	N	-	P	-	N	-	N	N
White flowered aster	-	G	N	-	N	N	N	N	-	-	N	-	N	N
Wild carrot	-	G	P	-	N	N	N	-	-	-	N	-	N	F
Wild strawberry	-	G	G	-	N	N	N	-	-	-	N	-	N	P
Yellow woodsorrel (from seed)	-	G	F	-	G	N	N	G	-	-	F	-	N	F
Special Perennial Weed Problems														
Bigroot morning-glory	-	N	N	-	N	N	N	N	N	-	N	-	N	N
Brambles (Rubus spp.)	-	N	N	-	N	N	N	N	N	-	N	-	N	N
Common greenbriar	-	N	N	-	N	N	N	N	N	-	N	-	N	N
Japanese honeysuckle	-	N	N	-	N	N	N	N	N	-	N	-	N	N
Poison ivy	-	N	N	-	N	N	N	N	N	-	N	-	N	N
Virginia creeper	-	N	N	-	N	N	N	N	N	-	N	-	N	N
Wild garlic	-	F	N	-	N	N	N	N	N	-	N	-	N	N

(E=excellent; G=good; F=fair; P=poor; N=none; - = not registered or information lacking)

[1]Designates restricted use pesticide - must be trained and certified as a private applicator to purchase or use these more toxic chemicals in your vineyard. Refer to Publication 456-001 and the pesticide label for safety information. Ask your local Extension agent how to become a certified applicator.

Table 3.7 - Relative Effectiveness of Selected Postemergence Herbicides and Ratings in Grapes

Weeds	Bentazon (Basagran)	Carfentrazone (Aim)	Pyraflufen (Venue)	Clethodim (Select)	Fluazifopbutyl (Fusilade)	Glufosinate (Rely)	Glyphosate (Various)	Paraquat1 (Gramoxone)	Sethoxydim (Poast)
Annual Grasses									
Barnyardgrass	N	N	N	E	E	G	E	E	E
Cheat	N	-	N	-	G	G	E	E	G
Crabgrasses	N	N	N	E	E	G	E	E	E
Fall panicum	N	N	N	E	E	G	E	E	E
Foxtails	N	N	N	E	E	G	E	E	E
Goosegrass	N	N	N	E	E	G	E	E	E
Johnsongrass (seedling)	N	N	N	E	E	G	E	E	E
Annual Broadleaf Weeds									
Annual fleabane	-	-	-	N	N	-	E	E	N
Annual morningglory	P	F	-	N	N	G	E	G	N
Black nightshade	N	G	-	N	N	G	E	G	N
Carpetweed	-	G	-	N	N	-	E	E	N
Common chickweed	-	F	-	N	N	G	E	E	N
Common lambsquarters	G	G	-	N	N	G	E	E	N
Common ragweed	G	P	-	N	N	G	E	E	N
Hairy galinsoga	-	-	-	N	N	-	E	E	N
Henbit	-	G	-	N	N	G	E	E	N

Table 3.7 - Relative Effectiveness of Selected Postemergence Herbicides and Ratings in Grapes (continued)

Weeds	Bentazon (Basagran)	Carfentrazone (Aim)	Pyraflufen (Venue)	Clethodim (Select)	Fluazifopbutyl (Fusilade)	Glufosinate (Rely)	Glyphosate (Various)	Paraquat1 (Gramoxone)	Sethoxydim (Poast)
Annual Broadleaf Weeds									
Horseweed	N	-	-	N	N	G	E	F	N
Knotweed	-	-	-	N	N	-	E	F-G	N
Mustards	-	-	-	N	N	G	E	G	N
Pennsylvania smartweed	G	-	-	N	N	G	E	G	N
Pigweeds	-	G	G	N	N	G	E	G	N
Prickly lettuce	-	-	-	N	N	G	E	G	N
Prickly sida	-	-	-	N	N	G	E	E	N
Purslane	-	-	-	N	N	G	E	G	N
Shepherds' purse	-	-	-	N	N	G	E	F-G	N
Speedwells	-	G	-	N	N	-	E	P	N
Velvetleaf	G	E	-	N	N	G	E	E	N
Virginia pepperweed		-	-	N	N	-	E	G	N
Perennial Grasses And Sedges									
Fescues	N	N	N	-	P	F	E	F	P-F
Johnsongrass (rhizome)	N	N	N	G	G	P	E	P	G
Nimblewill	N	N	N	-	F-G	-	G-E	P	F-G
Orchardgrass	N	N	N	-	F	P	E	F	F
Quackgrass	N	N	N	-	G	P	G	P	G
Yellow nutsedge	F-G	N	N	N	N	F-G	G	P	N
Purpletop, redtop	N	N	N	-	G	-	E	P	G
Dallisgrass	N	N	N	-	G	-	E	P	G
Bermudagrass	N	N	N	G	G	F	G	P	G
Perennial Broadleaf Weeds									
Broadleaf plantain	-	-	-	N	N	F	E	P	N
Buckhorn plantain	-	P	-	N	N	F	E	P	N
Canada thistle	-	-	-	N	N	-	F-G	P	N
Chicory	-	-	-	N	N	-	E	P	N
Common dandelion	-	P	-	N	N	G	E	P	N
Common mallow	-	-	-	N	N	-	E	P	N
Common milkweed	-	-	-	N	N	-	G	P	N
Common yarrow	-	-	-	N	N	-	G	P	N
Docks (broadleaf, curly)	-	P	-	N	N	-	G	P	N
Goldenrod	-	-	-	N	N	-	E	P-F	N
Ground Ivy	-	-	-	N	N	G	G	P-F	N
Hemp dogbane	-	-	-	N	N	P	F	P	N
Horsenettle	-	-	-	N	N	F-G	F-G	P	N
Mugwort	-	-	-	N	N	-	F	P	N
Red sorrel	-	-	-	N	N	G	G	P	N
Thistles (bull, musk, curl)	-	-	-	N	N	-	G	P	N
White flowered aster	-	-	-	N	N	-	E	P-F	N
Wild carrot	-	-	-	N	N	-	E	P	N
Wild strawberry	-	-	-	N	N	-	E	P-F	N
Yellow rocket	-	-	-	N	N	-	E	F	N
Yellow woodsorrel	-	-	-	N	N	G	E	P	N
Special Perennial Weed Problems									
Bigroot morningglory	-	-	-	N	N	-	F-G	P	N
Brambles	-	-	-	N	N	F-G	G	P	N

Table 3.7 - Relative Effectiveness of Selected Postemergence Herbicides and Ratings in Grapes (continued)

Weeds	Bentazon (Basagran)	Carfentrazone (Aim)	Pyraflufen (Venue)	Clethodim (Select)	Fluazifopbutyl (Fusilade)	Glufosinate (Rely)	Glyphosate (Various)	Paraquat1 (Gramoxone)	Sethoxydim (Poast)
Special Perennial Weed Problems									
Common greenbriar	-	-	-	N	N	-	P	P	N
Japanese honeysuckle	-	-	-	N	N	-	F-G	P	N
Poison ivy	-	-	-	N	N	-	G	P	N
Virginia creeper	-	-	-	N	N	-	F-G	P	N
Wild garlic	-	-	-	N	N	G	F	P	N

(E=excellent; G=good; F=fair; P=poor; N=none; - = not registered or information lacking)

[1]Designates restricted use pesticide - must be trained and certified as a private applicator to purchase or use these more toxic chemicals in your vineyard. Refer to Publication 456-001 and the pesticide label for safety information. Ask your local Extension agent how to become a certified applicator.

Table 3.8 - Chemical Names, Re-entry Times, and Days to Harvest[1]

Chemical (Other name)	Manufacturers	Re-entry time	Days to Harvest
Alion (indaziflam)	Bayer	12 hours	14
Aim (carfentrazone)	FMC	12 hours	3
Basagram (bentazon)	UPL	48 hours	365
Casoron (dichlobenil)	UPL	12 hours	30
Chateau (flumioxazin)	Valent	12 hours	60
Devrinol (napropamide)	United Phosphorus	12 hours	35
Diquat (diquat)	Nufarm	24 hours	365
Fusilade (fluazifop-butyl)	Syngenta	12 hours	50
Trellis (isoxaben)	Corteva	12 hours	60
Goal (oxyfluorfen)	Corteva	24 hours	NA2
Gramoxone (paraquat)	Syngenta	12 hours	NA5
Karmex (diuron)	ADAMA	12 hours	NA3
Kerb (pronamide)	Corteva	24 hours	NA4
Matrix (rimsulfuron)	Corteva	4 hours	14
Poast (sethoxydim)	BASF	12 hours	50
Princep (simazine)	Syngenta	12 hours	NA6
Prowl H2O (pendimethalin)	BASF	24 hours	21
Rely (glufosinate)	BASF	12 hours	14
Roundup (glyphosate)	Bayer	4 hours	14
Select (clethodim)	Valent	24 hours	365
Solicam (norflurazon)	Tessenderlo Kerley	12 hours	60
Surflan (oryzalin)	United Phosphorus	24 hours	NA6
Venue (pyraflufen-ethyl)	Nichino	12 hours	0
Zeus C (sulfentrazone)	FMC	12 hours	3
Zeus Prime XC	FMC	12 hours	3

[1]This information is given as a guideline only. Always read the label because there have been many changes in re-entry times and pre-harvest intervals in recent years, and more changes are expected in the future.

[2]Apply when crop is dormant.

[3]Apply between March and May.

[4]Apply in the fall after harvest.

[5]Do not allow paraquat to contact fruit.

[6]Apply between harvest and spring.

Hops: Diseases

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■ Nonchemical Approaches

PREPLANTING CONSIDERATIONS

SITE SELECTION AND EVALUATION

Air circulation and water drainage are the two key factors when it comes to disease management. Poorly drained soil promotes some soilborne pathogens, such as black root rot (caused by *Phytophthora citricola)* and crown gall (caused by *Agrobacterium tumefacience* aka *Rhizobium radiobacter).* Poor air circulation will promote diseases such as downy mildew and Botrytis gray mold because the pathogens for these diseases thrive in moist environments. Also, please note that variety selection can depend on site characteristics. For example, cultivars such as Magnum and Perle have been grown for centuries in European countries with well-drained and low pH (5.5-6.2) soil conditions. Therefore, it is recommended that you examine characteristics of your site, such as water drainage, pH, air circulation, sun exposure, availability of nutrients, etc., prior to the selection of cultivars.

CULTIVAR SELECTION

Both downy mildew (caused by *Pseudoperonospora humuli)* and powdery mildew (caused by *Podosphaera macularis)* are destructive diseases of hop. Considering environmental conditions during the growing season, it is best to select varieties that are not susceptible to these two diseases. Cascade, Fuggle, Magnum, Newport, and Perle are considered resistant to downy mildew. Comet, Crystal, First Gold, Newport, and Nugget are resistant to powdery mildew, and other cultivars, such as Cascade, Centennial, Hallertauer Tradition, Liberty, Pioneer, and Teamaker are moderately resistant to powdery mildew. On the other hand, cultivars such as Cluster, East Kent Golding, Tolhurst, and Vanguard are known to be susceptible to both powdery and downy mildew; thus, these cultivars should be avoided.

QUALITY OF RHIZOMES

The downy mildew pathogen as well as virus pathogens can survive in plant tissues. Therefore, it is very important to obtain certified rhizomes from reputable sources. Unfortunately, even certified, disease-tested rhizomes have a chance of carrying pathogens; however, certified rhizomes will be much cleaner than noncertified rhizomes and will greatly minimize the risk of disease development in young hop yards. The National Clean Plant Network has a program for hops since 2010, and producing 58 cultivars (https://www.nationalcleanplantnetwork.org/hops)

OTHER CULTURAL PRACTICES

Row spacing and row orientation need to be carefully planned, not only to maximize production per acreage, but also to achieve good air circulation. For example, higher planting density with Cascade is known to increase the risk of downy and powdery mildew development. If irrigation is considered for your hop yards, overhead irrigation should be avoided because it will create an environment that is conducive to disease development. Also, excessive nitrogen can make hop plants more susceptible to some diseases.

IN-SEASON CONSIDERATIONS

DORMANT SEASON DISEASE MANAGEMENT

Both downy mildew and powdery mildew pathogens can overwinter in infected dormant buds and crowns. The emerging buds can be infected during the winter and spring. Thus, it is important to manage downy mildew and powdery mildew as the season starts. Spring pruning can be done in late winter or early spring by removing all basal shoots to remove potentially infected shoots from the previous season. Also, "crowning," the removal of the top 1-2 inches of the crown prior to training, and "scratching," the removal of buds from within 1-2 inches of the soil surface using a special device, can be done. The timing of pruning is variety-specific and can affect yield potential; follow recommendations for your varieties.

STRIPPING

After the trained bines grow to a certain height, the lower 4-5 feet of the leaves and lateral branches need to be removed to minimize the spread of downy and powdery mildew. The process is called "stripping" and can be done mechanically.

■ Chemical Control Recommendations

PATHOGEN BIOLOGY AND TIMING OF FUNGICIDE APPLICAITON

Use of fungicides depends on other factors, such as site, weather, cultivar, cultural practice, etc. However, in general, preventative application of fungicides with 10-14-day intervals is recommended to minimize the risk of disease outbreak. The frequency of application depends on the growth of the bines as well as environmental conditions. For example, the downy mildew pathogen becomes active when the temperature is above 41 degrees Fahrenheit (F), and rain events promote their infection process. The powdery mildew pathogen becomes active at temperatures above 46˚F, and the optimal temperature for pathogen growth is 64-70˚F. The infection risk is very high when the minimum nighttime temperature is above 50˚F and the daily high temperature is below 68˚F. Once temperatures increase in the summer (3 or more hours above 86˚F per day), the risk of powdery mildew infection decreases. Another disease to be considered is Botrytis gray mold, caused by *Botrytis cinerea.* When a prolonged wetness event is expected at burr development, a specific application against Botrytis may be needed.

FUNGICIDE RESISTANCE MANAGEMENT

Use sufficient water to ensure complete coverage of the foliage. Make sure to (1) tank mix, (2) rotate the Fungicide Resistance Action Committee (FRAC) mode of action groups (www.frac.info), and (3) limit the use of the same FRAC group to 2-3 times per season (with exceptions for copper, sulfur, oil, and other materials that has M or NC in their FRAC group) to minimize the risk of fungicide resistance development. Tank mixing of fungicide can be done by placing two or more fungicidal chemicals into a spray tank. It is recommend to mix two or more different mode of action groups, which target the same disease, in order to reduce development of fungicide resistance. The mode of action of a chemical is the way(s) for the chemical to either kill or deactivate the target pathogens, and its classification is listed on the label as FRAC group. Fungicides with the same FRAC group share the same mode of action and are essentially the same in terms of the risk of fungicide resistance. In order to minimize the cost of application, it is often recommended to mix a material with a single mode of action and a broad-spectrum material, such as copper. Also, please note that some combinations of fungicides, oils, and plant nutrients are not compatible when mixed in the same tank, which may cause injury to your plant. Some labels list tank mixing partners.

In the case of a prolonged rain event, you may use either phosphorous acid (FRAC group P07) and/or metalaxyl (FRAC group 4) to control ongoing infection of downy mildew. However, application of the material has to be done within a few days of rain, prior to symptom development. Application of these materials against actively sporulating downy mildew colonies can increase the risk of fungicide resistance development. The same principle applies to fungicide resistance management of powdery mildew. Avoid the application of FRAC group 3, 7, 11, 13, 27, or U8 fungicide onto actively sporulating powdery mildew colonies. Potassium salt or oil-based products are recommended in such a case.

Table 4.1 - Fungicides Registered for Control of Hop Diseases in Virginia

Pest	Fungicide	Rate/Acre	FRAC* Grouping	Spray Timing and Remarks
Before bine training				
Downy mildew	Metastar 2E	1 qt	4	Timing and rate of application differ based on application method, row spacing, and product. Please refer to the label for the rate, amount of water, mixing partners, timing of application, etc.
	Ridomil Gold SL	0.5 pt	4	
	Ultra Flourish	1 qt	4	
	Orondis Gold	20.0-36.0 fl oz	4+49	
From the beginning of bine training				
Downy mildew	Curzate 60DF	3.2 oz	27	Ten to 14-day interval application (depends on the environmental conditions). See labels for mixing partners. Many modes of action (i.e., FRAC group) listed here are known for developing fungicide resistance. Always mix with a broad spectrum fungicide such as copper. For rainy season, consider mixing with a FRAC = P07 material. With other crops, downy mildew strains that are resistant to Flint, Pristine, and other strobilurin (aka QoI) and Metastar (metalaxyl) fungicides are common. Rotating and tank mixing with a different anti-downy-mildew material (e.g., copper) is highly recommended. There are many formulations of phosphorous acid and fosetyl-Al (both are FRAC group P07) and copper products; refer to the label for the rate for the product. A high concentration of a phosphorous acid may cause plant injury. Also, some formulations of phosphorous acid and copper may cause plant injury (please refer to the label for more details). Group 40 materials (Forum, Revus, and Zampro) provide very good protection against downy mildew; however, as with others, tank mix, rotation, and limited usage (2-3 times/year) are recommended. Curzate, Metastar, or Tanos has to be tank mixed with another broad-spectrum fungicide active against downy mildew, such as copper.
	fixed copper (various formulations)	See label	M1	
	Flint Extra	See label	11	
	Forum	6.0 oz	40	
	fosetyl-Al = Aluminum tris, various formulations	See label	P07	
	Luna Sensation	7.6 fl oz	7+11	
	Metastar 2E	1 qt	4	
	phosphorous acid (various formulations)	See label	P07	
	Orondis Gold	20.0-26.0 fl oz	4 + 49	
	Orondis Ultra	5.5-8.0 fl oz	40+49	
	Pristine	14.0 oz	7+11	
	Ranman 400SC	2.1-2.75 fl oz	21	
	Revus	8.0 oz	40	
	Ridomil Gold SL	0.5 pt	4	
	Tanos	8.0 oz	11+27	
	Ultra Flourish	1 pt	4	
	Viathon	2.0 - 4.0 pt	P07 +3	
	Zampro	11.0-14.0 fl oz	40 + 45	

Table 4.1 - Fungicides Registered for Control of Hop Diseases in Virginia (continued)

Pest	Fungicide	Rate/Acre	FRAC* Grouping	Spray Timing and Remarks
Powdery mildew	fixed copper (various formulations)	See label	M1	10 to 14-day interval application (depends on the environmental conditions). Due to the risk of fungicide resistance development, do not use sterol inhibitors (aka DMI; FRAC group 3) or strobilurins (aka QoI; FRAC group 11) continuously; rotate with other groups of fungicides. It is recommended that sterol inhibitors and strobilurins be tank mixed with sulfur or copper material, and limit the use of FRAC groups 3 and 11 to 2-3 times/season. Pristine contains a strobilurin along with a different active chemical (SDHI) that has an efficacy against Botrytis gray mold. Avoid using sterol inhibitors or strobilurins when there is a powdery mildew outbreak. Potassium bicarbonate products are recommended for an ongoing powdery mildew issue. The rate for sulfur is generally 2-3 lb/100 gal, but it can be increased to as high as 6 lb/100 gal. Severe disease pressure may warrant this, but beware of possible plant injury at higher rates. Mineral and neem oil products can control powdery mildew; however, there is some evidence of plant injury with the use of oil. See the label for detailed instructions. Also, avoid using oil and sulfur within two weeks of each other because it may cause injury to the plants. If there is an outbreak of powdery mildew, consider using copper, oil, potassium bicarbonate, and sulfur. If you plan to use Flint, Tanos or Ph-D, consider tank-mix with another FRAC material for fungicide resistance management.
	Flint Extra	4.0 oz	11	
	Luna Experience	8.0-17 fl oz	7+3	
	Luna Sensation	3.0-7.6 fl oz	7+11	
	mineral oil, neem oil	See label	NC	
	Ph-D	6.2 oz	19	
	potassium bicarbonate (Kaligreen, etc.)	See label	NC	
	Pristine	14.0 oz	7+11	
	triflumizole (Procure 480SC, etc.)	See label	3	
	Procure 480SC	4-8 lb	3	
	Quintec	4.0-8.2 oz	13	
	Rhyme	5.0-7.0 fl oz	3	
	Sonoma (various formulations)	See label	3	
	Tanos	8.0 oz	11+27	
	tebuconazole (various formulations)	2.0-8.0 oz	3	
	Torino	6.0-8.0 oz	U6	
	Trionic 4SC	12 fl oz	3	
	Velum Prime	6.5-6.84 fl oz	7	
	Viathon	2.0 - 4.0 pt	P07 +3	
	Vivando	15.4 fl oz	U8	
	wettable sulfur (various formulations)	2.0-6.0 lb	M2	
After burr development				
Botrytis	Pristine	14.0 oz	7+11	Although Pristine contains two different FRAC groups, strains of Botrytis that can overcome both FRAC groups are present in Virginia. Make sure to tank mix with a broad-spectrum fungicide, such as copper. Also, applications of Pristine should be limited to less than three times a season. Many biological control agents (e.g., Double Nickel, Howler, Serenade, etc.) list Botrytis on their labels. If you decided to use them, make sure to apply before potential infection event (i.e., rain). Also it is probably a good idea to test it in a small area before you apply broadly to make sure it fits your growing conditions.
	Luna Experience	8.0-17.0 fl oz	7+3	
	Luna Sensation	3.0-7.6 fl oz	7+11	
After harvest				
Downy mildew and powdery mildew	fixed copper (various formulation)	See label	M1	Once or twice after harvest. It is important to keep bines healthy after harvest to ensure the accumulation of carbohydrates into the rhizome for winter survival. Copper products should be sufficient to provide protection against both downy mildew and powdery mildew in most cases, but you may need to use sulfur to control powdery mildew. If there is a prolonged rain event and your hop yards have a history of downy mildew, you may need to use either phosphorous acid or fasetyl-Al.
	fosetyl-Al = Aluminum tris, various formulations	See label	P07	
	phosphorous acid (various formulations)	See label	P07	
	wettable sulfur (various formulations)	2-6 lb	M2	

* Fungicide Resistance Action Committee.

Table 4.2 - Product and Chemical Names, Restricted Entry Interval (REI), and Preharvest Interval (PHI)			
Product (chemical name) or if there are multiple products of the same chemical, Chemical name [product name]	**Manufacturer**	**REI (hours)**	**PHI (days)**
Actinovate AG (Steptomyces lydicus WYEC 108)	Novozimes BioAg Inc	4	0
Aliette WDG (Aluminum tris)	Bayer CropScience	4	0
Bio-Tam 2.0 *(Trichoderma gamsii,* strain ICC 080, and *Trichoderma asperellum,* strain ICC 012)	SePRO Corp	4	0
Carbon Defense (potassium silicate)	FBSciences	4	0
Curzate 60DF (cymoxanil)	Corteva	12	7
Double Nickel 55 and LC (Bacillus amyloliquefaciens, strain D747)	Certis USA	4	0
fixed copper [various formulations: Champ WG, Cueva, Kocide, Nordox 75WG, etc.]	Various	4-48 (see label)	0-14 (see label)
Empire (pyraclostrobin)	Sharda USA	12	14
Flint Extra (trifloxystrobin)	Bayer Cropscience	12	14
Forum (dimethomorph)	BASF	12	7
fosetyl-Al [aluminum tris; Aliette WDG, Linebacker WDG]	Various	12	24
Gatten (flutianil)	Nichino America	12	7
Howler and Howler EVO (Pseudomonas chlororaphis strain AFS009)	AgBiome	4	0
hydrogen dioxide or peroxide [OxiDate 5.0, Jet-Ag, etc.]	Various	4 (see label)	0 (see label)
JMS Stylet-Oil (paraffinic oil)	JMS Flower Farms	4	0
Luna Experience (fluopyram + tebuconazole)	Bayer	12	14
Luna Sensation (fluopyram + trifloxystrobin)	Bayer	12	14
metalaxyl [MetaStar 2E, ReCon 4F, etc.]	LG Life Sciences	48	45
mineral oil [various formulations: Damoil, Omni oil, Suffoil-X, etc.]	Various	4	0
neem oil [various formulations: Trilogy, Green Light, etc.]	Various	4	0
Orondis Gold (Oxathiapiprolin)	Syngenta	48	45
Orondis Ultra (Oxathiapiprolin)	Syngenta	4	7
Oxidate 2.0 or 5.0 (hydrogen peroxide and peroxyacetic acid)	BioSafe Systems	1	0
OxiPhos (phosphorous acid plus hydrogen peroxide)	BioSafe Systems	4	0
PerCarb (sodium carbonate peroxyhydrate)	BioSafe Systems	0	0
Ph-D (polyoxin D zinc salt)	UPL	4	0
phosphorous acid [phosphite; various formulations: Agri-Fos, Prophyt, Phostrol, etc.]	Various	4	0
potassium bicarbonate [various formulations: Armicarb, Kaligreen, etc.]	Various	4	0-1 (see label)
Pageant Intrinsic (boscalid)	BASF	12	14
Presidio (fluopicolide)	Valent	12	24
Pristine (pyraclostrobin + boscalid)	BASF	12	14
Procure 480SC	UPL	12	7
Quintec (quinoxyfen)	Dow Agrosciences, GOWAN	12	21
myclobutanil [Rally, Sonoma, etc]	Various	24	14
Ranman (cyazofamid) (various cyazofamid formulations available)	FMC, Summit Agro	12	3

Regalia, Regalia PTO, and Regalia Rx (Reynoutria sachalinensis)	Marrone Bioinnovations, Pro Farm Group	4	0
Revus (mandipropamid)	Syngenta	4	7
Rhyme (flutriafol)	FMC	12	7
Ridomil Gold SL (Mefenoxam) (various mefenoxam formulations available)	Syngenta	48	45
Serenade (various formulations)	Bayer Cropscience	4	0
Sodium Tetraborohydrate Decahydrate (two PREV-AM formulations)	Oro Agri	12	0
Sonata (various formulations)	Bayer Cropscience	4	0
sulfur [various formulations: Acoidal, Kumulus DF, Microthiol D, etc.]	Various	24	0
Tanos (cymoxanil + famoxadone)	Dupont, Corteva	12	7
tebuconazole [various formulations: AmTide Tebu 3.6 F, Orius, etc.]	Various	12	14
Tetraborohydrate Decahydrate (two PREV-AM formulations)	Oro Agri	12	0
triflumizole [various formulations: Procure, Trionic, Arkos, etc.]	Various	12 (see label)	14 (see label)
TRIONIC 4SC (Triflumizole)	UPI	12	7
Ultra Flourish (mefenoxam)	Nufarm	48	45
Velum Prime	Bayer CropScience	12	7
Viathon (phosphorous acid plus tebuconazole)	Helena	12	14
Vivando[2] (metrafenone)	BASF	12	3
Xyler FC (metalaxyl)	Vive Crop Protection, Inc	48	45
Zampro (amedoctradin + dimethomorph)	BASF	12	7
Zayin (geraniol)	GroPro Corporation	0	0
ZONIX (rhamnolipid)	Sepan Company	4	0

[1] Label recommends termination of use at burr development. [2] An older label does not list hops. A supplemental label is available.

Hops: Insects

Douglas G. Pfeiffer, Fruit Entomologist, Virginia Tech

■ Nonchemical Approaches

SITE SELECTION

The likelihood that some insects will develop into pest status in a commercial planting is affected by environmental factors. This is true for the Japanese beetle. Larvae of the Japanese beetle feed on grass roots; consequently, if a planting is adjacent to pastureland, there is a nearby breeding ground. Plantings surrounded by woods will have less immigration pressure. Twospotted spider mite is favored by hot temperatures.

BIOLOGICAL CONTROL

Some pests, such as the twospotted spider mite, are excellent candidates for biological control. A complex of native predators will feed on the twospotted spider mite and can maintain its populations below damaging levels unless disrupted by chemical controls for other pests. Toxicity to natural enemies should be considered when deciding on a chemical control program. If disruptive materials are to be used, pay close attention to twospotted spider mite populations.

■ Chemical Control Recommendations

RESISTANCE MANAGEMENT

Several factors affect the likelihood of resistance to pesticides, notably the number of generations per season and the number of offspring per female (fecundity). Spider mites are notorious for developing resistance to acaricides because they have a large number of generations annually and they produce many eggs. It is important to (1) rely on natural controls as much as possible and (2) obtain maximum coverage and rotate insecticides of different modes of action when chemical control is needed. Modes of action are indicated by the Insecticides Resistance Action Committee (IRAC) grouping (https://irac-online.org/documents/moa-classification/?ext=pdf).

Table 4.3 - Insecticides Registered for Control of Hop Insect Pest Control in Virginia

Pest	Insecticide	Rate/Acre (unless noted)	IRAC* Grouping	Spray Timing and Remarks
Variegated cutworm, loopers	Baythroid XL	3.2 fl oz	3A	An action threshold has not been established for these pests. Larvae may cause defoliation on the plant and may feed on cones directly, especially late in the season. Larval population should not be allowed in the upper canopy in the late season. Sample by spreading a sheet on the ground and shaking the bine vigorously for about 15 seconds. Dipel, Entrust and Venerate are OMRI-approved, suitable for organic production.
	Brigade 2SC	3.8-6.4 fl oz	3A	
	Coragen 1.67EC	3.5-5 fl oz	28	
	Delegate 25WG	2.5-4.0 oz	5	
	Dipel DF	1 lb	11A	
	Entrust 2SC	4.0-6.0 fl oz	5	
	Venerate	4.0-8.0 qt	–	
Twospotted spider mite	Acramite 50WS	0.75-1.5 lb	UN	Do not spray for spider mites preventatively in order to prevent the development of resistance. If multiple sprays are needed, rotate to a different IRAC class. Savey is strictly an ovicide and will not immediately reduce a high population. An action threshold has not been established, but a tentative threshold is 2-3 female mites/leaf until mid-July and 10 mites/leaf thereafter. Use a 10x hand lens when counting mites. Natural enemies often control spider mites, so sprays should not be used against sub-economic populations. Use of pyrethroid insecticides will often induce mite outbreaks. Acramite may be used only once per season.
	Agri-Mek 8SC	1.75-3.5 fl oz	6	
	Envidor 2SC	18.0-24.7 fl oz	23	
	Portal 0.4E	2.0-3.0 pt	21A	
	Savey 50DF	4.0-6.0 oz	10A	
	Zeal	3.0-4.0 oz	10B	
	Kanemite	31 fl oz	20B	
Aphids	Admire Pro (foliar)	2.8 fl oz	4A	Before flowering, use a tentative action threshold of 5-10 aphids/leaf. Control is difficult if aphids become established on cones. BotaniGard is OMRI-approved, suitable for organic production. Venerate provides only suppression for aphids, and is OMRI-approved. Aza-Direct is also OMRI-approved.
	Admire Pro (soil)	2.8-8.4 fl oz		
	Aza-Direct	1-2 pt		
	Baythroid XL	3.2 fl oz	3A	
	Beleaf 50SG	1.7-2.8 oz		
	BotaniGard ES	1 qt	N/A	
	Brigade 2SC	3.8-6.4 fl oz	3A	
	Fulfill 50WDG	4.0-6.0 oz	9B	
	Malathion 57EC	1 pt	1B	
	Movento 2EC	5.0-6.0 fl oz	23	
	Sivanto	7.0-10.5 fl oz	4D	
	Venerate	4-8 qts	—	

Table 4.3 - Insecticides Registered for Control of Hop Insect Pest Control in Virginia (continued)				
Pest	**Insecticide**	**Rate/Acre (unless noted)**	**IRAC* Grouping**	**Spray Timing and Remarks**
European corn borer	Baythroid XL	3.2 fl oz	3A	
	Brigade 2SC	3.8-6.4 fl oz	3A	
	Dipel DF	1 lb	11A	
	Coragen 1.67EC	3.5-5.0 fl oz	2B	
Japanese beetle	Aza-Direct	1-2 pt		Surround, Neemix, Trilogy, Aza-Direct, and PyGanic are all OMRI-approved. Neemix and Trilogy are to be applied together. Aza-Direct, Neemix and Trilogy should be applied before JB reaches high levels.
	Brigade 2SC	3.8-6.4 fl oz	3A	
	Neemix 4.5 + Trilogy	1-2 gal Neemix + 7.0-16.0 fl oz Trilogy/100 gal	UN	
	PyGanic 5EC	16-32 fl oz/100 gal	3A	
	Surround	25-50 lb	UN	
Potato leafhopper	Malathion 57EC	1 pt	1B	Potato leafhopper may be more common if alfalfa is grown nearby, especially after alfalfa cutting. M-Pede is OMRI-approved.
	M-Pede	2% solution	—	
	Movento 2SC	5-6 fl oz	23	
Question mark	Aza-Direct	1-2 pt		
	Delegate 25WG	2.5-4 oz	5	
	Botanigard Maxx	2 qt	3A	
	Dipel DF	1 lb	11A	
	Coragen 1.67EC	3.5-5.0 fl oz	2B	
Spotted lanternfly	Baythroid XL	3.2 fl oz	3A	Spotted lanternfly is a new invasive pest in the state. SLF was initially located in northern Virginia, but has been expanding its geographic range significantly. While this insect feeds on more than 70 different host plants, hop may be a host plant. Feeding by both nymphs and adults produces a large amount of honeydew, which may contaminate cones. Check cones for contamination if SLF is present on bines. Please read the SLF material posted at https://www.virginiafruit.ento.vt.edu/SLF.html. This site has identification and control information, as well as updated distribution maps.
	Brigade 2SC	3.8-6.4 fl oz	3A	
Stink bugs	Beleaf 50SG	1.0-2.8 oz		
*Insecticides Resistance Action Committee				

Table 4.4 - Insecticide Names, Restricted Entry Interval (REI), and Preharvest Interval (PHI)			
Pesticide	**Manufacturer**	**REI (hours)**	**PHI (days except where noted)**
Acramite (bifenazate)	Chemtura	12	14
Admire Pro	Bayer	12	60 (soil), 28 (foliar)
Agri-Mek (abamectin)	Syngenta	96	28
Aza-Direct (azadirachtin)	Gowan	4	0
Baythroid (beta-cyfluthrin)	Bayer	12	7
Beleaf (flonicamid)	FMC	12	10
BotaniGard ES *(Beauveria bassiana)*	LAM International	4	0
Botanigard Maxx *(Beuaveria bassiana)*	LAM InternationaL	12	0
Brigade (bifenthrin)	FMC	12	14
Coragen (chlorantraniliprole)	Dupont	4	0
Delegate (spinetoram)	Dow	4	1
Dipel *(Bacillus thuringiensis)*	Valent	4	0
Entrust SC (spinosad)	Dow	4	1
Envidor (spirodiclofen)	Bayer	12	14
Fulfill (pymetrozine)	Syngenta	12	14

Table 4.4 - Insecticide Names, Restricted Entry Interval (REI), and Preharvest Interval (PHI) (continued)

Pesticide	Manufacturer	REI (hours)	PHI (days except where noted)
Kanemite (acequinocyl)	Arysta	12	7
Malathion (malathion)	Loveland	12	10
Movento (spirotetramat)	Bayer	24	7
M-Pede (insecticidal soap)	Gowan	12	0
Neemix (azadirachtin)	Certis	4	0
Portal (fenpyroximate)	Nichino	12	15
PyGanic (pyrethrins)	MGK	12	0
Savey 50DF (hexythiazox)	Gowan	12	Until burr formation
Sivanto Prime (flupyradifurone)	Bayer	4	21
Surround (kaolin)	NovaSource	4	0
Trilogy (clarified extract of neem oil)	Certis	4	0
Venerate (Burkholderia)	Marrone	4	0
Zeal (etoxazole)	Valent	12	7

A new invasive insect

In January 2018, a new invasive insect was found in Virginia. Spotted lanternfly came to Virginia from southeastern Pennsylvania, and had been expanding its range within Frederick County. SLF feeds on more than 70 different hosts, and can cause significant injury on some. Some of our important fruit crops are on the host list: grape, caneberry, blueberry, stone and pome fruits, and hops. There have been conflicting reports on severity of injury to hops in Pennsylvania; for the time being, hop growers are urged to be vigilant. Populations can build to create a severe nuisance in residential areas as well. An eradication effort has been implemented in 2018, and a quarantine was established by VDACS in May 2019. More information on the quarantine program is posted (https://www.pubs.ext.vt.edu/ENTO/ENTO-319/ENTO-319.html). An online training is available too allow certification as part of the quarantine effort (https://register.ext.vt.edu/search/publicCourseSearchDetails.do?method=load&courseId=210837&selectedProgramAreaId=25577&selectedProgramStreamId=). So far, SLF has not caused economic loss in our agricultural crops. Nevertheless, hop growers should be aware of the pest's appearance, and how to handle finds you may make in your operations. For updated information, visit the spotted lanternfly page in the Virginia Cooperative Extension web site (https://ext.vt.edu/). For updated control information, visit the SLF page in Virginia Fruit (https://www.virginiafruit.ento.vt.edu/SLF.html). To report suspected discoveries, please visit the SLF reporting page (https://ask.extension.org/groups/1981/ask).

Hops: Weed Management

Jeffrey Derr, Extension Weed Scientist, Hampton Roads AREC

■ Nonchemical Approaches

Apply mulch at a 2-4 inch depth using a mulch that is free of weed seed or use shallow cultivation (2-4 inches).

■ Chemical Control Recommendations

ORGANIC PRODUCTION

Acetic acid (Weed Pharm) can be applied as a directed spray for nonselective contact control of small annual weeds. This will suppress perennial weeds; repeat treatments will be needed to control regrowth. Do not allow spray to contact hops foliage.

CONVENTIONAL PRODUCTION

Table 4.5 - Herbicide Common and Trade Names, Rate per Acre, and Comments

Application	Common Name (Trade Name)	Rate of Active Ingredient per Acre (Rate of Product per Acre)	Timing and Remarks
Preemergence to weeds	flumioxazin (Chateau)	3 oz (6 oz)	Apply to dormant hops in January-March as a 1-1.5-foot strip on each side of the row. Make only 1 application/ year. For small areas, apply 0.13 oz Chateau/1,000 sq ft. Controls a range of annual weeds
	pendimethalin (Prowl H2O)	1.0-4.0 lb (1.1-4.2 qt/A)	Do not apply overtop hops; instead apply as a direct spray. Do not apply more than 4.2 qt/A/year. For small areas apply 0.8-3.0 fl oz/1000 sq ft. PHI is 90 days.
	norflurazon (Solicam)	2-4 lb (2.5-5.0 lb)	Apply as a directed spray to hops established at least 6 months. Use lower rates on sandy soils. For small areas, apply 0.9-1.8 oz Solicam/1,000 sq ft. Controls a range of annual weeds and suppresses yellow nutsedge.
	trifluralin (Treflan 4EC or other labeled formulation)	0.50-0.75 lb (1.0-1.5 pt)	Apply as a directed spray to dormant, established hops, avoiding hops crowns. Immediately incorporate 1-2 inches deep. Do not spray over hops. For small areas, apply 0.37-0.55 fl oz Treflan 4EC/1,000 sq ft. Controls annual grasses and certain small-seeded annual broadleaf weeds.
Postemergence to weeds	carfentrazone (Aim EC)	0.016-0.031 lb (1.0-2.0 fl oz/A for broadleaf weeds, 2.0 fl oz/A for sucker management)	Contact herbicide for control of broadleaf weeds less than 4 inches tall using a hooded sprayer. Can also be applied post-directed for sucker management. Add a nonionic surfactant or crop oil concentrate. Apply after trained hops stems are woody when used for sucker management.
	clethodim (Select Max)	0.07-0.12 lb (9-16 fl oz)	Apply to actively growing annual and perennial grassy weeds. Will not control nongrass monocots or any broadleaf weeds. Perennial grasses like johnsongrass and bermudagrass generally will require retreatment. Add a nonionic surfactant at 0.25% V/V. There is a 21-day PHI.
	2,4-D (2,4-D Amine 4 or other labeled formulation)	0.48 lb ae (1 pt)	Make a directed spray to the row middles. Use a shielded or hooded sprayer to prevent contact with hops foliage. Controls certain annual broadleaf weeds. The PHI is 28 days.
	glyphosate (Roundup PowerMAX or other labeled formulation)	0.39-3.70 lb ae (11.0 fl oz-3.3 qt)	Apply only when there are no green shoots of hops within the spray zone. For small areas, mix 2 fl oz/gallon and lightly wet the weed foliage. There is a 14-day PHI. Controls annual and perennial weeds. Use a shielded spray to avoid contact with hops foliage.
	pelargonic acid (Scythe)	(3-7% V/V)	Rapid acting contact herbicide. Treat weeds when they are less than 4 inches tall. Avoid contact with hops foliage except when used for sucker management. Apply after trained hops stems are woody when used for sucker management.

Table 4.6 - Herbicide, Manufacturer, Restricted Entry Interval (REI), and Preharvest Interval (PHI)			
Herbicide Trade Name	**Manufacturer**	**REI (hours)**	**PHI (days)**
2,4-D Amine 4	WinField Solutions	48	28
Aim	FMC	12	7
Chateau	Valent	12	30
Prowl H2O	BASF	24	90
Roundup PowerMax	Bayer	4	14
Scythe	Gowan	12	1
Select Max	Valent	24	21
Solicam	Tessenderlo Kerley	12	60
Treflan 4EC	Helena	12	—

Nursery Crops: Diseases

Chuan Hong, Extension Plant Pathologist,
Hampton Roads AREC

The most cost-effective way to managing nursery crop diseases is a systems approach. This approach includes three major components. The first and most important component is to prevent pathogens from entering a production facility or production system by using new containers, fresh potting mixes and healthy plant materials including liners and plugs, and irrigating with decontaminated water. It is advisable to to use locally propagated plant materials whenever possible. When bringing in plant materials from another nursery is absolutely necessary, buy them from an accredited nursery and place incoming materials in an isolated areas for several weeks to observe whether they are free of high-impact diseases such as boxwood blight and sudden oak death. The second component is to create an environment that is against pathogens while promoting plant growth. This includes fertilizing and irrigating crops as needed and reducing free water on foliage. The third component is to treat the disease with right product in a timely manner when a disease emerges.

Fungicides and bactericides play an important part in the prevention of container and field-grown ornamental and flower diseases. They do not take the place of cultural control methods, but should be used to complement them. In some disease situations there are no effective chemicals available. Only chemicals registered by the Environmental Protection Agency (EPA) are recommended.

Most fungicides on the market protect woody shrubs, ground cover plants, and flowers against diseases. This protection is accomplished by preventing plant pathogens from becoming established. Systemic fungicides are therapeutic and may eradicate pathogens that are already established. Because chemicals are subject to weathering and degradation, they must be reapplied to the soil or container or susceptible parts at regular intervals as long as the danger of plant disease exists. In general, protectants must not be reapplied more frequently than recommended treatment intervals, or applied in excess of recommended rates.

In every instance, the manufacturer's label should be read carefully and attention should be directed particularly to the safety measures listed on the label regarding mixing, handling, compatibility with other chemicals, and application methods and rate. It is always essential that the user familiarize himself with the antidote given on the label. In many instances, the addition of a surfactant will improve retention of the chemical.

Table 5.1 - Common Diseases and Chemical Control Options

Plant Disease	Fungicide Rate/100 Gal	Remarks
Ajuga Sclerotium rot	Terraclor (75% WP) 2.0 lb/1,000 sq ft or 2.5 lb/300.0 gal water; pentachloronitrobenzene	Dust or drench on soil surface before planting and thoroughly work into the top 2 inches of soil.
	Heritage (50%); 1.0-4.0 oz (spray) 0.2-0.9 oz (drench) azoxystrobin	Apply every 1 to 4 weeks.
	Palladium (62.5% WDG) 2.0 to 4.0 oz cyprodinil and fludioxonil	Apply at 7- to 14-da intervals
	Pageant (38%) 12.0 to 18.0 oz pyraclostrobin and boscalid	Apply every 7 to 14 days
Andromeda (Japanese) *(Pieris* spp.) *Phytophthora* dieback	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Spray every 7 days.
	Alliete (80% WDG) 1.3-4.0 lb; fosetyl-Al	Spray at new leaf emergence or at first sign of diseases and at 7- to 14-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Spray plants at a 28-day interval.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz; fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
Andromeda *Phytophthora* root rot	Alliette (80% WDG) 1.0-2.0 lb/1,000 sq ft; fosetyl-Al	Drench Alliette monthly (2.0 pt/sq ft) over the surface of the potting medium.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days

Table 5.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	**Fungicide Rate/100 Gal**	**Remarks**
Andromeda *Phytophthora* root rot (continued)	Orvego (46.2%) 14.0 fl oz ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Subdue MAXX 1.0-2.0 fl oz; mefenoxam	Repeat at 3-month intervals. Provide good drainage. After application, irrigate to thoroughly wet soil.
	Terrazole (35% WP) 3.5-10.0 oz; etridiazole	Treat soil at 4- to 12-week intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pints per square foot at a 28-day interval.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz; fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
Arborvitae Phomopsis needle twig blight	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Begin application at bud break and repeat at 7- to 10-day intervals throughout the growing season.
	Heritage (50%) 1.0-4.0 oz; azoxystrobin	Apply at 1- to 4-week intervals.
Arborvitae Cercospora blight	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Cleary 3336 should be applied when disease first appears and repeat on 10- to 14-day intervals. Shorten interval during humid, rainy weather.
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days as needed
	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14- to 21-day intervals
	Dithane Rainshield or Fore Rainshield, 1.5 lb; mancozeb	Mancozeb should be applied at 7- to 10-day intervals.
Aucuba Phytophthora root rot	Alude 1.0-2.0 qt Vital 2.0-4.0 pt phosphite	Spray every 7 days.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Subdue MAXX 1.0-2.0 fl oz; mefenoxam	See Andromeda.
	Terrazole (35% WP) 3.5-10.0 oz; etridiazole	Treat soil at 4- to 12-week intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pints per square foot at a 28-day interval.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz; fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz; cyazoflamid	Apply at 14- to 28-day intervals.
Azalea Cylindrocladium root rot	Dithane Rainshield or Fore Rainshield, 1.5 lb; mancozeb	See Arborvitae.
	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Drench Cleary 3336 on the surface of growing medium to prevent disease development. Repeat at 2- to 4-week intervals during disease pressure period.
	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply every 14 to 21 days
	Pageant (38%) 12.0 to 18.0 oz pyraclostrobin and boscalid	Apply every 7 to 14 days
	Spectro TM (90% WDG) 1.0 to 2.0 lb chlorothalonil and thiophanate-methyl	Apply every 14 days
	Terraguard 50W; triflumizole	Soil drenched for propagation beds, 6.0-8.0 oz or established root systems 6.0-12.0 oz.
	Torque (38.7%) 4.0 to 10.0 fl oz; tebuconazole	Apply every 14 to 21 days
	OHP 26 GT-O 1.0 qt; iprodione	Dip cuttings for 5 minutes prior to planting.

Table 5.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	**Fungicide Rate/100 Gal**	**Remarks**
Azalea Exobasidium leaf and flower gall	Dithane Rainshield or Fore Rainshield, 1.5 lb; mancozeb	Hand pick infected leaves and remove from plant. Apply mancozeb just before leaves unroll in spring and 10 days later.
Azalea Rust	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Spray to run-off when rust first appears.
Azalea Botrytis blight (Gray mold)	Broadform 4.0 to 8.0 fl oz fluopyram and trifloxystrobin	Spray at 7 to 14 day intervals.
	Compass 2.0-4.0 oz; trifloxystrobin	Spray at 7- to 14-day intervals.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Apply to petals to protect from disease. Continue at 10- to 14-day intervals as long as disease conditions are favorable.
	Cleary 3336-WP (50% WP) 0.8 lb, thiophanate methyl	Repeat every 7 to 10 days as needed during disease periods.
	Decree (50 WDG) 0.7-1.5 lb; fenhexamide	Repeat at 7- to 10-day intervals.
	Pageant (38%) 12.0-18.0 oz pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Azalea Ovulinia petal blight	Strike (25% WDG) 8.0-16.0 oz; triadimefon	Apply Strike to all flower buds to point of run-off. Application should be made during the expanded bud stage (color showing). A second application may be needed.
	Cleary 3336-F, 12.0 to 16.0 fl oz; Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Apply Cleary 3336 as flowers open. Repeat every 4 to 6 days as needed during disease periods.
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Daconil Weather Stik 1.4 pt; chlorothalonil	Spray Daconil every 7 days during wet weather.
	Dithane Rainshield or Fore Rainshield, 1.5 lb; mancozeb	Spray mancozeb or ziram at 7- to 10-day intervals when flowers start to show color.
	Ziram (F-4) 3.0-4.0 pt; ziram	Spray mancozeb or ziram at 7- to 10-day intervals when flowers start to show color.
Azalea Phomopsis dieback	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Spray at 7- to 10-day intervals. Prune out all diseased branches. Avoid stress.
Azalea Phytophthora root and crown rot	Alude 1.0-2.0 qt Vital 2.0-4.0; phosphite	Spray every 7 days.
	Subdue MAXX 0.6-1.2 fl oz; mefenoxam	Thoroughly wet soil after application of Subdue and repeat at 3-month intervals.
	Terrazole (35% WP) 3.5-10.0 oz; etridiazole	Treat soil at 4- to 12-week intervals.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride	Treat soil at 3-week to 3-month intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pints per square foot at a 28-day interval.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin	Apply at 7-to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
Azalea Phytophthora shoot blight	Alliette (80% WDG) 2.5-5.0 lb; fosetyl-Al	One application every 30 days.
	Alude 1.0-2.0 qt Vital 2.0-4.0; phosphite	Spray every 7 days.
	FenStop 7.0-14.0 fl oz; fenamidone	Spray plants at a 28-day interval.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.

Table 5.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	**Fungicide Rate/100 Gal**	**Remarks**
Azalea Phytophthora shoot blight (continued)	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
Azalea Powdery mildew	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Spray to run-off when mildew first appears.
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Cygnus (50%) 1.6-3.2 oz; kresoxim-methyl	Apply at 10- to 14-day intervals.
	Banner Maxx 2.0-4.0 fl oz; propiconazole	Apply at 2- to 3-week intervals.
Azalea Rhizoctonia web blight	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Avoid crowding the plants. Use a drench spray treatment. Repeat at 2- to 4-week intervals.
	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed.
	Hurricane (48%) 1.5 oz; fludioxonil and mefenoxam	Apply at 21- to 28-day intervals
	Medallion (50% WP) 1-2 packets; fludioxonil	Only in greenhouses and closed structures at 7- to 14-day intervals.
	Pageant (38%) 12.0 to 18.0 oz pyraclostrobin and boscalid	Apply at 7- to 14-day intervals
	Palladium (63.5% WDG) 2.0 to 4.0 oz Cyprodinil and fludioxonil	Apply at 7- to 14-day intervals
	OHP 26 GT-O 1.0-2.5 qt; iprodione	Spray plants every 7 to 14 days.
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals
Azalea Septoria leaf spot	Cleary 3336-F 12.0-16.0 fl oz thiophanate methyl	Repeat at 10- to 14-day intervals throughout the growing season.
Boxwood (English, American, Korean, Japanese) Phytophthora root rot	Alude 1.0-2.0 qt Vital 2.0-4.0; phosphite	Spray every 7 days.
	Alliette (80% WDG) 6.4-12.8 oz (drench) sq ft fosetyl-Al	See Azalea.
	Subdue MAXX 1.0-2.0 fl oz; mefenoxam	See Azalea.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0- 2.0 pints per square foot at a 28-day interval.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Terrazole (35% WP) 3.5-10.0 oz; etridiazole	See Azalea.
	Stature (43.5% SC) 6.0-13.0 fl oz; dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz; cyazoflamid	Apply at 14- to 28-day intervals.
	Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride	Treat soil at 3-week to 3-month intervals.
Boxwood boxwood blight	Concert II 1.4-2.2 pt; propiconazole + chlorothalonil	Apply at 14- to 21-day intervals only under open field conditions and rotate with fungicides of different modes of action.
	Daconil weather Stik 2.0 pt; chlorothalonil Medallion WDG 2.0-4.0 oz, fludioxonil 2.0-4.0 oz Cleary 3336-F, 12.0 to 16.0 fl oz Dithane 75 DF Rainshield 1.5 lb; mancozeb Pageant 12.0-18.0 oz; boscalid + pyraclostrobin Torque 10 fl oz; tebuconazole Spectro 90WDG 1.5 lb chlorothalonil + thiophanate methyl	Apply and repeat at 7- to 14-day intervals during prolonged wet periods in spring and fall. Every 14 days, 3 applications maximum Every 14 days

Table 5.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	**Fungicide Rate/100 Gal**	**Remarks**
Boxwood boxwood dieback/ anthracnose	Daconil Weather Stik 2.0 pt; chlorothalonil Mural 4.0 to 7.0 oz azoxystrobin + benzovindiflupyr	Apply every 7 to 14 days.
Camellia Leaf gall	See Azalea.	Hand pick infected leaves.
Camellia Sclerotinia flower blight	Pageant (38%) 12.0 to 18.0 oz pyraclostrobin and boscalid	Apply every 7 to 14 days
	Palladium (62.5% WDG) 2.0 to 4.0 oz cyprodinil and fludioxonil	Apply at 7- to 14-day intervals
	Terraclor (75% WP) 1 cup in enough water to give thorough coverage of 100 sq ft pentachloronitrobenzene	Drench soil surface in late December or early January.
Camellia Phytophthora root rot	See Azalea.	
Cedar Phomopsis needle and twig blight	Heritage (50%) 1.0-4.0 oz; azoxystrobin	Apply every 1 to 4weeks.
	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Begin application at bud break and repeat at 7- to 10-day intervals throughout the growing season.
Cedar Cercospora blight	Cleary 3336-F 12.0-16.0 fl oz thiophanate methyl	Spray at 7- to 10-day intervals, starting when plants are well leafed out or at first sign of disease.
	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14- to 21-day intervals
	Dithane Rainshield or Fore Rainshield, 1.5 lb; mancozeb	Spray at 7- to 10-day intervals, starting when plants are well leafed out or at first sign of disease.
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days as needed
Chrysanthemum Rhizoctonia root rot	Cleary 3336-F 12.0-16.0 fl oz or Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Apply Cleary 3336-F as a heavy drench or spray.
	Chipco 26019 (50% WP) 0.4 lb; iprodione	Apply after transplant (1.0-2.0 pt/sq ft). Repeat every 14 days.
	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed.
	Hurricane (48%) 1.5 oz fludioxonil and mefenoxam	drench to completely wet root zone at 21- to 28-day intervals
	Medallion (50% WP) 1 packet; fludioxonil	Apply after transplant (1.0-2.0 pt/sq ft). Repeat every 14 days.
	Pageant (38%) 12.0 to 18.0 oz pyraclostrobin and boscalid	Drench to completely wet root zones at 7- to 14-day intervals
	Palladium (63.5% WDG) 2.0 to 4.0 oz Cyprodinil and fludioxonil	Apply at 7- to 14-day intervals
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals
Chrysanthemum Mycosphaerella ray blight	Banner Maxx 2.0-4.0 fl oz; propiconazole	Apply on a 14-day schedule.
	Chipco 26019 (50% WP) 1.0-2.0 lb; iprodione	Apply at 7- to 10-day intervals.
	Daconil Weather Stik 1.4 pt; chlorothalonil	Apply first spray of Daconil just before flower color shows and at 7-day intervals.
	Dithane Rainshield or Fore Rainshield, 1.5 lb mancozeb	Apply mancozeb at 7- to 10-day intervals. Apply at transplant of cuttings.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Apply at first sign of disease and repeat at 10- to 14- day intervals.
	Cleary 3336-F, 12.0 to 16.0 fl oz; Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Apply Cleary 3336 at 7- to 10-day intervals as needed.

Table 5.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	**Fungicide Rate/100 Gal**	**Remarks**
Chrysanthemum Botrytis gray mold and Septoria leafspot	Broadform 4.0 to 8.0 fl oz fluopyram and trifloxystrobin	Spray at 7 to 14 day intervals.
	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Apply at prebloom and repeat at 7- to 14-day intervals.
	Daconil Weather Stik 2.0 pt Concorde (54% SST) 1.4 pt; chlorothalonil	Apply at prebloom and repeat at 7- to 14-day intervals.
	Dithane Rainshield or Fore Rainshield, 1.5 lb; Junction (15% DF) 1.5 lb; mancozeb	Apply at 7- to 10-day intervals.
	Pageant (38%) 12.0-18.0 oz pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Chrysanthemum Leaf rust	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Apply at first sign of disease and repeat at 7- to 14-day intervals.
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Cygnus (50%) 3.2-6.4 oz; Kresoxim-methyl	Apply at 10- to 14-day intervals.
	Dithane Rainshield or Fore Rainshield, 1.5 lb; mancozeb	Spray at 7- to 10-day intervals.
Chrysanthemum Pythium root rot	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Spray every 7 days.
	Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride	Treat soil at 3-week to 3-month intervals.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pints per square foot at a 28-day interval.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Subdue MAXX 0.05-1.0 fl oz; mefenoxam	See Azaleas
	Terrazole (35% WP) 4.0-6.0 oz; etridiazole	Repeat bedding plants at 4- to 8-week intervals. Repeat container plants at 4- to 12-week intervals.
Chrysanthemum Powdery mildew	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Rubigan 3.0-5.0 fl oz; fenarimol	Spray every 10 to 14 days.
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	See manufacturer's directions. Spray to run-off when mildew first appears.
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
Chrysanthemum Southern blight (Sclerotium)	Pageant (38%) 12.0 to 18.0 oz pyraclostrobin and boscalid	Apply every 7 to 14 days
	Palladium (62.5% WDG) 2.0 to 4.0 oz cyprodinil and fludioxonil	Apply at 7- to 14-da intervals
	Terraclor (25% WP) 8.0 oz ; pentachloronitrobenzene	See manufacturer's directions.
Crabapple Cedar-apple rust	Banner Maxx 2.0-4.0 fl oz; propiconazole	Three applications every 14 days starting at green tip.
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Daconil Weather Stik 1.4 pt; chlorothalonil	Start as flower buds open and spray 3 times at 10-day intervals.
	Dithane Rainshield or Fore Rainshield, 1.5 lb; mancozeb	Begin application at 1/4 inch to 1/2 inch green tip and continue on a 7- to 10-day schedule.

Table 5.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	**Fungicide Rate/100 Gal**	**Remarks**
Crabapple Cedar-apple rust (continued)	Maneb 80 (80% WP) 1.5 lb; maneb	Begin application at 1/4 inch to 1/2 inch green tip and continue on a 7- to 10-day schedule.
	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
Crabapple Fire blight	Alliette (80% WP) 2.5 lb; fosetyl-Al	Apply every 7 days.
	Agri-Strep 0.5 lb; streptomycin sulfate	Apply at early, mid, and late flowering.
Crabapple Powdery mildew	Banner Maxx, 2.0-4.0 fl oz; propiconazole	Apply Banner every 14 to 21 days.
	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Spray to run-off when mildew first appears.
	Terraguard 50W 4.0-8.0 oz; triflumizole	Apply as foliar spray as needed.
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
Crabapple Scab	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Banner Maxx, 2.0-4.0 fl oz; propiconazole	Banner applied on a 14-day schedule. Begin at green tip.
	Daconil Weather Stik 2.0 pt Concorde (54% SST) 1.4 pt; chlorothalonil	Apply at bud break and at 7-day intervals during wet weather.
	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Apply at 7- to 10-day intervals from bud break until two weeks after petal fall.
	Dithane Rainshield or Fore Rainshield, 1.5 lb; Junction (15% DF) 1.5 lb; mancozeb	Apply at 7- to 10-day intervals from bud break until two weeks after petal fall.
	Manzate 80 (80 % WP) 1.5 lb; maneb	Apply at 7- to 10-day intervals from bud break until two weeks after petal fall.
Crape Myrtle Powdery mildew	Banner Maxx 2.0-4.0 fl oz; propiconazole	Apply Banner every 21 days.
	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Spray Strike to run-off when mildew first appears.
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Terraguard 50W 4.0-8.0 oz; triflumizole	Use higher rates under severe conditions.
	Tourney (50% WDG) 1.0 to 4.0 oz metconazole	Apply every 14 to 28 days
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
	Trinity (19.2%) 8.0 to 12.0 fl oz triticonazole	Apply at 7 to 14 day intervals
Daffodil Botrytis blight	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Apply every 10-14 days.
	Decree (50 WDG) 0.7-1.5 lb; fenhexamid	Repeat at 7- to 10-day intervals.
	Pageant (38%) 12.0-18.0 oz pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Daffodil Fusarium and Penicillium bulb rots	Cleary 3336-F, 12.0 to 16.0 fl oz; Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Soak bulbs for 15 to 30 minutes in a warm dip (80˚ to 85°F.)
Dahlia Powdery mildew	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Spray to run-off when mildew first appears.
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals

Table 5.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	**Fungicide Rate/100 Gal**	**Remarks**
Dahlia Botrytis blight (Gray mold)	Dithane Rainshield or Fore Rainshield, 1.5 lb; mancozeb	
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Apply to protect against disease. Repeat at 10- to 14- day intervals.
	Cleary 3336-F, 12.0 to 16.0 fl oz; Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Apply to protect against disease. Repeat at 10- to 14- day intervals.
	Decree (50 WDG) 0.7-1.5 lb; fenhexamid	Repeat at 7- to 10-day intervals.
Dogwood Vascular streak dieback	Terraguard SC (42.14%), 0.125 to 0.250 lb ai per acre; triflumizole	More fungicide options are provided at https://www.pubs.ext.vt.edu/SPES/spes-483/spes-483.html Apply soil drench at 2 to 4 week interval as needed.
Dogwood Rhizoctonia root rot	Chipco 26019 (50% WP) 6.5 lb; iprodione	Use as a drench and apply 1.0-2.0 pts of solution/sq ft.
	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed.
	Hurricane (48%) 1.5 oz fludioxonil and mefenoxam	drench to completely wet root zone at 21- to 28-day intervals
	Pageant (38%) 12.0 to 18.0 oz pyraclostrobin and boscalid	Drench to completely wet root zones at 7- to 14-day intervals
	Palladium (63.5% WDG) 2.0 to 4.0 oz Cyprodinil and fludioxonil	Apply at 7- to 14-day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals
Dogwood Botrytis petal blight	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Apply Chipco 26019 at 7- to 14-day intervals.
	Cleary 3336-F, 12.0 to 16.0 fl oz; Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Apply Cleary 3336 at 10- to 14-day intervals.
	Decree (50 WDG) 0.7-1.5 lb; fenhexamid	Repeat at 7- to 10-day intervals.
	Pageant (38%) 12.0-18.0 oz pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Dogwood Botrysphaeria canker	Pageant (38%) 12.0 to 18.0 oz pyraclostrobin and boscalid	Apply every 7 to 14 days as needed
Dogwood Phytophthora root rot	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Spray every 7 days.
	Disarm (40.3% SC) 1.0-6.0 fl oz; fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pints per square foot at a 28-day interval.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Subdue MAXX 1.0-2.0 fl oz; mefenoxam	See Azalea.
Dogwood Septoria leaf spot	Dithane Rainshield or Fore Rainshield, 1.5 lb; Junction (15% DF) 1.5 lb; mancozeb	Begin at first sign of disease and spray at intervals of 7 to 10 days.
	Daconil Weather Stik 1.4 pt Concorde (54% SST) 1.4 pt; chlorothalonil	Apply at early bloom. Apply at 7- to 14-day intervals.
	Cleary 3336-F 12.0-16.0 fl oz thiophanate methyl	Spray when disease first appears and repeat at 10- to 14-day intervals.

Table 5.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	**Fungicide Rate/100 Gal**	**Remarks**
Dogwood Spot anthracnose, Leaf and flower blight Anthracnose *(Discula* sp.)	Dithane Rainshield or Fore Rainshield, 1.5 lb; mancozeb	Apply when buds begin to open, when bracts have fallen, 4 weeks later, and again in late summer after flower buds for next season have formed.
	Banner Maxx, 2.0-4.0 fl oz ; propiconazole	Apply Banner at 14-day intervals.
	Daconil Weather Stik 2.0 pts.; chlorothalonil	For spot anthracnose and leaf and flower blight apply when buds begin to open. Repeat when bracts have fallen, 4 weeks later and in the late summer after flower buds have formed. For anthracnose *(Discula* sp.) apply 3 to 4 sprays during leaf expansion in the spring, at 10- to 14-day intervals.
	Maneb 80 (80% WP) or Maneb Plus Zinc F4 Fungicide (37% F) 1.0-1.5 lb or 0.8-1.2 qt; maneb Junction (15% DF) 1.5 lb; mancozeb	For spot anthracnose, leaf and flower blight apply when buds begin to open. Repeat when bracts have fallen, 4 weeks later and in the late summer after flower buds have formed. For anthracnose *(Discula* sp.) apply 3 to 4 sprays during leaf expansion in the spring, at 10- to 14-day intervals.
Dogwood Powdery mildew	Concert II (41.4%) 22.0 to 35.0 fl ozpropiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Cygnus (50%) 1.6-3.2 oz; kresoxim-methyl	
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Spray to run-off when mildew first appears.
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
Euonymus Powdery mildew	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Cygnus (50%) 1.6-3.2 oz; kresoxim-methyl	
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Spray to run-off when mildew first appears.
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
Euonymus Crown gall	Galltrol-A	See manufacturer's directions. Purchase healthy plants. Do not replant in beds where infected plants have been removed.
Euonymus Anthracnose *(Colletotrichum)*	Dithane Rainshield or Fore Rainshield, 1.5 lb; Junction (15% DF) 1.5 lb; mancozeb	Spray at bud break, then repeat at 14-day intervals.
	Daconil Weather Stik 1.375 pt Concorde (54% SST) 1.37 pt; chlorothalonil	Spray at bud break, then repeat at 14-day intervals.
Euonymus Botrytis blight (Gray mold)	Decree (50 WDG) 0.7-1.5 lb; fenhexamid	Repeat at 7- to 10-day intervals.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Repeat at 10- to 14-day intervals.
	Pageant (38%) 12.0-18.0 oz pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Forsythia Rhizoctonia	Chipco 26019 (50% WP) 0.4 lb; iprodione	Apply after transplanting (1.0-2.0 pt/sq ft). Repeat after 14 days.
	Cleary 3336-F 12.0-16.0 fl oz thiophanate methyl	Apply as a drench or heavy spray.
	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed
	Hurricane (48%) 1.5 oz; fludioxonil and mefenoxam	Drench to completely wet root zone at 21- to 28-day intervals
	Pageant (38%) 12.0 to 18.0 oz pyraclostrobin and boscalid	Drench to completely wet root zones at 7- to 14-day intervals

Table 5.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	**Fungicide Rate/100 Gal**	**Remarks**
Forsythia Rhizoctonia (continued)	Palladium (63.5% WDG) 2.0 to 4.0 oz Cyprodinil and fludioxonil	Apply at 7- to 14-day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals
Forsythia Phytophthora shoot blight	See Azalea shoot blight	
Gladiolus Botrytis leaf blight	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Chipco 26019 at 10- to 14-day intervals.
	Daconil Weather Stik 1.4 pt; chlorothalonil	Apply Daconil every 7 to 10 days during normal weather, every 2 to 3 days during wet periods.
	Decree (50 WDG) 0.7-1.5 lb, fenhexamid	Apply at 7- to 10-day intervals.
	Pageant (38%) 12.0-18.0 oz pyraclostrobin and boscalid	Apply every 7 to 14 days as needed
Gladiolus Penicillium and Fusarium corm rots (pre-planting)	Cleary 3336-F, 12.0 to 16.0 fl oz; Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Submerge clean corms for 15-30 minutes in warm water (80˚ to 85°F). Stir solution constantly to be sure chemical remains in suspension.
Gladiolus Curvularia and Leaf spots *Stemphyliam*	Maneb 80 (80% WP) or Maneb Plus Zinc F4 Fungicide (37% F) 1.5 lb or 1.2 qt; maneb	Begin when flower spikes are developing. Repeat 2 to 3 times at weekly intervals.
Hawthorn Rust and *Fabraea* leaf spot	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Daconil Weather Stik 1.4 pt; chlorothalonil	Spray at prebloom with cover sprays at 7- to 10-day intervals as needed.
	Dithane Rainshield or Fore Rainshield, 1.5 lb; mancozeb	
Holly (Japanese) Root rot *(Thielaviopsis basicola, Rhizoctonia)*	Affirm or Veranda-O (11.3%) 0.3 to 0.5 lb polyoxin D zinc salt	Drench to completely wet root zone at 14- to 28-day intervals as needed
	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Sanitation in propagation. Apply as heavy drench or spray to 800 sq ft of bench area (1.0-2.0 pts/sq ft). Repeat at 2- to 4-week intervals.
	OHP 26 GT-0 13.0 fl oz	Drench 1.0 to 2.0 pints of solution per square foot every 14 days.
Holly (Japanese) Rhizoctonia web blight *(Rhizoctonia solani)*	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Apply as a heavy drench or spray to 800 sq ft of bench or bed area, (1.0-2.0 pts/sq ft). Repeat at 2- to 4-week intervals.
	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed.
	Hurricane (48%) 1.5 oz fludioxonil and mefenoxam	Apply at 21- to 28-day intervals
	Pageant (38%) 12.0 to 18.0 oz pyraclostrobin and boscalid	Apply at 7- to 14-day intervals
	Palladium (63.5% WDG) 2.0 to 4.0 oz Cyprodinil and fludioxonil	Apply at 7- to 14-day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals
Holly (Japanese) Phytophthora and Pythium root rot	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Alliette (80% WDG) 1.0-2.0 lbs/1000 sq ft fosetyl-Al	
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Spray every 7 days.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pints per square foot at a 28-day interval.
	Subdue MAXX 1.0-2.0 fl oz; mefenoxam	See Azalea.

Table 5.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	**Fungicide Rate/100 Gal**	**Remarks**
Holly (Japanese) Phytophthora and Pythium root rot (continued)	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7- to 14 days
	Orvego (46.2%) 14.0 fl oz ametoctradin and dimethomorph	Apply at 10- to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
Hydrangea Botrytis leaf blight	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Spray every 10 to 14 days.
	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Apply when disease first appears, repeat at 10- to 14-day intervals.
	Decree (50 WDG) 0.7-1.5 lb; fenhexamid	Repeat at 7- to 10-day intervals.
	Dithane Rainshield or Fore Rainshield, 1.5 lb; mancozeb	Apply at 7- to 14-day intervals.
	Pageant (38%) 12.0-18.0 oz pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Juniper Phomopsis needle and twig blight	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Begin application at bud break and repeat at 7-day intervals through the growing season.
	Dithane Rainshield or Fore Rainshield, 1.5 lb; mancozeb	Begin application at bud break and repeat at 7-day intervals through the growing season.
Juniper Rhizoctonia web blight *(Rhizoctonia solani)*	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Apply as a heavy drench or spray to 800 sq ft of bench or bed area, (1.0-2.0 pts/sq ft). Repeat at 2- to 4-week intervals. Avoid crowding plants.
	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed.
	Hurricane (48%) 1.5 oz fludioxonil and mefenoxam	Apply at 21- to 28-day intervals
	OHP 26 GT 1.0-2.5 qt; iprodione	Spray plants every 7 to 14 days.
	Pageant (38%) 12.0 to 18.0 oz pyraclostrobin and boscalid	Apply at 7- to 14-day intervals
	Palladium (63.5% WDG) 2.0 to 4.0 oz Cyprodinil and fludioxonil	Apply at 7- to 14-day intervals
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals
Juniper Phytophthora and Pythium root rot	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Alliette (80% WP) 1.0-2.0 lbs/1000 sq ft; fosetyl-Al	See Azalea.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Spray every 7 days.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pints per square foot at a 28-day interval.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Subdue Maxx 1.0-2.0 fl oz; mefenoxam	See Azalea.

Table 5.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	**Fungicide Rate/100 Gal**	**Remarks**
Lilac Powdery mildew	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Spray to run-off when mildew first appears.
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
Liriope Fusarium root and crown rot	Empress (23.3%) 2.0 to 6.0 fl oz; pyraclostrobin	Apply at 7- to 28-day intervals as needed
Maple Vascular streak dieback	Terraguard SC (42.14%), 0.125 to 0.250 lb ai per acre; triflumizole	More fungicide options are provided at https://www.pubs.ext.vt.edu/SPES/spes-483/spes-483.html Apply soil drench at 2 to 4 week interval as needed.
Mountain Laurel *(Kalmia latifolia)* Cercospora leaf spot	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14- to 21-day intervals
	Daconil Weather Stik 2.0 pt; chlorothalonil	Spray at 7-day intervals during wet weather. Spray when buds break in the spring and twice more at 2-week intervals.
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days as needed
Pachysandra Volutella leaf and stem blight	Dithane Rainshield, 1.5 lb; mancozeb	Apply first spray in the spring. Make 5 applications at 10- to 14-day intervals.
	Fixed Copper (WP) 1.0 lb; copper	Apply Fixed Copper at 7- to 10-day intervals.
Peony Botrytis blight (Gray mold)	Cleary 3336-F 12.0-16.0 fl oz, thiophanate methyl	Begin when disease first appears and repeat at 10- to 14-day intervals.
	Decree (50 WDG) 0.7-1.5 lb; fenhexamid	Repeat at 7- to 10-day intervals.
	Pageant (38%) 12.0-18.0 oz pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Peony Alternaria leaf spot and Phytophthora blight	Maneb 80 (80% WP) or Maneb Plus Zinc F4 Fungicide (37% F) 1.5 lb or 1.2 qt; maneb	Begin when disease first appears and repeat at 10- to 14-day intervals.
Peony Leaf blotch, red spot or measles (Cladosporium paeoniae)	Mancozeb DG (75%) 1.0 to 2.0 lb; mancozbe	Apply every 7 to 14 days after removing symptomatic plant parts
Peony Rhizoctonia root and stem rot	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Apply as a heavy drench or spray to 800 sq ft of bench or bed area, (1.0-2.0 pts/sq ft). Repeat at 2- to 4-week intervals. Avoid crowding plants.
	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed.
	Hurricane (48%) 1.5 oz fludioxonil and mefenoxam	Apply at 21- to 28-day intervals
	OHP 26 GT 1.0-2.5 qt; iprodione	Spray plants every 7 to 14 days.
	Pageant (38%) 12.0 to 18.0 oz pyraclostrobin and boscalid	Apply at 7- to 14-day intervals
	Palladium (63.5% WDG) 2.0 to 4.0 oz Cyprodinil and fludioxonil	Apply at 7- to 14-day intervals
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals
Periwinkle (Vinca minor) Phomopsis stem rot	Cleary 3336-F 12.0-16.0 fl oz thiophanate methyl	Begin when disease first appears and repeat at 10- to 14-day intervals.

Table 5.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	**Fungicide Rate/100 Gal**	**Remarks**
Photinia Powdery mildew	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
	Trinity (19.2%) 8.0 to 12.0 fl; oztriticonazole	Apply at 7 to 14 day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
Photinia Entomosporium leaf spot (Entomosporium maculatum)	Banner MAXX 2.0-4.0 fl oz; propiconazole	Apply in early spring as growth starts and reapply on 14-day schedule until new growth is fully expanded.
	Strike (25% WDG) 16.0 oz; triadimefon	
	Daconil Weather Stik 1.4 pt Concorde (54% SST) 1.4 pt; chlorothalonil	Spray at 2- to 4-week intervals. Avoid overhead irrigation. Avoid crowding containers.
	Dithane Rainshield or Fore Rainshield, 1.5 lb; mancozeb	Spray at 7- to 14-day intervals.
	Cleary 3336-F 12.0-16.0 fl oz thiophanate methyl	Spray at 7- to 14-day intervals.
Pine (White, Japanese, Black) Phytophthora root rot	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Alliette (80% WP) 1.0-2.0 lbs/100 sq ft fosetyl-Al	See Azalea.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Spray every 7 days.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pints per square foot at a 28-day interval.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.55% SC) 6.0-13.0 fl oz; dimethomorph	Apply at 10- to 14 day intervals. Constant agitation required.
	Subdue Maxx 1.0-2.0 fl oz; mefenoxam	See Azalea.
Pyracantha (Firethorn) Fire blight	Alliette (80% WP) 2.5 lb; fosetyl-Al	Begin spray at pre-bloom. Repeat as necessary but do not exceed one application every 7 days until blooming period ends.
	Streptomycin agric. compd. 100 ppm streptomycin sulfate	Spray when 20% of the blossoms are open and repeat 5 to 7 days during bloom period. COMMERCIAL ORNAMENTAL USE ONLY.
	Fixed copper 1.0 lb; copper	Apply the first spray at bud break, 10 to 14 days later and at petal fall.
Pyracantha Scab	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Daconil Weather Stik 1.4 pt Concorde (54% SST) 1.4 pt; chlorothalonil	Spray at bud break and repeat twice at 10-day intervals.
	Dithane Rainshield or Fore Rainshield, 1.5 lb; Junction (15% DF) 1.5 lb; mancozeb	Spray at 7- to 14-day intervals.
	Fixed Copper 1.0 lb; copper	Spray at 7- to 14-day intervals.
	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Begin when disease appears and repeat at 10- to 14-day intervals.
Redbud Vascular streak dieback	Terraguard SC (42.14%), 0.125 to 0.250 lb ai per acre; triflumizole	More fungicide options are provided at https://www.pubs.ext.vt.edu/SPES/spes-483/spes-483.html Apply soil drench at 2 to 4 week interval as needed.
Rhododendron Ovulinia petal blight	Same as for Azalea.	Same as for Azalea.

Table 5.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	**Fungicide Rate/100 Gal**	**Remarks**
Rhododendron Phytophthora root rot and wilt	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Alliette (80% WDG) 2.5-5.0 lb; fosetyl-Al	Spray to run-off at monthly intervals.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Spray every 7 days.
	Banol (66.5%) 20.0-30.0 fl oz propamocarb hydrochloride	Repeat every 3 weeks to 3 months.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
Rhododendron Phytophthora root rot and wilt (continued)	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin	Apply at 7- to 14-day intervals.
	Terrazole (35% WP) 4.0-10.0 oz; etridiazole	See Azalea.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Subdue Maxx 1.0-2.0 fl oz; mefenoxam	See Azalea.
Rhododendron Rust	Same as for Azalea.	Same as for Azalea.
Rhododendron Botrytis gray mold	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	See Azalea.
	Cleary 3336-F, 12.0 to 16.0 fl oz; Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	See Azalea.
	Decree (50 WDG) 0.7-1.5 lb; fenhexamid	Apply at 7- to 10-day intervals.
	Pageant (38%) 12.0-18.0 oz pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Rose Crown gall	Galltrol-A	See manufacturer's directions. Purchase healthy rose bushes. Do not injure the roots or crowns of roses.
Rose Black spot	Banner EC Maxx, 2.0-4.0 fl oz; propiconazole	Tank mix with a registered contact fungicide labeled for black spot control.
	Cleary 3336-F, 12.0 to 16.0 fl oz; Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Start applications in the spring as leaves expand. During dry weather, treat at 7- to 10-day intervals for Daconil.
	Daconil Weather Stik 1.375 pt; chlorothalonil	Start applications in the spring as leaves expand. During dry weather, treat at 7- to 10-day intervals for Daconil.
	Dithane Rainshield or Fore Rainshield, 1.5 lb; Junction (15% DF) 1.5 lb; mancozeb	Apply at 7- to 14-day intervals.
	Maneb 80 (80% WP) or Maneb Plus Zinc F4 Fungicide (37% F) 1.5 lb or 1.2 qt; maneb	Apply at 7- to 14-day intervals.
	Triact 70 0.5-1.0 gal, neem oil	Apply every 14 days.
	Torque (38.7) 4.0 to 10.0 fl oz; tebuzonazole	Apply every 14 to 21 days as needed
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
Rose Botrytis blight (Gray mold)	Decree 0.7-1.5 lb; fenhexamid	Spray every 7 to 14 days.
	Cleary 3336-F, 12.0 to 16.0 fl oz; Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Apply to buds to protect against disease. Repeat at 10- to 14-day intervals.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Apply to buds to protect against disease. Repeat at 10- to 14-day intervals.
	Pageant (38%) 12.0-18.0 oz pyraclostrobin and boscalid	Apply every 7 t o14 days as needed

Table 5.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	**Fungicide Rate/100 Gal**	**Remarks**
Rose Downy mildew	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Alliette (80% WDG) 2.5 lb; fosetyl-Al	Apply every 7 to 14 days.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Spray every 7 days.
	Cygnus (50%) 3.2-6.4 oz; kresoxim-methyl	
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Spray plants at a 28-day interval.
	Heritage (50%) 2.0-4.0 oz; azoxystrobin	Apply every 1 to 3 weeks.
Rose Downy mildew (continued)	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin	Apply at 7- to 14-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
Rose Powdery mildew	Banner Maxx, 2.0-4.0 fl oz; propiconazole	Thorough coverage is needed for best results.
	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Cygnus (50%) 1.6-3.2 oz; kresoxim-methyl	Start applications in the spring as leaves expand. Treat at 10- to 14-day intervals to protect. Spray at 7-day intervals if mildew is present.
	Strike (25% WDG) 2.0-4.0 oz triadimefon	Start applications in the spring as leaves expand. Treat at 10- to 14-day intervals to protect. Spray at 7-day intervals if mildew is present.
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Terraguard 50W 4.0-16.0oz triflumizole	Apply on a 7- to 14-day interval as needed. Use the high rate on an existing infection.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
Willow Crown gall	Galltrol-A	See manufacturer's directions.
Yew *(Taxus)* Phytophthora root rot and crown rot	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but not more than twice per crop cycle.
	Alliette (80% WDG) 1.0-2.0 lbs/1000 sq ft; fosetyl-Al	See Azalea.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Spray every 7 days.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pints per square foot at a 28-day interval.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin	Apply at 7- to 14-day intervals.
	Terrazole (35% WP) 4.0-10.0 oz; etridiazole	Repeat every 4 to 12 weeks.
	Segway (34.5% SC) 2.0-6.0 fl oz; cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz; dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.

Nursery Crops: Organic Controls for Insect Pests

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Table 5.2 - Organic Controls, Predators and Pathogens

Products or pathogens	Insects Controlled	Remarks
Azadirachtin	Thrips, aphids, caterpillars, mealybugs, leafhoppers, leafminers	Sold under many trade names including; Aza-Direct, AzaGuard, Azatin, AzaSol, Azatrol,Triact, Molt-X, Ornazin, Trilogy
Bacillus thuringiensis	Leaf-feeding caterpillars, elm and willow leaf beetle	Known as *"Bt;"* sold under many trade names, including Dipel, Javelin. A strain of *Bt* is sold as Trident for beetle control
Beauveria bassiana	Beetles, aphids, others	Various trade names, including BioCeres, BotaniGard, BoteGHA, Mycotrol
Burkholderia spp. strain A396	Aphids, leafhoppers, stinkbugs, thrips	Sold as Venerate
Capsicum oleoresin extract, garlic and soybean oils	Thrips and mites	Sold as Captiva Prime
Chromobacterium subtsugae strain PRRA4-1	Caterpillars, cottonwood leaf beetle	Sold as Grandevo; See label for rates for specific pests.
Entomopathogenic nematodes (*Steinernema* and *Heterorhabditis*)	Root-feeders, borers, black vine weevil	For grubs or weevil larvae, apply to ground at base of plants. Rates are on product label; soil temperature should exceed 60˚ F. Apply late in the day, irrigate immediately. For borers, inject directly into galleries using syringe or turkey baster. Not effective against foliar feeding pests as desiccation and exposure to ultraviolet light on the leaf surface kills the nematodes within hours.
Garlic juice	Repels a wide variety of insects	Sold as Garlic Barrier
GS-omega/kappa-Hxtx-Hv1a peptide	Aphids, mites, thrips, whiteflies, lepidopterans	Sold as Spear-T or Spear-Lep
Insecticidal soap	Works well on soft bodied insects in particular aphids, mites, lacebugs, mealybugs	This product is sold under many trade names and is a fatty acid soap, including M-Pede. Least impact on natural enemies.
Isaria fumosorosea Apopka Strain 97	Aphids, thrips, whiteflies, weevils, psyllids, leafminers, spider mites, mealybugs	See label. Foliar and soil applications. Sold as PFR-97.
Kaolin clay	Beetles, aphids, caterpillars, others	Various trade names
Pyrethrins	Broad spectrum, works on a wide variety of insects	Sold under numerous trade names, including Pyganic. Pycana is mixed with canola oil and is labeled for use on flowers, shrubs, fruits, and vegetables in shadehouse, nursery, hoophouse, container-grown nursery crops, and greenhouses.
Soybean and corn oils	Broad spectrum, works on a wide variety of insects	Sold as PureCrop1
Spinosad	Many insect pests, including thrips, caterpillars, and leaf beetles	Entrust is for certified organic production.
Predators	**Insects Controlled**	**Remarks**
Lady beetles	Feed on aphids and other soft bodied insects	Lady beetles may leave to find other prey after release. *Cryptolaemus* is used for mealybug, *Delphastus* is used for whitefly. *Chilocorus* is used for scales.
Lacewings	Aphids, scales, mealybugs, other soft bodied insects	Immature are called aphid lions. Usually sold as eggs. Several Chrysoperla species being sold, including *C. rufilabris*.
Predatory mites	Mostly for control of spider mites, thrips	*Phythoseiulus persimilus* will feed on spider mites and *Amblyseius* spp. will feed on thrips.
Parasitic wasps	Many insect pests on the foliage including caterpillars, whiteflies	*Trichogramma* wasps work well on many Lepidoptera eggs; *Encarsia formosa* for whiteflies; *Diglyphus* for leaf miners; *Aphytis* for armored scale; *Aphidius colemani* for aphids.

Table 5.3 - Organic Controls, Predators and Pathogens

UPDATED List of Commercial Suppliers and Insectaries/Laboratories selling predators and parasitoids for augmentative biocontrol

*The following table was completed using information from the 2015 Directory of Least-Toxic Pest Control Products, published on The IPM Practitioner Magazine (https://www.birc.org/Final2015Directory.pdf). There are more companies/suppliers offering beneficial arthropods and are not included in this table. Appearance on this table does not reflect endorsement by VCE.

**Companies might offer additional products, besides the ones listed in this table. Check the respective company's website for a complete list of products, prices and availability.

Company Name*	City	State	Products**	Website for Ordering
A-1 Unique	Citrus Height	California	Lacewings, Lady beetles	https://organiccontrol.com/welcome-a1-unique/
Arbico Organics	Oro Valley	Arizona	Lacewings, Lady beetles	https://www.arbico-organics.com/
Associates Insectaries	Santa Paula	California	Lady beetles	https://www.associatesinsectary.com/
Beneficial Insectaries	Redding	California	Parasitic wasps, Lacewings, Predatory mites	https://www.insectary.com/
BFG Supply	Burton	Ohio	Lacewings	https://www.bfgsupply.com/
Biobee	Salisbury	Maryland	Parasitic wasps, Lacewings, Lady beetles, Predatory mites	https://biobee.us/
Biobest	Romulus	Michigan	Parasitic wasps, Lady beetles	https://www.biobestgroup.com/
Bioline Agrosciences	Oxnard	California	Parasitic wasps, Lacewings, Predatory mites	https://www.biolineagrosciences.com/
Bioworks	Victor	New York	Parasitic wasps, Lacewings, Predatory mites	https://bioworksinc.com/
Buglogical	Tucson	Arizona	Lacewings, Lady beetles	https://www.buglogical.com/
Evergreen Grower Supply	Clackamas	Oregon	Parasitic wasps, Lacewings	https://www.evergreengrowers.com/
Garden Alive	Lawrenceburg	Indiana	Lacewings, Lady beetles	https://www.gardensalive.com/
Greenmethods	Redding	California	Parasitic wasps, Lacewings, Lady beetles	https://greenmethods.com/
IPM Laboratories Inc.	Locke	New York	Parasitic wasps, Lacewings, Lady beetles	https://www.ipmlabs.com/
Koppert	Howell	Michigan	Parasitic wasps, Lacewings, Lady beetles, Predatory mites	https://www.koppertus.com/
Kunafin	Quemado	Texas	Lacewings	https://www.kunafin.com/
Natural Pest Control	Orangevale	California	Lacewings, Lady beetles	https://www.natpestco.com/
Nature's Control	Medford	Oregon	Parasitic wasps, Lacewings, Lady beetles	https://naturescontrol.com/
Organic Control	Harbor City	California	Lacewings	https://www.organiccontrol.com/
Peaceful Valley	Grass Valley	California	Lacewings, Lady beetles	https://www.groworganic.com/
Planet Natural	Bozeman	Montana	Lacewings, Lady beetles	https://www.planetnatural.com/
Rincon-Vitova Insectaries	Ventura	California	Parasitic wasps, Lacewings, Lady beetles	https://www.rinconvitova.com/
Tip Top	Westlake Village	California	Parasitic wasps, Lacewings, Lady beetles	https://tiptopbiocontrol.com/

Nursery Crops: Insects

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These recommendations are for use by nursery producers, commercial and municipal arborists, and other certified applicators, Category 3, who are responsible for the production, care, and protection of herbaceous, shade trees, shrubs, and other woody ornamental plants.

There is no simple magic formula for pest control on herbaceous plants, trees and shrubs. More than 250 species of insects and mites are commonly found which damage or are potentially injurious to over 100 genera of ornamental plants. Great diversity by insects in host preferences, seasonal development, periods of activity, habits, and susceptibility to insecticides requires careful planning and critical timing of control measures. It is a simple fact that insects and mites will occur, multiply, and cause serious losses if ignored or inadequately controlled. The most frequent cause of insect problems is the failure of nursery personnel and arborists to carry out necessary control procedures properly at the right time due to pressures from other phases of production and maintenance.

The best way to control insects and mites is a preventive program. First, do not introduce pest problems. In nursery production, propagate or buy **ONLY** clean, uninfested stock plants. In municipal tree plantings or private landscaping, set out **ONLY** insect-free plant materials. The presence of a few hardly noticeable insects or mites at planting time is a sure source of extra work and costly effort later on. Second, draw up a seasonal pest monitoring schedule to prevent the establishment and buildup of insects and mites. Third, maintain regular surveillance of established plant materials and be prepared to schedule control measures for difficult or complex pest problems which arise. Take advantage of assistance from your local Extension faculty and the Extension specialists at Virginia Tech.

■ How to Use These Recommendations

Prepare a seasonal monitoring and management schedule for your specific plant types and pest problems. Each nursery, municipality, or local area tends to have its own unique pest situations depending on routine cultural and control practices. If the pest situation is not known, conduct a thorough survey to determine which problems exist and what the control needs are. Select those treatments which most conveniently fit the work plan in your own operation. With careful study and planning these recommendations can be adapted to an effective, seasonal, preventive control program. It is essential to carry out the control program precisely. Thoroughness and proper timing are critical in obtaining effective results. Some degree day (DD) accumulations to the susceptible life stage are included (50°F base temperature) in the timing section. Beware that using DD information without scouting can lead to unnecessary insecticide applications.

PRECAUTIONS

Be absolutely sure to read and follow ALL of the directions and precautions on the labels and accompanying brochures of the pesticides used. Every statement included is important and can prevent serious injuries or losses. Be sure that those involved in the application of pesticides are fully informed of all precautions for use and are certified applicators. Formulations and amounts to mix in preparing sprays are given; however, consult the labels for precise directions. It is illegal to use pesticides inconsistent with uses specified on the label. Be sure the host plants and pests to be controlled are stated on the label of the product you use.

TOXICITY AND HAZARD TO HUMANS AND ANIMALS

As a guide to general hazards of chemicals, know the relative toxicities of common insecticides. Also study the precautionary statements on pesticide labels. Certain chemicals may be more readily absorbed through the skin than if ingested, or vice versa. Some may be relatively non-toxic to bees and birds, but highly toxic to fish. Other chemicals may be acutely or chronically toxic to bees. Read the label for special precautions. When spraying, it is essential to stay out of drift and direct spray. Wear protective equipment as directed by the label.

SPECIAL PRECAUTIONS FOR POLLINATORS

Some insecticides may be acutely or chronically toxic to bees. Read the label for special precautions. Certain labels contain special precaution section titled “Protection of Pollinators”. A bee hazard icon may warn applicators of special application restrictions to protect pollinators. Follow instructions from the label to mitigate any potential hazard for pollinators originated by the application of a selected pesticide.

PLANT INJURY

Insecticides vary greatly in their phytotoxicity. Be sure to avoid treating sensitive or stressed plants. Cautions on the label usually indicate plants which should not be sprayed. Read the entire label carefully. Petroleum oils for dormant or summer spraying are much safer, but may injure birch, beech, sugar and Japanese maple, hickory, walnut, butternut, douglas fir, spruces, or juniper.

It is important not to mix pesticides which are not compatible with each other, and avoid formulations not intended for use on plants. Formulations used for structural pest control should never be applied to plants.

Table 5.4 - Control Measures for Major Pests and Pest Groups

Pest	Control	Timing of Treatment	Remarks
Adelgids spruce gall adelgid	bifenthrin cyclaniliprole imidacloprid	Treat just before buds break in the spring, and/or in September and early October after galls have opened.	Spring treatments should be applied before cottony egg masses are evident on buds in the spring. Cooley spruce gall adelgid on Douglas fir does not produce galls; it feeds openly on the needles.
pine bark adelgid	bifenthrin cyclaniliprole deltamethrin horticultural oil imidacloprid insecticidal soap	Treat in late April or early May and repeat 2-3 weeks later.	Use a forceful spray to penetrate cottony secretions. Use less-toxic materials in public areas and around homes. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/2907/2907-1402/2907-1402.html
hemlock woolly adelgid	bifenthrin cyclaniliprole dinotefuran horticultural oil insecticidal soap imidacloprid thiamethoxam	Treat in late June and/or in September or October.	When spraying, thoroughly wet entire plant including the bark of branches and the trunk. Use a forceful spray; be sure the new growth is thoroughly wet. Use care when treating soil to avoid runoff from site. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/3006/3006-1451/3006-1451.html
Ambrosia Beetles	bifenthrin permethrin	Treat trunk and larger branches in April when the daytime temperature exceeds 70˚F for the first time.	Sawdust projecting from the trunk like a toothpick is diagnostic for this insect. Trees can often survive a small infestation.
Ants see "imported fire ant"			
Aphids general	abamectin acephate acetaprimid afidopyropen azadirachtin *Beauveria bassiana* clothianidin cyantraniliprole dinotefuran flonicamid flupyradifurone fluvalinate imidacloprid insecticidal soap pymetrozine spinetoram+sulfoxaflor spirotetramat thiamethoxam tolfenpyrad	Some aphids (spirea, willow twig, white pine) occur in the spring. Others (crape myrtle, giant bark, willow leaf, linden, maple and oak) build up in mid-summer. Many (white pine aphid) may migrate to hosts throughout the season and in the fall. Look for honeydew or sooty mold.	Apply control measures before populations become large. Aphids may infest buds, leaves, stems, branches, or trunks of the host plants. Be sure to follow all label directions and precautions. Use less toxic and less hazardous materials in public areas, around homes, and where plants are to be moved or transplanted. Be aware of lady beetles, aphids lions, syrphid larvae, and other beneficial populations. Do not apply when plants are flowering and honeybees are active. Do not apply dinotefuran to linden, basswood or other tilia. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/444/444-220/444-220.html
Bagworm	acephate azadirachtin bifenthrin chlorantraniliprole cyantraniliprole cyclaniliprole cyfluthrin emamectin benzoate fluvalinate indoxacarb gamma-cyhalothrin lambda-cyhalothrin methoxyfenozide permethrin spinosad tebufenozide	Apply treatments when bags are less than 1/2 inch. Late May in coastal Virginia, early to mid-June elsewhere. Degree Days DD-600 controls less effective in mid-late summer.	Lightly misting the foliage is sufficient. Mist blower treatments are effective. Do not use the more toxic or hazardous materials in public areas or around homes. Permethrin may lead to mite increases. Light infestations can be handpicked and destroyed. Indoxacarb and chlorantraniliprole are for landscape use only. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/2808/2808-1008/2808-1008.html
	Bacillus thuringiensis (Bt)	Treat when larvae are young in mid to late June.	
	sanitation	Remove and burn bags from August to May for light infestation of a few infested trees.	Overwintering eggs remain inside the bags until hatching in late May. Destroy the bags; eggs will hatch from bags thrown on the ground.

Table 5.4 - Control Measures for Major Pests and Pest Groups (continued)

Pest	Control	Timing of Treatment	Remarks
Bark Beetles deciduous trees	bifenthrin cypermethrin permethrin	Treatments should be applied to prevent infestation of and breeding in the bark. Treat weakened or injured trees in late April and repeat 2 or 3 times at monthly intervals.	Thoroughly soak the bark of the trunk and branches. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/444/444-216/444-216.html
	sanitation	Immediately destroy all branches larger than 1-1/2" in diameter as soon as they begin to die or are cut to prevent infestation and breeding by beetles.	Wood should NEVER be piled or stored unless all of the bark is removed. Where possible, susceptible wood should be burned or buried with at least 18 inch fill.
	bifenthrin methoxychlor permethrin	As late in the spring as possible before LEAF BUDS open. This treatment can be supplemented with a second spray in early June.	Complete coverage of all bark is absolutely essential, especially the one year-old twigs in the tops and outer reaches of the trees. The trunk and larger branches should be soaked thoroughly. Spraying is supplementary to sanitation.
conifers	bifenthrin permethrin	Treat unhealthy, weakened, or damaged trees in early April, early June, and August if near infested trees. Also effective in preventing spread if sprayed on infested trees or wood before beetles emerge, or in preventing infestations in uninfested wood that is cut but cannot be disposed of immediately.	Thoroughly wet the bark. Healthy vigorous trees are not likely to be attacked and do not require spraying. Beetles will not reinfest or attack wood or trees dead more than one year.
	sanitation	Throughout the year, particularly during the growing season, when trees begin dying or wood is cut. Prune out large, dying, or recently dead branches.	Dispose of susceptible wood, slash, and bark from stumps by burning, burying where feasible. Beetles will not reinfest or attack wood or trees dead longer than one year.
shot-hole borer, fruit tree bark beetles, ash bark beetle (*Scolytus*)	bifenthrin permethrin	Spray the bark of healthy trees in late April and early June.	
Borers banded ash borer	bifenthrin permethrin	Treat trunk and main stems in late July and again in early September	Control measures are aimed at newly hatched larvae prior to tunneling into the tree. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/ENTO/ENTO-133/ENTO-133.html
lilac borer ash borer	bifenthrin permethrin	Treat trunk and branches in early May and again 6 weeks later. DD-148	Treatments kill emerging as well as entering borers. Thorough wetting and soaking of the bark is necessary. Foliage need not be treated. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/444/444-278/444-278.html
dogwood borer	bifenthrin permethrin	Treat trunk and larger branches in mid-May and repeat after 6 weeks. DD-250	Brown frass around bark cracks and wounds indicate an infestation. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/444/444-625/444-625.html
peach tree borer	acelepryn bifenthrin chlorantraniliprole permethrin	Treat trunks and soil around the base in July and repeat in 6 weeks.	Cracked bark, frass, and gummosis at the root crown are signs of infestation.
rhododendron borer	bifenthrin permethrin	Treat the trunks and larger branches in late June. DD-192	Wilting foliage and dieback are symptoms.
bronze birch borer	bifenthrin permethrin emamectin benzoate	Treat all bark surfaces, especially in the uppermost part of the tree in mid-May, early, mid-, and late June. DD-440	Emamectin benzoate could be applied by injection.
Borers emerald ash borer	bifenthrin cyfluthrin dinotefuran emamectin benzoate imidacloprid spinosad permethrin	Branch and trunk applications in early May and early June.	Additional insecticides are labeled as soil drenches and tree injections. See PMG 456-018 Insects of trees and shrubs. Do not move firewood. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/ENTO/ENTO-76/ENTO-76.html

Table 5.4 - Control Measures for Major Pests and Pest Groups (continued)

Pest	Control	Timing of Treatment	Remarks
round-headed and flat-headed tree borer	bifenthrin permethrin	Treat bark of trunk and branches in early May, early June, and early July.	Bifenthrin is labeled for flatheaded appletree borer in landscapes. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/444/444-215/444-215.html
oak borer	bifenthrin permethrin	Treat trunk to ground level early June.	Populations are larger in even-numbered years.
locust borer	permethrin	Treat the trunk and larger branches in late August to mid-September or in spring.	Sprays applied in early spring are directed at small larvae. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/ENTO/ENTO-141/ENTO-141.html
Cicada (periodical cicada)	bifenthrin	Treat bark of twigs on susceptible hosts soon after adult male singing becomes evident, usually around early May.	Cicada damage is caused by adult females inserting eggs in deep slits in twigs. Control is necessary only for young trees.
Defoliators general	acephate azadirachtin *Bacillus thuringiensis (Bt)* bifenthrin chlorantraniliprole clothianidin cyantraniliprole cyclaniliprole methoxychlor novaluron permethrin spinetoram+sulfoxaflor tolfenpyrad	When insects are first observed feeding. Timing varies with the species. It is critical to observe plants regularly to detect feeding as soon as it begins.	Insecticide combinations marketed by formulators and distributors are available. Consult the labels for specific uses and precautions. Mist blowers are effective. (Use Bt only for caterpillars).
cankerworms	acephate azadirachtin *Bacillus thuringiensis (Bt)* cyfluthrin emamectin benzoate fluvalinate lambda-cyhalothrin methoxychlor permethrin spinosad tebufenozide	In May when leaves are half to two-thirds full size, treatments must be applied when larvae are small. DD-148	Do not use methoxychlor on Chinese elm, Japanese or red maple, or redbud. Mist blowers are very effective.
elm leaf beetle	bifenthrin cyfluthrin cypermethrin fluvalinate imidacloprid lambda-cyhalothrin methoxychlor spinosad spinetoram+sulfoxaflor	Treat in mid-to-late May, when eggs have hatched but larvae are small. Second generation may need treatment in mid-to-late July.	Do not use methoxychlor on Chinese elm.
flea beetles	bifenthrin cyantraniliprole cyfluthrin fluvalinate lambda-cyhalothrin spinosad	When insects are found feeding on host plants as adults or as larvae. For red-headed flea beetles, see separate section down below.	Flea beetles can appear suddenly and cause serious injury to foliage. Monitoring of susceptible plants is critical. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/3104/3104-1549/3104-1549.html
grasshoppers	bifenthrin lambda-cyhalothrin	When grasshoppers are found feeding.	Grasshoppers are infrequent pests but can be destructive when abundant. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/3104/3104-1550/3104-1550.html

Table 5.4 - Control Measures for Major Pests and Pest Groups (continued)

Pest	Control	Timing of Treatment	Remarks
japanese beetle	azadirachtin bifenthrin chlorantraniliprole clothianidin cyantraniliprole cyclaniliprole cyfluthrin dinotefuran gamma-cyhalothrin imidacloprid lambda-cyhalothrin methoxychlor permethrin tolfenpyrad	In late June or early July after adults have begun to congregate on selected hosts. Repeat as necessary into August. (DD-1029)	Since adults actively fly and move continuously, they seem to be present constantly even where treatments have been applied. Do not apply dinotefuran to linden, basswood and other tilia. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/2902/2902-1101/2902-1101.html
rose chafer	azadirachtin methoxychlor	During June and mid-summer when insects are found.	Adults are active flyers and move continually onto susceptible hosts. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/3104/3104-1564/3104-1564.html
rose slugs	chlorantraniliprole methoxychlor	Throughout the growing season when young larvae are seen on plants, especially in May, June.	Time treatments to when larvae are young and damage is not yet severe.
spongy moth	acephate *Bacillus thuringiensis (Bt)* bifenthrin cyantraniliprole cyclaniliprole cypermethrin diflubenzuron emamectin benzoate fluvalinate indoxacarb gamma-cyhalothrin lambda-cyhalothrin methoxychlor methoxyfenozide permethrin spinosad spinetoram+sulfoxaflor tebufenozide	When leaves have expanded but caterpillars are small, usually in mid-May. (DD-90)	Mist blowers and aerial applications are effective.
tussock moth	azadirachtin bifenthrin cyfluthrin fluvalinate gamma-cyhalothrin indoxacarb lambda-cyhalothrin methoxychlor methoxyfenozide tebufenozide spinetoram+sulfoxaflor spinosad	In mid-May or late August.	Treat when larvae are small.
willow leaf beetle	methoxychlor spinetoram+sulfoxaflor spinosad	In May, June, and later if infestations persist. There may be several generations in a season.	Be sure to treat the undersides of the leaves. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/ENTO/ENTO-139/ENTO-139.html
Gall Insects	fenoxycarb spinetoram+sulfoxaflor spinosad thiamethoxam	Treatments are effective when insects are active, before galls appear in spring.	Spinosad is labeled for dipterous gall midges (e.g. honeylocust pod gall midge). Fenoxycarb is labeled for honeylocust pod gall midge. Thiamethoxam is labeled for honeylocust podgall, nipple gall, and blister gall. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/ENTO/ENTO-146/ENTO-146.html

Table 5.4 - Control Measures for Major Pests and Pest Groups (continued)

Pest	Control	Timing of Treatment	Remarks
Imported Fire Ant	abamectin (bait) acephate bifenthrin dinotefuran fenoxycarb (bait) fipronil hydramethylnon (bait) indoxacarb (bait) lambda-cyhalothrin metaflumizone methoprene (bait) pyriproxyfen (bait) spinosad	When ants or mounds are observed.	Nurseries and landscapers shipping out of the quarantine area must contact VDACS. The Two-Step method of a bait followed in several days by mound treatments to sensitive or highly trafficked areas is effective within the quarantine area. Combinations of chemicals are also available. Many products are sold under multiple trade names.
Lacebugs	acephate bifenthrin chlorantraniliprole cyantraniliprole cyclaniliprole cyfluthrin dinotefuran fenpropathrin flupyradifurone imidacloprid lambda-cyhalothrin methoxychlor permethrin spinetoram+sulfoxaflor spirotetramat	On evergreens, overwintering eggs hatch in mid-late May. Treat in late May or early June. On deciduous hosts, adults emerge in May. Treat in late May.	Nonsystemic treatments must cover the undersides of the leaves thoroughly. Control of the first generations is most important to slow populations buildup. Examine foliage for lacebugs. Repeat at 3-week intervals if using a low residual product. Do not apply dinotefuran to linden, basswood and other tilia. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/3104/3104-1581/3104-1581.html
Leafhoppers	acetaprimid azadirachtin bifenthrin buprofezin clothianidin cyfluthrin dinotefuran flonicamid flupyradifurone fluvalinate gamma-cyhalothrin imidacloprid lambda-cyhalothrin permethrin spirotetramat thiamethoxam tolfenpyrad	When leafhoppers are first seen and before stippling on leaves becomes extensive.	Thorough coverage of the undersides of the leaves improves control when using nonsystemics. Do not apply dinotefuran to linden, basswood and other tilia. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/ENTO/ENTO-412/ENTO-412.html
Leafminers arborvitae leafminer	bifenthrin cyantraniliprole imidacloprid permetrin	Larvae overwinters in the foliage. Treat adults when present during the summer. Systemic insecticide can be used to control larvae of this pest.	Bifenthrin and permetrin can control adult moths.
azalea leafminer	abamectin acephate azadirachtin bifenthrin clothianidin cyantraniliprole diazinon fenoxycarb lambda-cyhalothrin permethrin	Treat in mid-late May or when mines are first seen on the plants.	Fenoxycarb will not control adult stages. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/3104/3104-1554/3104-1554.html
boxwood leafminer adults	cyromazine lambda-cyhalothrin permethrin spinosad	Treat in late April or early May when adults are active. DD-448	Numerous adults can be eliminated before eggs are laid.

Table 5.4 - Control Measures for Major Pests and Pest Groups (continued)

Pest	Control	Timing of Treatment	Remarks
boxwood leafminer larvae	cyromazine dinotefuran imidacloprid	Treat in May-June after eggs have hatched.	Systemic treatment are most effective in eliminating miners. They are also effective later in the fall season, and persist into the following year.
holly leafminer adults	cyromazine lambda-cyhalothrin permethrin spinosad	Treat in mid-May when new leaves are unfolding and adults are active on the foliage. (DD-192)	Helps reduce feeding punctures on undersides of leaves but may not prevent all mines in the foliage.
holly leafminer larvae	acephate cyromazine dinotefuran imidacloprid	Treat in mid-late June after eggs have hatched.	Systemics are effective in eliminating miners.
oak leafminer	acephate permethrin lambda-cyhalothrin fenoxycarb	Treat when mines are first seen - less than 1/4 inch. Several generations occur each summer.	Rake and destroy leaves in fall.
Leaf-rollers, Leaf Tiers	azadirachtin *Bacillus thuringiensis (Bt)* bifenthrin cyfluthrin emamectin benzoate gamma-cyhalothrin lambda-cyhalothrin methoxyfenozide permethrin	Treat when insects are first seen. On some hosts, injury occurs in early spring when new buds are opening.	
Mealybugs	horticultural oil	Treat in late spring, before new growth begins.	Spray on warm days when the temperature remains above 40˚F (5˚C) for 12-24 hours. Do not spray sensitive plants listed on the label.
	acephate acetaprimid afidopyropen azadirachtin *Beauveria bassiana* bifenthrin buprofezin clothianidin cyclaniliprole cyfluthrin dinotefuran fenpyroximate flonicamid flupyradifurone imidacloprid lambda-cyhalothrin permethrin pyridaben spinetoram+sulfoxaflor spirotetramat thiamethoxam tolfenpyrad	Treat whenever mealybugs are first noticed. Repeat 2-3 applications if necessary until infestation is eliminated.	Forceful spray streams help penetrate cracks and crevices in the bark and waxy secretions that protect the mealybugs. Destroying infested plants is another option. Fenpyroximate for supression only. Do not apply dinotefuran to linden, basswood and other tilia.
Mites hemlock rust mite eriophyid mites	horticultural oil	Treat in early spring before new growth develops.	Do not use on sensitive plants indicated on the label.
	abamectin azadirachtin fenazaquin fenpyroximate spiromesifen	Treat when mites are found in very early spring, in late fall, or during the growing season.	Thoroughly wet the undersides of leaves with a full coverage spray.

Table 5.4 - Control Measures for Major Pests and Pest Groups (continued)

Pest	Control	Timing of Treatment	Remarks
spruce mite, southern red mite, boxwood mite	abamectin acequinocyl azadirachtin bifenazate clofentazine etoxazole fenazaquin fenbutatin-oxide fenpropathrin fenpyroximate fluvalinate hexythiazox milbectin pyridaben spinosad spiromesifen	Treat in late April or early May and/or in September and October.	Thoroughly wet all of the foliage and stems with a full coverage spray. Fenpropathrin and etoxazole are labeled for shade and lath house use only. Acequinocyl is labeled for spruce spider mite and two-spotted spider mite. See spiromesifen label for list of mite species. For additional information on the spruce mite, refer to: https://www.pubs.ext.vt.edu/444/444-235/444-235.html For additional information on the boxwood mite, refer to: https://www.pubs.ext.vt.edu/ENTO/ENTO-42/ENTO-42.html
honeylocust mite	abamectin fenazaquin spiromesifen	Treat when mites occur, repeat after 10 days.	Thoroughly wet the undersides of leaves with a full coverage spray.
two spotted spider mite	abamectin acequinocyl bifenthrin cyflumetofen etoxazole fenazaquin fenbutatin-oxide fenpyroximate fluvalinate hexythiazox milbectin pyridaben spiromesifen	Treat whenever mites first appear. Infestations may occur from spring to fall. Mite infestations are directly proportionate to increasingly warmer temperatures.	Thoroughly wet the foliage and stems with a full coverage spray. Do not use acequinocyl on miniature roses. Etoxazole for shade and lath house use only. See bifenthrin label for special instructions. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/444/444-221/444-221.html
Oriental Beetle	bifenthrin imidacloprid	Treat when small larvae are present.	Most effective against early instars. Beneficial nematodes may be effective for immatures. Apply bifenthrin as granules, other materials as soil drenches.
Plant Bugs, Planthoppers	bifenthrin buprofezin cyfluthrin flonicamid flupyradifurone fluvalinate lambda-cyhalothrin permethrin thiamethoxam	Treat when insects or signs of damage first appear. Treat honeylocust as soon as new growth begins.	Control is difficult because plant bugs are active flyers and move around continuously. Fluvalinate is labeled for plant bugs. Permethrin is labeled for Lygus bugs.
Psyllids boxwood psyllid, hackberry psyllid	azadirachtin *Beauveria bassiana* bifenthrin cyclaniliprole dinotefuran flupyradifurone lambda-cyhalothrin spirotetramat	Treat in late April or early May as new growth begins to develop.	Addition of a wetting agent or spreader-sticker is advised.
Red Headed Flea Beetle	bifenthrin cyantraniliprole cyclaniliprole dinotefuran imidacloprid spinosad thiamethoxam tolfenpyrad	Treat when adults first appear. Repeated applications may be necessary.	Hydrangea paniculata, hollies, and iteas are especially susceptible. Drench, sprench or the use of granulated formulations on the pots (top dressed) might aid to reduce immature populations inside pots. For more information on this pest, refer to: https://www.pubs.ext.vt.edu/ENTO/ENTO-464/ENTO-464.html

Table 5.4 - Control Measures for Major Pests and Pest Groups (continued)			
Pest	**Control**	**Timing of Treatment**	**Remarks**
Sawflies	acetaprimid azadirachtin bifenthrin chlorantraniliprole cyclaniliprole cyfluthrin dinotefuran gamma-cyhalothrin imidacloprid lambda-cyhalothrin methoxychlor spinetoram+sulfoxaflor spinosad thiamethoxam	Treat when insects are first seen. Treat in April for Virginia pine sawfly. Larvae are gregarious and broods often cluster on one branch.	Do not apply dinotefuran to linden, basswood and other tilia.
Scale Insects all scales	cyantraniliprole dinotefuran flonicamid horticultural oil imidacloprid lambda-cyhalothrin pyriproxyfen spinetoram+sulfoxaflor spirotetramat thiamethoxam	Treat with horticultural oil in late March or early April before new growth develops, and when temperatures are not likely to go below 40˚F (5˚C) for 12 to 24 hours. Oils can also be used as summer sprays when indicated on the label.	Do not spray oil-sensitive plants listed under precautions on the label. Thiamethoxam and Cyantraniliprole are labeled for soft scales. Pyriproxyfen, Deltamethrin and spirotetramat are labeled for scale crawlers.
azalea bark scale	insecticidal soap lambda-cyhalothrin	Crawlers: June 5-25.	Scale is often mistaken for mealybugs.
brown soft scale	bifenthrin buprofezin fenoxycarb insecticidal soap lambda-cyhalothrin pyriproxyfen	Treat when scale insects appear. Treat 2-3 times at 10-day intervals.	This scale insect does not winter outside in colder plant zones of Virginia.
calico scale	insecticidal soap lambda-cyhalothrin pyriproxyfen	Crawlers: June 1-20. Treat June 15-30.	Often seen on Zelcova and honeylocust trees.
camellia scale	insecticidal soap lambda-cyhalothrin	Crawlers first appear in May. Treat at 2-week intervals as needed.	
cottony camellia scale	insecticidal soap lambda-cyhalothrin	Crawlers: June 1-10.	
cottony maple leaf scale	acephate insecticidal soap lambda-cyhalothrin	Crawlers: June 1-10.	Ovisacs are found on foliage.
cottony maple scale	insecticidal soap lambda-cyhalothrin pyriproxyfen	Crawlers: June 5-25.	Be sure to thoroughly cover stems and branches near the ground. Dinotefuran is also effective as a bark spray. More information at: https://www.pubs.ext.vt.edu/2808/2808-1011/2808-1011.html
crape myrtle bark scale	buprofezin clothianidin dinotefuran imidacloprid pyriproxyfen thiamethoxam	Best control May-July	Allow several weeks after drenching to be effective. See label regarding bark sprays. See label for dinotefuran commercial landscapes. Do not spray or drench when lady beetle larvae or adults are present. More information at: https://www.pubs.ext.vt.edu/ENTO/ento-465/ento-465.html
euonymus scale	afidopyropen fenoxycarb insecticidal soap lambda-cyhalothrin	Crawlers: first generation May 1-10; second July 5-15.	Do not spray when beneficial lady beetles are present. Afidopyropen is for suppression. More information at: https://www.pubs.ext.vt.edu/444/444-277/444-277.html
euonymus alatus scale	lambda-cyhalothrin	Crawlers: in June and July.	

Table 5.4 - Control Measures for Major Pests and Pest Groups (continued)

Pest	Control	Timing of Treatment	Remarks
european elm scale	insecticidal soap lambda-cyhalothrin	Crawlers: June 5-25.	
fern scale	buprofezin insecticidal soap lambda-cyhalothrin	Crawlers: first appear in mid-May. Treat at 2-week intervals as needed.	Often on liriope, near the base of the plant.
fletcher scale	insecticidal soap lambda-cyhalothrin	Crawlers: in early to mid-June.	On Taxus and Arborvitae.
florida red scale	acephate buprofezin insecticidal soap lambda-cyhalothrin	Crawlers: May 5-15.	Found on burford holly.
forbes scale	insecticidal soap lambda-cyhalothrin	Crawlers: June 1-15.	
gloomy scale	insecticidal soap lambda-cyhalothrin	Crawlers: peak June 10-20.	Serious pest of maples that is difficult to control.
golden oak scale	insecticidal soap lambda-cyhalothrin	Crawlers: June 1-30.	
hemlock scale	insecticidal soap lambda-cyhalothrin	Crawlers: peak May 15-June 20, some produced throughout the season.	Also called fiorinia hemlock scale. More information at: https://www.pubs.ext.vt.edu/ENTO/ento-552/ento-552.html
japanese maple scale	buprofezin lambda-cyhalothrin pyriproxyfen spinetoram+sulfoxaflor	Crawlers: June 1-September 1. Treat at 2-week intervals June-September when crawlers present.	Serious pest that is difficult to control. Thorough coverage is needed. More information at: https://www.pubs.ext.vt.edu/ENTO/ento-572/ento-572.html
juniper scale	insecticidal soap lambda-cyhalothrin	Crawlers: April 5-20 and June 5-20.	Crawler dates vary based on temperature. More information at: https://www.pubs.ext.vt.edu/ENTO/ento-533/ento-533.html
latania scale	insecticidal soap lambda-cyhalothrin	Crawlers: continuous from June through season.	
lecanium scale	lambda-cyhalothrin	Crawlers: May 25-June 25.	Avoid harming beneficials by using soaps or oils in March-April.
oak kermes	lambda-cyhalothrin	Crawlers: June 1-20.	
obscure scale	diazinon lambda-cyhalothrin	Crawlers: on red oak during July.	Also treat with oil as a dormant spray. Can be a serious pest. More information at: https://www.pubs.ext.vt.edu/3104/3104-1583/3104-1583.html
oystershell scale	buprofezin insecticidal soap lambda-cyhalothrin	Crawlers: May 1-20 and July 15-25.	Hatches at around 370 DD. Oils and soaps are also effective.
peony scale	insecticidal soap lambda-cyhalothrin	Crawlers: mid-May.	Often found on azaleas.
pine needle scale	bifenthrin gamma-cyhalothrin insecticidal soap lambda-cyhalothrin	Crawlers: April 20-May 30 and July 10-20.	Sporadic outbreaks can occur.
pine tortoise scale	insecticidal soap gamma-cyhalothrin lambda-cyhalothrin	Crawlers: June 10-July 5.	More information at: https://www.pubs.ext.vt.edu/3104/3104-1529/3104-1529.html
rose scale	insecticidal soap lambda-cyhalothrin	Crawlers: late May-June 30, possible second generation in August.	More information at: https://www.pubs.ext.vt.edu/3104/3104-1565/3104-1565.html
san jose scale	bifenthrin buprofezin insecticidal soap lambda-cyhalothrin pyriproxyfen	Crawlers: at least 3 generations June, July, and September.	

Table 5.4 - Control Measures for Major Pests and Pest Groups (continued)

Pest	Control	Timing of Treatment	Remarks
tea scale	afidopyropen insecticidal soap lambda-cyhalothrin	Crawlers: throughout season in overlapping generations. Treat 2-3 times at 10-day intervals when infested.	Afidopyropen is for suppression
wax scale	buprofezin fenoxycarb lambda-cyhalothrin	Crawlers: June 1-25. Treat June 5-30.	Thoroughly wet foliage and bark with a full-coverage spray. More information at: https://www.pubs.ext.vt.edu/444/444-622/444-622.html
white peach scale, white prunicola scale	buprofezin diazinon fenoxycarb insecticidal soap lambda-cyhalothrin	Crawlers: April 25-May 15, July 1-15, August 20-September 15.	
Spittle Bug	bifenthrin cyfluthrin gamme-cyhalothrin lambda-cyhalothrin spirotetramat	Treat if yellowing or damage occurs.	Often noticed on pines, but rarely causes any injury.
Spotted Lanternfly	acetamiprid bifenthrin dinotefuran imidacloprid thiamethoxam	Treat in early spring and summer	Dinotefuran is labeled as a basal trunk spray on tree-of-heaven only in Virginia. See label for rate. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/ENTO/ENTO-180/ENTO-180.html
Slugs and Snails	Iron phosphate metaldehyde methiocarb orthoboric acid	Apply when pests are observed.	Iron phosphate is available in homeowner packaging.
Stink Bug	bifenthrin flonicamid	Apply when pests are observed.	Some pansy cultivars may be sensitive. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/444/444-356/444-356.html
Tent Caterpillars	azadirachtin *Bacillus thuringiensis (Bt)* bifenthrin chlorantraniliprole cyantraniliprole cyfluthrin emamectin benzoate gamma-cyhalothrin indoxacarb lambda-cyhalothrin methoxychlor methoxyfenozide permethrin spinetoram+sulfoxaflor spinosad tebufenozide	Treat in early spring as new growth is developing and when caterpillars are small.	Caterpillars leave the nests to feed on the foliage during the day. Apply full coverage spray to the entire tree. Forest tent caterpillar does not make a tent. Spinosad and lambda-cyhalothrin are labeled for eastern tent caterpillar only. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/444/444-274/444-274.html

Table 5.4 - Control Measures for Major Pests and Pest Groups (continued)

Pest	Control	Timing of Treatment	Remarks
Thrips	abamectin acephate acetaprimid azadirachtin Beauveria bassiana bifenthrin cyantraniliprole cyfluthrin dinotefuran flonicamid fluvalinate imidacloprid lambda-cyhalothrin novaluron permethrin spinetoram+sulfoxaflor spinosad spirotetramat tolfenpyrad	Treat when thrips are active on new foliage.	Spirotetramat provides suppression at low levels. Dinotefuran and flonicamid are for suppression. Pyrethroid applications may results in higher levels of western flower thrips. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/444/444-281/444-281.html
Tip Moths	acephate azadirachtin bifenthrin cyfluthrin diflubenzuron gamma-cyhalothrin lambda-cyhalothrin methoxyfenozide permethrin tebufenozide	Treat with liquid formulation when moths are flying.	Spray entire tree to runoff. Two and three-needle pines are susceptible to tip moth. Younger trees are preferred.
Treehoppers	bifenthrin	Treat when nymphs are seen on twigs (usually in clusters) before adults are present to begin egg-laying, usually in late summer and fall.	Apply sprays to cover the small twigs thoroughly.
Webworms cotoneaster webworm	cyfluthrin gamma-cyhalothrin lambda-cyhalothrin permethrin	Treat when larvae are first found.	Apply a full-coverage spray, wetting foliage to the point of runoff.
juniper webworm	bifenthrin cyfluthrin gamma-cyhalothrin lambda-cyhalothrin permethrin	Treat when larvae are small. Spring treatments may be applied when plants are found to be infested.	Apply a forceful spray to penetrate severely webbed foliage. Thoroughly wet the foliage to runoff.
fall webworm	*Bacillus thuringiensis (Bt)* bifenthrin chlorantraniliprole cyantraniliprole cyfluthrin emamectin benzoate indoxacarb gamma-cyhalothrin lambda-cyhalothrin methoxychlor permethrin methoxyfenozide spinetoram+sulfoxaflor spinosad tebufenozide	Treat when larvae are small and webs just starting to form. Treat for second generation in August or early September.	Caterpillars are gregarious and infest individual branches. Apply full-coverage foliar spray to infested area, or entire tree in years of high populations. Indoxacarb and chlorantraniliprole are for landscape use only. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/2808/2808-1013/2808-1013.html

Table 5.4 - Control Measures for Major Pests and Pest Groups (continued)			
Pest	**Control**	**Timing of Treatment**	**Remarks**
mimosa webworm	cyfluthrin emamectin benzoate gamma-cyhalothrin lambda-cyhalothrin permethrin	Apply foliage sprays at 4-5 day intervals until the infestation is controlled.	
pine webworm	bifenthrin cyfluthrin gamma-cyhalothrin lambda-cyhalothrin permethrin		
Weevils two banded japanese weevil, black vine weevil	acephate *Beauveria bassiana* bifenthrin dinotefuran flupyradifurone lambda-cyhalothrin	Apply as a full-coverage spray when foliar feeding is first observed.	Lambda-cyhalothrin is for black vine weevil adults. Flupyradifurone is for black vine weevil larvae. Do not apply dinotefuran to linden, basswood and other tilia. For additional information on the Japanese weevil, refer to: https://www.pubs.ext.vt.edu/444/444-624/444-624.html For additional information on the black vine weevil, refer to: https://www.pubs.ext.vt.edu/444/444-210/444-210.html
white pine weevil	bifenthrin gamma-cyhalothrin diflubenzuron	Apply sprays in the late spring before adults lay eggs.	Treat only the main terminal leaders of the tree down to the first whorl of branches. Thoroughly wet the bark.
	Cut out and burn infested leaders.	Prune out infested leaders during June.	Adults begin emerging from infested leaders in July. For additional information on the white pine weevil, refer to: https://www.pubs.ext.vt.edu/444/444-270/444-270.html
Whiteflies	abamectin acetaprimid afidopyropen azadirachtin Beauveria bassiana bifenthrin clothianidin cyantraniliprole cyfluthrin dinotefuran fenoxycarb flonicamid flupyradifurone fluvalinate imidacloprid lambda-cyhalothrin novaluron permethrin pymetrozine pyridaben pyriproxyfen spinetoram+sulfoxaflor spiromesifen spirotetramat thiamethoxam	When whiteflies are found. Treat every three weeks until infestation is controlled.	See labels for whitefly species. Do not apply dinotefuran to linden, basswood and other tilia. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/444/444-280/444-280.html
Zimmerman Pine Moth	bifenthrin methoxyfenozide	Treat in early- to mid-April and in early September. (DD-121)	Apply as full coverage spray to the point of runoff.

Table 5.5 - Directions for Pesticide Usage

Chemical	Chemical Formulation	Pests Controlled	Amount to Use per 100 gal	Phytotoxicity and Remarks
abamectin (Avid)	0.15EC	aphids, eriophyid mites, leafminers, thrips, whiteflies, imported fire ants	4.0-8.0 fl oz	Do not use on ferns or Shasta Daisy. Generic products exist. 12-hr REI. SIGNAL WORD - WARNING
acephate (Orthene)	97	All labeled uses	See label for rates	Rates differ as to pests. See label for phytotoxicity list. 24-hr REI. Some formulations are labeled for use as a basal soil injection for trees. SIGNAL WORD - CAUTION
acequinocyl (Shuttle)	15SC	two-spotted spider mite, spruce spider mite	6.4-12.8 fl oz	Do not use on miniature roses or impatiens. Use low rate on standard roses. See label for resistance management. 12-hr REI. SIGNAL WORD - CAUTION
acetaprimid (Tristar)	70WSP 30SG	aphids, European pine sawfly, tentiform leaf miner, mealybug, leafhopper, whiteflies, thrips	See label for rates	See label for resistance management, restrictions, and precautions. 12-hr REI. SIGNAL WORD - CAUTION
afidopyropen (Ventigra)	0.83DC	aphids whiteflies mealybugs scales	See label for rates	See label for resistance management, restrictions and precautions. 12-hr REI. SIGNAL WORD - CAUTION
azadirachtin (Azatin, Triact, Ornazin, Neemazid, Trilogy, Azatrol)	various	All labeled uses.	See label for rates	Product is sold by several companies, and in many formulations. 4-hr REI. SIGNAL WORD - CAUTION
Bacillus thuringiensis (Bt)	various	defoliating caterpillars (see label)	See label for rates	Product is sold by many companies, and in many formulations. 4-hr REI. SIGNAL WORD - CAUTION
Beauveria bassiana (BotaniGard)	22WP ES	aphids, mealybugs, thrips, whiteflies	0.5-2.0 lb 0.5-2.0 qt	12-hr REI. SIGNAL WORD - CAUTION
bifenazate (Floramite, Sirocco)	50WP	mites	See label for rates	See label for species controlled. 12-hr REI. SIGNAL WORD - CAUTION. Sirocco is a bifenazate/abamectin combo for ornamentals and greenhouses.
bifenthrin (Talstar, Onyx Pro, Allectus, Aloft)	F	All labeled uses	See label for rates	Onyx Pro is labeled for nurseries. Generic products exist. 12-hr REI. SIGNAL WORD - WARNING.
	0.2G	All labeled uses.	See label for rates	SIGNAL WORD - CAUTION
	various	All labeled uses	See label for rates	Allectus is a bifenthrin/imidacloprid combo for landscape ornamentals. Aloft is a bifenthrin/clothianidin combo for landscape ornamentals.
buprofezin (Talus)	70WSP 40SC 70DF	leafhoppers, mealybugs, planthoppers, scales, whiteflies	See label for rates	Sold in water soluble bags. Consult label for rate. 12-hr REI. Do not mix with oils. SIGNAL WORD - CAUTION

Table 5.5 - Directions for Pesticide Usage

Chemical	Formulation	Pests Controlled	Amount to Use per 100 gal	Phytotoxicity and Remarks
chlorantraniliprole (Acelepryn)	1.67SC	Leaf-feeding caterpillars, lacebugs, bagworms, birch leaf miner, clearwing borers, Japanese beetles, Viburnum leaf beetle	See label for rates	No signal word required. 4-hr REI. For optimum suppression of Japanese beetle, apply when feeding is first observed and repeat in 10-14 days if required. For dogwood borer, apply to bottom 60cm of tree trunk at first sign of feeding.
clofentezine (Ovation)	5SC	mites	2.0 fl oz	Not for landscape use. 12-hr REI. SIGNAL WORD - CAUTION
clothianidin (Arena, Aloft)	50WDG .25G	See label	See label	Landscape use only. Aloft also contains bifenthrin. Do not apply this product while bees are foraging. Do not apply this product until flowering is complete and all petals have fallen. 12-hr REI. SIGNAL WORD - CAUTION
cyantraniliprole (Mainspring)	SC	aphids, whiteflies	2.0 - 8.0 fl. oz	4-hr REI. SIGNAL WORD - WARNING
cyclaniliprole (Sarisa)	.42SC	See label for pests	See label for rates	4-hr REI. SIGNAL WORD-CAUTION. Pradia is a cyclaniliprole/flonicamid combination product
cyflumetofen (Sultan)	18.7SC	mites	13.7 fl. oz	12-hr REI. SIGNAL WORD - CAUTION
cyfluthrin (Discus, Decathlon)	20WP F	See label.	1.3-1.9 oz	Discus also contains imidacloprid. 12-hr REI. SIGNAL WORD - WARNING
cypermethrin (Cynoff)	EC, WP	box elder bug, elm leaf beetle	See label for rates	Only in landscapes. 12-hr.- REI. SIGNAL WORD - WARNING (WP) CAUTION (EC).
cyromazine (Citation)	75WP	leaf miners, shoreflies, fungus gnats	2.66 oz	Sold in water-soluble pouches. Not to exceed 6 applications/crop. Shoreflies on greenhouse crops only. 12-hr REI. SIGNAL WORD - CAUTION
diflubenzuron (Dimilin, Adept)	25W	Pine tip moth, gypsy moth	see label	12-hr REI. SIGNAL WORD - CAUTION
dinotefuran (Safari, Transtect, Zylam)	20SG	All labeled uses.	See label for rates.	Apply as foliar spray or drench. 12-hr REI. SIGNAL WORD - CAUTION Make applications post-bloom when bees are not present. Do not apply this product while bees are foraging. Do not apply this product until flowering is complete and all petals have fallen. Zylam and Transtect also labeled for trunk banding or soil injection.
emamectin benzoate (Tree-age, Enfold)	F 5SG	All labeled uses	See label for rates	Applied by injection to base of tree. Effective against fall webworm 12-hr REI. SIGNAL WORD - CAUTION
etoxazole (TetraSan)	5WDG 5WSP	spider mites	See label for rates	Shade and lath house use only. 12-hr REI. SIGNAL WORD - CAUTION
fenazaquin (Magus)	200SC	mites, whiteflies	12.0-24.0 fl oz	Do not exceed 24 oz per acre per year. Do not use on roses. 12-hr REI. SIGNAL WORD - WARNING
fenbutatin oxide (Promite)	50WP	mites	8.0-16.0 oz	Sold in soluble pouches. 48-hr REI. SIGNAL WORD - DANGER
fenoxycarb (Precision)	25WP	All labeled uses.	2.0-8.0 oz	See label for proper rate for target pest. Sold in 1-oz pouches. 12-hr REI. SIGNAL WORD - CAUTION
fenpropathrin (Tame)	2.4EC	All labeled uses.	5.33-16.0 oz	24-hr REI. SIGNAL WORD - DANGER
fenpyroximate (Akari)	5SC	mites, mealybugs	16.0-24.0 fl oz	Good coverage is essential. 12-hr REI. SIGNAL WORD - WARNING

Table 5.5 - Directions for Pesticide Usage

Chemical	Formulation	Pests Controlled	Amount to Use per 100 gal	Phytotoxicity and Remarks
fipronil (Topchoice)	G	ants, fire ants	—	Broadcast application: 87 lb per acre. 12-hr REI, SIGNAL WORD - CAUTION
flonicamid (Aria)	WSP	All labeled uses	0.7-2.1 oz	Sold in 20.0 g packets 12-hr REI. SIGNAL WORD - CAUTION.
flupyradifurone (Altus)	1.67SC	All labeled uses	See label for rates.	4-hr REI. SIGNAL WORD - CAUTION
fluvalinate (Mavrik)	2F	All labeled uses.	4.0-10.0 fl oz	See label for precautions and rates for root weevils. For outdoor plantings and containerized nursery stock. 12-hr REI. SIGNAL WORD - CAUTION
gamma-cyhalothrin (Proaxis)	(0.5F)	All labeled uses	2.56-5.12 fl oz	SIGNAL WORD - CAUTION
hexythiazox (Hexygon)	50WP	mites	1.0-2.0 oz or 4.0-6.0 oz/A	Use only once/crop cycle. 12-hr REI. SIGNAL WORD - CAUTION.
horticultural oils	various	All labeled uses.	See label for rates.	Numerous companies sell this product. See label for phytotoxicity. 4- to 12-hr REI. SIGNAL WORD - CAUTION
hydramethylnon (Amdro, Max Force)	various	imported fire ant	See label for rates	Apply when ants are foraging. 12-hr REI. SIGNAL WORD - CAUTION
imidacloprid (Marathon, Discus, Allectus, Merit, Zenith)	Various	All labeled uses	See label for rates	Labeled for soil and foliar application. Discus also contains cyfluthrin. Allectus also contains bifenthrin. Generic products exist. Merit and Zenith are labeled for landscape ornamentals. Do not apply this product while bees are foraging. Do not apply this product until flowering is complete and all petals have fallen. 12-hr REI. SIGNAL WORD - CAUTION
indoxacarb (Provaunt, Advion)	30WDG 0.45G	caterpillars, sawfly, leafhoppers, imported fire ant	1.25-5.0 oz	Granular form for imported fire ants. SIGNAL WORD - CAUTION.
insecticidal soap	various	All labeled uses.	See label for rates.	Several companies sell this product. 12-hr REI. SIGNAL WORD - WARNING
iron phosphate	1% bait	snails, slugs	Per 100 gl2.56 to 10 fl. oz	Rate is 1.0 lb per 1000 sq ft. SIGNAL WORD - CAUTION.
lamba-cyhalothrin (Warrior II)	22.8CS	All labeled uses	Per 100 gl2.56 to 10 fl. ozPer 3 gl	Labeled for commercial and residential turf and landscape ornamental plants. Generic products are sold by many companies. 24-hr REI. SIGNAL WORD - WARNING
lamba-cyhalothrin (Scimitar)	9.7GC 9.7CS	All labeled uses.	1.5-5.0 fl oz	Scimitar CS is only labeled for commercial landscapes; 24-hr REI. SIGNAL WORD - CAUTION
metaflumizone (Siesta)	G	ants, fire ants	—	Broadcast application: 1.5 lb per acre. 12-hr REI, SIGNAL WORD - CAUTION
metaldehyde (Deadline, Metarex)	Bait	slugs, snails	Ready-to-use.	12-hr REI. SIGNAL WORD - CAUTION
methoprene s-methoprene (Extinguish)	various	imported fire ant	See label for rates	Also sold in combination with hydramethylnon. 4-hr REI. SIGNAL WORD - CAUTION
methoxychlor (Marlate)	50WP	All labeled uses.	2.0-3.0 lb	Do not use on Chinese elm, Japanese and red maple, redbud, privet and viburnum, repeated uses on evergreens. 12-hr REI. SIGNAL WORD - CAUTION
methoxyfenozide (Intrepid)	2F	All labeled uses	4.0 to 16.0 fl. oz/acre	4-hr REI. SIGNAL WORD - CAUTION

Table 5.5 - Directions for Pesticide Usage

Chemical	Formulation	Pests Controlled	Amount to Use per 100 gal	Phytotoxicity and Remarks
novaluron (Pedestal)	10SC	whiteflies, thrips, leafminers, armyworms	6.0-8.0 oz	Registered for container-grown ornamentals. 12-hr REI. SIGNAL WORD - CAUTION
orthoboric acid (Niban)	5G	snails and slugs	See remarks for rates	4-hr REI. Apply evenly at 6.0 oz per 100 sq ft.
permethrin (Astro, Perm-up)	2E 3.2EC	All labeled uses.	6.4-12.8 oz 4.0-8.0 oz	Permethrin is sold under several trade names. Do not apply to salvia or snapdragon. 12-hr REI. SIGNAL WORD - CAUTION
pymetrozine (Endeavor)	50WG	aphids, whiteflies	2.5-5.0 oz	Sold in WSP. 12-hr REI. Labeled for spray and drench applications. SIGNAL WORD - CAUTION
pyriproxyfen (Distance, Fulcrum)	0.86EC 0.5G	scale crawlers, imported fire ant, whiteflies	See label for rates	See label for sensitive species. 12-hr REI. SIGNAL WORD - CAUTION
pyridaben (Sanmite)	75SP	All labeled uses.	2.0-6.0 oz	Sold in 1.0 oz soluble bags only. 12-hr REI. SIGNAL WORD - WARNING
spinetoram + sulfoxaflor (XXpire)	SG	aphids, lepidopterous larvae, mealybugs, plant bugs, thrips, whiteflies and scales	2.0-3.5 fl oz	See label for rates for target pests. 12-hr REI. SIGNAL WORD - CAUTION
spinosad (Conserve, Entrust)	SC	All labeled uses.	6.0-22.0 fl oz	See label for resistance management strategies. Compatible with IPM programs. 4-hr REI. SIGNAL WORD - CAUTION
spiromesifen (Forbid, Judo, Savate)	4F	spider and eriophyid mites, whiteflies	2.0-4.0 fl oz	Forbid registered for outdoor landscapes only; Judo registered for nursery and greenhouse sites. 12-hr REI. SIGNAL WORD - CAUTION
spirotetramat (Kontos)	240SC	See label.	1.7-3.4 fl oz	24-hr REI. as foliar spray; no REI. for drench. SIGNAL WORD - CAUTION
tebufenozide (Confirm)	2E	See label.	4.0-16.0 fl oz	4-hr REI. SIGNAL WORD - CAUTION
thiamethoxam (Flagship, Meridian)	25WG .22G .33G	All labeled uses.	See label	Granular is labeled for aphids, mealybugs, whiteflies, and beetle larvae (grubs). Meridian is for landscape ornamentals. Refer to label for special application restrictions for protection of pollinators. Do not apply this product while bees are foraging. Do not apply this product until flowering is complete and all petals have fallen. 12-hr REI. SIGNAL WORD - CAUTION
tolfenpyrad (Hachi-Hachi)	15%EC	aphids, leafhoppers, lepidopteran early instars, scale, thrips, whiteflies	See label	See label for phytotoxicity. Rate for cuttings (cut flowers) is lower than other plants. 12-hr REI. SIGNAL WORD - WARNING

Abbreviations
W, WP = wettable, wettable powder; WSP = water-soluble packets; S, SP = sprayable powder; L, LS = liquid, liquid spray; E, EC = emulsifiable, emulsifiable concentrate; SC = spray concentrate; CS = capsule suspension; GS = granule suspension; DC = Dispersible concentrate

Precautions:
Do not apply liquid concentrate when the temperature is above 85°F (29-30°C.) or any spray when the temperature is above 90°F (32°C).
Do not apply oil sprays if the temperature is below 40°F (4-5°C) or is likely to approach or go below freezing within 24 hours.
Never use a sprayer or a tank that has been used previously to apply herbicides.
Use only the recommended dosage rates. The label directions are the final authority. Wettable powders and other suspensions (flowable) require continuous agitation in the tank to avoid settling. Do not allow spray suspensions to remain in the tank without agitation, or any spray mixture to remain in a non-operating sprayer for more than 1 hour.
Clean all spraying equipment thoroughly after each use.
Use spreader-stickers only for hard-to-wet foliage and special uses. Unnecessary wetting agents and spreaders cause excess run-off.

Equivalents:
1 pt liquid in 100 gal = 1 tsp in 1 gal
1 lb powder in 100 gal = 1 tbsp in 1 gal
1 gal = 4 qt = 8 pts = 128 fl oz
1 cup = 1/2 pt = 8 fl oz = 16 tbsp
1 fl oz = 1/8 cup = 2 tbsp = 29.57 milliliter
1 lb = 16 oz = 454 grams
1 tbsp = 1/2 fl oz = 3 tsp = 14.78 milliliter
1 oz = 28.3 grams

Nursery Crops: Weeds

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■ Nonchemical Weed Control

Use a 2- to 4-inch depth of mulch. Avoid overmulching. Suitable mulch materials include pine bark, hardwood bark, pine straw, leaves, or similar organic materials. Rock mulches can also be used in certain landscape situations for weed management and tend to provide greater weed control than an organic mulch. Consider placing a landscape fabric under a rock mulch to act as a soil separator. Do not spread mulch that has an off-odor (rotten egg/sulfur smell or an ammonia odor) or plant injury can occur. Mulches will suppress annual weeds but generally will not control perennial weeds.

Landscape fabrics overcome the porosity problem inherent to solid black plastic. Use a shallow mulch layer (1 inch) above the fabric. A rock mulch/fabric combination would be expected to provide greater weed control than an organic mulch/fabric combination. Fabric/mulch combinations improve weed control over mulch alone. Use a landscape fabric with limited open space. Use landscape fabrics only in woody landscape beds. Fabrics will inhibit emergence of herbaceous perennials and will inhibit rooting in of groundcovers. Certain weeds, such as yellow nutsedge, can penetrate through landscape fabrics. Biobarrier with slow release trifluralin provides greater weed control than do landscape fabrics that do not contain an herbicide.

■ Chemical Weed Control

There is now a selection of herbicides for use in nursery stock. Selection of a given herbicide must be based on the particular weed and crop situation. None of the preemergent herbicides are effective against all weed species. Tank-mixing of herbicides often broadens the spectrum of weed control. If a chemical application kills all but one species, that species will multiply. This results in a shift in weed population and eventually weed control with that product becomes ineffective. Chemical rotation can reduce the buildup of a tolerant species. Use of directed sprays of a nonselective herbicide (diquat, glufosinate, paraquat, or glyphosate) or cultivation is usually necessary to give control of all species.

One application of a preemergent herbicide will not give adequate weed control for an entire year. Late fall or winter applications of isoxaben, simazine, dichlobenil, or pronamide will provide weed control well into the growing season. When control begins to decrease, the area can be cultivated or a postemergence herbicide could be applied and application of one of the other preemergent herbicides can be made.

Applications should be made to limited areas until experience is gained with a given herbicide. Any application of a new herbicide should include an untreated area to allow observation of weed control and possible injury. Small and shallow-rooted plants are more easily injured than large established plants. Sandy soil and excessive watering also increases chances of injury. Irrigate after a granular herbicide application to wash the granules off the leaf surfaces. Certain granular herbicides can cause spotting of foliage if granules are not washed off leaves.

Tables 4.6, 4.7, 4.8, and 4.9 list which herbicides are registered for use on individual nursery species. Check herbicide labels to determine specific cultivars that can be treated. These registrations are only for liners or rooted cuttings planted into the field or planted in containers which are maintained outdoors. Consult herbicide labels to determine which compounds can be used in propagation, be it seedbeds or vegetative propagation. See the section on weed control in the greenhouse for plants maintained indoors.

It is wise to keep a separate sprayer for herbicides since certain ones are difficult to clean from the spray tank.

Table 5.6 - Herbicides

Time of Application	Weed Problem	Chemical Rate/Acre	Remarks
Preplant soil fumigation	Most annual and perennial weeds	dazomet (Basamid 218-421 lb/A or 5.0 to 9.6 lb/1000 sq ft)	Incorporate after application. Irrigate or cover with plastic after application. Do not use below soil temperature of 43° F. Waiting period for transplants ranges from 10 to over 25 days.
Postplant but preemergence to weeds	Annual grasses and certain broadleaf weeds	dithiopyr 0.38-0.5 lb (Dimension 2EW 1.5-2.0 pt/A)	Apply to established ornamentals. Combine with a broadleaf herbicide such as isoxaben for improved broadleaf weed control. Do not apply more than 2 pt/A/application or 6 pt/A/year. For small areas apply 0.7 fl oz/1000 sq ft.
		napropamide 4.0-6.0 lb (Devrinol 2-XT 2.0-3.0 gal or Devrinol DF-XT Ornamental 8.0-12.0 lb)	Use on container or field grown nursery stock. Apply to weed-free soil or include an appropriate postemergence herbicide. Safe on a wide variety of plant material. May be used on newly transplanted stock after soil has settled from first watering. Needs incorporation (mechanical or irrigation). For small areas, apply 2.9-4.4 oz Devrinol 50DF/1000 sq ft.

Table 5.6 - Herbicides (continued)

Time of Application	Weed Problem	Chemical Rate/Acre	Remarks
Postplant but preemergence to weeds (continued)	Annual grasses and certain broadleaf weeds (continued)	oryzalin 2.0-4.0 lb (Surflan 4AS 2.0-4.0 qt, Oryzalin 4AS 2.0-4.0 qt)	Can be applied overtop or as a directed spray on field and container grown ornamentals. Will not control established weeds. Irrigation will improve weed control. For small areas, apply 1.5-2.9 fl oz Surflan 4AS/1000 sq ft. Oryzalin is currently unavailable so consider other options.
		prodiamine 0.65-1.5 lb (Barricade 65WG 1.0-2.3 lb, Barricade 4FL 21.0-48.0 oz)	Apply prior to weed germination. Do not apply more than 2.3 lb Barricade 65WG or 48 fl oz Barricade 4FL/year. For small areas apply 0.4-0.8 oz Barricade 65WG or 0.5-1.1 fl oz Barricade 4FL/1000 sq ft.
		pendimethalin 2.0-4.0 lb (Corral 2.7G 76.0-113.0 lb, Pendulum 2G 100.0-200.0 lb, Pendulum AquaCap 2.1-4.2 qt, Pendulum 3.3EC 2.4-4.8 qt)	Can be applied to container and field grown ornamentals. Do not apply to moist foliage. Will not control established weeds. For small areas apply 1.7-2.6 lbs Corral 2.7G, 2.3-4.6 lbs Pendulum 2G, or 1.6-3.2 fl oz Pendulum AquaCap, Pendulum 3.3EC 1.8-3.6 fl oz/1000 sq ft. DO NOT APPLY PENDULUM 3.3EC OVERTOP ACTIVELY GROWING NURSERY PLANTS.
		trifluralin 0.5-4.0 lb (Treflan 5G 10.0-80.0 lb, Preen Garden Weed Preventer 270 lb)	Will not control established weeds. Use lower rate if incorporated or higher rate and irrigate after application. Apply as a directed spray. Consult label for use on specific soil types. For small areas, apply 0.3-1.8 lb Treflan 5G/1000 sq ft or 6.2 lb Preen Garden Weed Preventer.
	Annual grasses and broadleaf weeds	flumioxazin 0.375 lb (BroadStar 150.0 lb/A)	Apply granules to dry foliage prior to weed germiniation and follow with irrigation or use a leaf blower to remove granules from the nursery foliage. For use in woody ornamental production and in landscape maintenance. For small areas, apply 3.4 lb/1000 sq ft. DO NOT APPLY TO NEWLY PLANTED LINERS.
		flumioxazin 0.25-0.375 lb (SureGuard 8.0-12.0 oz/A)	Preemergence and early postemergence action. Apply as a directed spray to dormant nursery trees or to established woody landscape ornamentals prior to weed germination or to small emerged weed seedlings. Combine with a labeled postemergence herbicide for control of larger annual weeds or perennials. Can be applied overtop dormant conifers. For small areas, apply 0.18-0.275 oz/1000 sq ft.
		flumioxazin 0.21 lb plus pyroxsulfone 0.27 lb (SureGuard Xtra 20 fl oz)	Make only one application per year. Apply as a directed spray to established woody ornamentals in nursery production or in landscape maintenance. Treat a small area first to check tolerance prior to large-scale use.
		indaziflam 0.029-0.058 lb (Specticle FLO 6-12 fl oz, Specticle G 100-200 lb) indaziflam 0.036-0.075 lb (Marengo 7.5-15.5 fl oz, Marengo G 100-200 lb)	Use Marengo in nursery production and Specticle in landscape beds. Apply to established trees and shrubs as a direct spray, ideally when the plants are dormant. Do not exceed 18.5 fl oz/acre/ year or 400 lb/acre/year. Long residual herbicide for preemergence control of many annual weeds. Include a postemergence herbicide for control of emerged weeds as indaziflam has limited postemergence activity. Do not apply to herbaceous ornamentals. For small areas, apply Specticle G or Marengo G at 2.3-4.6 lb/1,000 sq ft
		isoxaben 0.5-1.0 lb (Gallery 75DF 0.6-1.3 lb, Gallery SC 16-31 fl oz)	Do not apply to new plantings until soil has settled and no cracks are present. Apply prior to weed germination. Combine with an annual grass herbicide for improved control of crabgrass and other annual grasses. For small areas, apply 0.25-0.5 oz Gallery 75DF or 0.3-0.7 fl oz Gallery SC/1000 sq ft.
		isoxaben 0.5-0.1.0 lb + prodiamine 0.75-1.5 lb (Gemini 3.7SC 43.5-87 fl oz/A)	Apply to established plants or after the soil has settled with root development for new plantings. Do not apply more than 87 fl oz/A/ year. For small areas, apply 1.0-2.0 fl oz/1,000 sq ft.

Table 5.6 - Herbicides (continued)

Time of Application	Weed Problem	Chemical Rate/Acre	Remarks
Postplant but preemergence to weeds (continued)	Annual grasses and broadleaf weeds (continued)	isoxaben 0.75 lb + dithiopyr 0.375 lb (Fortress 150 lb, Crew 150 lb)	Maximum 2 applications per year. Do not apply to containers less than 4 inches wide. Do not apply to unrooted cuttings. For small areas apply 3.4 lb/1000 sq ft. The focus for Fortress is nursery production while the focus for Crew is landscape maintenance.
		isoxaben 0.25-0.5 lb + prodiamine 0.4-0.8 lb (Gemini Granular 100-200 lb)	Apply to established plants or after the soil has settled with root development for new plantings. Do not apply more than 375 lb/A/ year. For small areas apply 37-75 oz/1000 sq ft.
		isoxaben 0.5-1.0 lb + trifluralin 2.0-4.0 lb (Snapshot 2.5TG 100-200 lb)	A prepackaged mix of the active ingredients in Gallery and Treflan. For small areas apply 2.3- 4.6 lb Snapshot 2.5TG/1000 sq ft. Apply prior to weed germination.
		flumioxazin 0.125 lb + prodiamine 0.75 lb (Fuerte 100 lb)	Apply after soil has settled for new plantings. Primarily used in woody ornamentals. For small areas apply 2.29 lb/1000 sq ft. Maximum 2 applications per year. Irrigate after application.
		oxadiazon 2.0-4.0 lb (Ronstar 2G, Oxadiazon 2G 100-200 lb, Ronstar 50WP 4.0-8.0 lb)	Use on container or field grown nursery stock. The granular formulation is safe on a wide variety of plant material. Apply prior to weed germination. Disturbing soil after application may result in reduced weed control. Do not apply when foliage is wet. For continued weed control, an additional application to certain ornamentals can be made 60-120 days later. Toxic to fish. Do not contaminate water by washing equipment or disposal of waste. For small areas, apply 2.3-4.5 lb Ronstar 2G/1000 sq ft. Ronstar WP can cause foliar injury to certain species that are not injured by Ronstar G. Check WP label to determine which species can be treated.
		oxyfluorfen 1.0-2.0 lb - conifers (Goal 2XL 4.0-8.0 pt, GoalTender 2.0-4.0 pt) oxyfluorfen 0.5-1.5 lb Shadetrees (Goal 2XL 2.0-6.0 pt, GoalTender 1.0-3.0 pt)	Apply to seedbeds, containers, or transplants of many conifer species and to certain field-grown trees. Apply before bud-break or after new growth has hardened-off. Goal has preemergence and postemergence activity if applied to weeds less than 3-4 inches in height.
		oxyfluorfen 2.0 lb + prodiamine 0.75 lb (Biathlon100.0 lb)	Apply to weed-free soil immediately after transplanting or to established ornamentals grown in containers or in the field. Do not apply to ornamentals when foliage is moist or foliar injury can result. Apply overhead irrigation or use leaf blowers to remove granules from leaf surfaces. For small areas, apply 2.3 lb Biathlon/1000 sq ft.
		oxyfluorfen 2.0 lb + pendimethalin 1.0 lb (Ornamental Herbicide 2 100.0 lb)	Apply to weed-free soil immediately after transplanting or to established ornamentals grown in containers or in the field. Do not apply to ornamentals when foliage is moist or foliar injury can result. Apply overhead irrigation to wash granules off leaf surfaces. For small areas, apply 2.3 lb OH2/1000 sq ft.
		oxyfluorfen 2.0 lb + oryzalin 1.0 lb (Rout Ornamental Herbicide 100 lb) Not currently available due to the unavailability of oryzalin.	Apply to a weed-free soil surface when foliage is dry and plants are not making a flush of growth. Use on container and field grown stock. Apply overhead irrigation to wash granules off leaf surface. Do not apply to ornamentals when foliage is moist or foliar injury can result. For small areas, apply 2.3 lb Rout/1000 sq ft. Not currently available due to the unavailability of oryzalin.
		simazine 1.0-3.0 lb (Princep Liquid 1.0-3.0 qt, or other labeled formulation)	Apply to weed-free soil in the fall or spring before new weed growth appears. Apply no more than once per year. Apply at least one year after transplanting. For small areas, apply 0.8-2.2 fl oz Princep Liquid/1000 sq ft.
	Annual broadleaf weeds and yellow nutsedge	sulfentrazone 0.08-0.25 lb (Dismiss Turf 4-12 fl oz)	Provides preemergence control of certain annual broadleaf weeds plus postemergence yellow nutsedge control. Apply as a directed spray. Add an annual grass herbicide for broader-spectrum control and add a postemergence herbicide if weeds are present.
	Annual and certain perennial weeds	dichlobenil 4.0-6.0 lb (Barrier, Casoron 100.0-150.0 lb)	Apply in the late fall, winter, or early spring. If dichlobenil remains on the soil surface during warm weather, activity will be lost. Do not apply until 4 weeks after transplanting. NOTE: Use higher rate for control of certain perennials in ornamentals established at least one year. Do not remove old weed growth before making a surface application in the fall for control of perennial weeds. For small areas, apply 2.3-3.4 lb Barrier or Casoron/1000 sq ft.

Table 5.6 - Herbicides (continued)

Time of Application	Weed Problem	Chemical Rate/Acre	Remarks
Postplant but preemergence to weeds (continued)	Primarily annual grasses and yellow nutsedge	metolachlor 1.2-2.4 lb (Pennant Magnum 1.3-2.6 pt)	Apply to weed-free soil. Direct toward base of ornamentals established for at least 2 weeks. For additional broadleaf weed control, tank-mix with Princep where labeled. For small areas, apply 0.5-0.9 fl oz Pennant Magnum/1,000 sq ft.
	Annual grasses, yellow nutsedge, and certain annual broadleaf weeds	pendimethalin + dimethenamid 1.75-3.5 lb ai (FreeHand 1.75G 100-200 lbs)	Apply to established plantings prior to weed emergence. Delay application for 2-4 weeks after transplanting bare-root liners. Irrigate after transplanting to settle the soil prior to application. For small areas, apply 2.3-4.6 lb/1000 sq ft.
	Annual grasses, yellow nutsedge, and certain annual broadleaf weeds	dimethenamid 0.98-1.5 lb (Tower 6EC 21.0-32.0 fl oz)	Apply to established plantings prior to weed emergence or include a postemergence herbicide to control emerged weeds. Apply as directed spray either prior to bud break or after new growth has hardened. Combine with a preemergence broadleaf herbicide for broader-spectrum control. Use a shielded spray if ornamentals have been in the ground less than one year. For small areas, apply 0.48-0.73 fl oz/1000 sq ft.
	Annual weeds and certain perennial grasses	pronamide 1.0-2.0 lb (Kerb 50W 2.0-4.0 lb, Kerb SC 2.5-5.0 pt)	Fall application when temperatures are below 60˚ F. High rate has given quackgrass control as well as control of other cool season grasses. Do not use on fine-textured soils of high organic content. Kerb should not be applied to transplants less than 1 year old. For small areas, apply 0.7-1.4 oz Kerb 50W or or 0.9-1.8 fl oz Kerb SC/1,000 sq ft. RESTRICTED USE.
Postemergence to weeds	All weeds contact kill	diquat 0.5 lb (Reward 2.0 pt + nonionic surfactant, Diquat SPC 2.0 pt + a nonionic surfactant)	Avoid contact with desired foliage. For spot treatment, mix 3/4 fl oz Reward plus a nonionic surfactant per gallon. Thorough coverage of weed foliage is needed for best results.
		pelargonic acid (Scythe 3-7% V/V)	Rapid acting contact herbicide. Can be used to control weeds prior to crop emergence and can be applied under greenhouse benches. Treat weeds when they are less than 4 inches tall. Avoid contact with desired foliage.
		glufosinate 0.5-1.5 lb (Finale XL T & O 27-82 fl oz, Cheetah Pro 24-82 fl oz)	Apply as a directed spray. Do not contact bark or foliage of desired plants. Contact herbicide with some systemic action. For spot application, mix 0.5-3.2 fl oz Finale XL T&0 per gal or 0.5-2.0 fl oz Cheetah Pro per gal. Ensure complete coverage of weed foliage.
	All weeds controlled	glyphosate 0.75-3.75 lb ae (Roundup Pro 1.0-5.0 qt, Roundup Pro Max 1.0-3.3 qt, or other labeled formulation.For wiper application, use 1 part herbicide to 2 parts water; for cut stump treatments, use a 50% to 100% solution)	Apply as a directed spray in established plantings. Adjust rate of application to weed species according to label instructions. Do not contact bark or foliage of desired plants or serious systemic injury may occur. For small area application with a hand sprayer, use 2.0 fl oz/gal water and lightly wet the foliage. Also cleared for site preparation prior to planting nursery stock. Other glyphosate formulations are available. See label for application rates. Compare products based on the lb/gal glyphosate acid and the presence of a surfactant.
	Annual and perennial grasses including bermudagrass, quackgrass, and johnsongrass	clethodim 0.09-0.25 lb (Envoy Plus 9.0-32.0 fl oz + 0.25% nonionic surfactant)	Apply to actively growing grasses. For spot treatment use a 0.44-0.88 fl oz/gal solution plus 0.25% nonionic surfactant (0.33 fl oz/gal). A repeat application may be required for perennial grass control.
		fenoxaprop-ethyl 0.06-0.17 lb (Acclaim Extra 13.0-39.0 fl oz)	Primarily useful in landscape maintenance. Controls annual grasses and suppresses bermudagrass and johnsongrass. Apply when grasses are small and actively growing. Do not apply under drought stress. For spot treatment, mix 0.3-0.46 fl oz Acclaim Extra/gal.
Postemergence to selected weeds	Annual and perennial grasses including bermudagrass, quackgrass, and johnsongrass	fluazifop-P-butyl 0.25-0.375 lb (Ornamec 64.0-96.0 fl oz, Fusilade II 16.0-24.0 fl oz, or other labeled formulation + 0.5 pt nonionic surfactant/25.0 gal)	May be applied overtop to ornamentals and as a directed spray to others. Treat bermuda- grass when runners are 4-8" long, quackgrass when 6-10" tall and johnsongrass when 8-10" tall. Treat annual grasses prior to tillering. Apply only to actively growing grasses not under moisture stress. For spot treatment, use 2.5 fl oz Ornamec or 0.75 fl oz Fusilade II plus 0.5 fl oz nonionic surfactant/ gal and lightly wet grass.

Table 5.6 - Herbicides (continued)

Time of Application	Weed Problem	Chemical Rate/Acre	Remarks
Postemergence to selected weeds (continued)	Annual and perennial grasses including bermudagrass, quackgrass, and johnsongrass	sethoxydim 0.28-0.46 lb (Segment II 1.5-2.5 pt/A) + 2 pt/A crop oil concentrate or 1.5 pt/A methylated seed oil	Apply overtop of ornamentals to actively growing grasses. Use lower rate on annual grasses less than 6 inches tall and higher rate on grasses up to 12 inches in height. Treat perennial grasses with higher rate as follows: bermudagrass, 6 inch runners; johnsongrass, 15-20 inches tall; quackgrass, 6 inches tall; wirestem muhly, 6 inches tall. Repeat applications may be necessary on perennial grasses. Less than optimum results are likely if treatments are applied during moisture stress. For spot treatment, use 1.3 fl oz Segment II + 0.6 fl oz COC or 0.5 fl oz MSO per gal.
	Yellow nutsedge and certain broadleaf weeds	bentazon 0.75-1.0 (Basagran T/O 1.5-2.0 pt + 1 qt crop oil concentrate)	Apply as a directed spray to small, actively growing weeds. A second application 7-10 days later may be needed for acceptable yellow nutsedge control. Minimize contact with foliage of desired trees and shrubs. For small areas, mix 3/4 to 1 1/2 fluid ounces Basagran T/O plus 3/4 fl oz crop oil concentrate/gal.
	Yellow and purple nutsedge	halosulfuron 0.0321-0.062 lb (SedgeHammer 0.66-1.33 oz plus 0.25-0.5% V/V nonionic surfactant)	Apply as a directed spray around woody ornamentals that have been established at least 3 months after transplanting in landscapes. Do not contact leaves of desired woody plants. Do not apply to herbaceous perennials or bedding plants. For small areas, mix 0.9 g SedgeHammer plus 2 tsp (0.33 fl oz) nonionic surfactant/ gal and wet entire foliage of sedges.
	Certain broadleaf weeds	clopyralid 0.09-0.5 lb (Lontrel 0.25-1.33 pt)	Provides postemergence control of primarily legume and composite weeds such as clover, vetch, thistles, ragweed, and horseweed. Do not apply to container-grown ornamentals. Avoid drift to sensitive ornamentals such as daisy, redbud, locust, or linden. Apply as a directed spray.
	Poison ivy	glyphosate (Roundup Pro 2.67 fl oz/gal, Roundup Pro Max 2.0 fl oz/gal or other labeled formulation) triclopyr (Bioadvanced Brush Killer Plus 4 fl oz per gallon)	Apply glyphosate as a foliar spray when poison ivy is actively growing. Do not allow herbicide to contact leaves or green bark of desired plants. Use shielded sprays or other techniques. For wiper applications, use a 33% to 70% solution. For cut stump treatments, apply a 50% to 100% solution immediately after cutting stems. Apply triclopyr to the leaves of actively growing poison ivy. Keep the spray off desired broadleaf plants and off warm season turf species.
	Phragmites (common reed)	glyphosate (various)	Apply to foliage during active growth. Repeat applications will be needed for control. Use a formuation registered for aquatic sites if treating near water, such as Aquamaster or AquaNeat.

Table 5.7 - Guide for Herbicide Selection - Annual and Perennial Flowers, Vines, and Groundcovers[1]

	Acclaim	Barricade	Devrinol	Envoy	Fortress	FreeHand	Gallery	Ornamec	Pendulum G	Pennant	Segment	Ronstar G	Snapshot	Surflan	trifluralin	Tower
Annual And Perennial Flowers																
Alyssum	-	-	-	C,F	-	C,F	-	-	C,F	F	C,F	-	-	-	F	-
Aster	-	C,F	C	-	C,F	C,F	-	-	C,F	F	-	-	C,F	-	F	-
Begonia	F	-	-	-	-	-	-	-	C,F	-	C,F	-	-	-	-	-
Chrysanthemum	F	-	C	C,F	-	-	-	-	C,F	F	C,F	-	C,F	F	F	C,F
Coleus	F	-	-	C,F	-	C,F	-	-	-	-	C,F	-	-	-	-	C,F
Daffodil	-	C,F	C	-	-	C,F	-	-	C,F	F	-	-	-	F	F	C,F
Dahlia	-	-	C	C,F	C,F	-	-	-	C,F	-	-	-	-	-	F	-
Daylily	F	C,F	-	C,F	C,F	C,F	C,F	C,F	C,F	F	F	-	C,F	-	-	C,F
Delphinium	-	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-
Ferns	-	-	-	-	-	-	-	-	C,F	-	-	-	-	-	-	-

Table 5.7 - Guide for Herbicide Selection - Annual and Perennial Flowers, Vines, and Groundcovers[1]

	Acclaim	Barricade	Devrinol	Envoy	Fortress	FreeHand	Gallery	Ornamec	Pendulum G	Pennant	Segment	Ronstar G	Snapshot	Surflan	trifluralin	Tower
Annual And Perennial Flowers (continued)																
Forget-me-not	F	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-
Four-o'clock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-
Geranium	F	-	C	C,F	-	-	-	-	C,F	F	C,F	-	-	F	-	-
Gladiolus	-	F	C	-	-	C,F	-	-	C,F	F	C,F	-	-	F	F	-
Hosta	F	C,F	C	C,F	C,F	C,F	C,F	C,F	C,F	C,F	C,F	-	C,F	-	-	C,F
Impatiens	-	-	-	-	-	-	-	-	C,F	-	C,F	-	-	F	F	-
Iris	F	C,F	-	C,F	C,F	C,F	-	-	C,F	F	C,F	-	C,F	F	F	C,F
Lily	-	C,F	-	-	-	-	-	-	C,F	F	-	-	-	-	-	C,F
Marigold	-	-	-	C,F	-	C,F	-	C,F	C,F	F	C,F	-	-	F	F	C,F
Nasturtium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-
Pansy	-	-	-	-	-	-	-	-	C,F	-	C,F	-	-	F	-	-
Peony	F	-	-	-	-	C,F	-	-	C,F	-	-	-	-	-	-	-
Periwinkle	F	-	-	-	-	C,F	-	-	C,F	-	C,F	-	-	-	-	-
Petunia	F	-	C	C,F	-	C,F	-	-	C,F	F	C,F	-	-	-	F	C,F
Phlox	F	-	-	C,F	-	C,F	-	-	C,F	F	-	-	-	-	F	
Salvia	-	-	-	C,F	C,F	C,F	-	-	C,F	-	C,F	-	-	-	F	C,F
Shasta daisy	F	-	C	-	C,F	C,F	-	C,F	C,F	-	C,F	-	-	-	F	-
Snapdragon	F	-	-	C,F	-	-	-	-	C,F	F	C,F	-	-	-	F	-
Sunflower	-	-	-	-	-	C,F	-	-	C,F	-	-	-	-	-	F	-
Sweetpea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-
Sweet William	F	-	-	-	-	C,F	-	C,F	C,F	F	C,F	-	-	-	F	-
Tulip	-	C,F	-	-	-	C,F	-	-	C,F	F	-	-	-	F	F	-
Zinnia	F	-	C	C,F	-	C,F	-	C,F	C,F	F	C,F	-	-	F	F	C,F
Vines And Groundcovers																
Ajuga	F	-	F	C,F	-	-	-	-	C,F	C,F	-	F	-	-	-	-
Bamboo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clematis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C,F
English ivy	F	C,F	F	C,F	C,F	-	C,F	C,F	C,F	C,F	C,F	F	C,F	F	F	-
Euonymus	-	C,F	-	-	-	-	-	C,F	C,F	C,F	-	F	C,F	C,F	-	-
Honeysuckle	-	C,F	-	C,F	C,F	-	-	-	-	F	-	F	F	-	-	-
Jasmine	-	C,F	-	C,F	C,F	C,F	-	-	C,F	-	-	-	-	-	-	-
Liriope	F	C,F	F	C,F	C,F	C,F	C,F	C,F	C,F	C,F	C,F	-	C,F	C,F	F	C,F
Pachysandra	-	-	F	C,F	-	C,F	C,F	C,F	C,F	C,F	C,F	F	C,F	-	F	-
Pampasgrass	-	C,F	-	-	-	-	C,F	-	C,F	F	-	-	C,F	-	-	-
Santolina	-	C,F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sedum	-	C,F	F	C,F	-	C,F	-	-	C,F	F	-	F	C,F	-	F	-
Vinca (Periwinkle)	F	C,F	F	C,F	C,F	-	-	C,F	C,F	F	C,F	F	F	F	F	-
Yucca	-	C,F	-	-	-	-	-	C,F	C,F	C,F	-	-	-	C,F	-	-

[1]This table should be used only as a guide. A 'C' indicates the herbicide is registered for use on that species when container-grown. An 'F' indicates the herbicide is registered for use on that species when field-grown or planted in landscapes. Check the herbicide label for special considerations such as variety, plant growth stage, rate adjustment, or application precautions prior to application.

Table 5.8 - Guide for Herbicide Selection - Narrowleaf and Broadleaf Evergreens

Tolerant Species	Acclaim	Barricade	BroadStar	Casoron	Devrinol	Fortress	Pennant	Ornamec	Gallery	Goal	Kerb	Lontrel
Narrowleaf Evergreens	C,F	C,F	C,F	-	C,F	C,F	-	C,F	C,F	C,F		
Arborvitae	-	C,F	C,F	F	C	C,F	C,F	C,F	C,F	C,F	F	F
Cedar (Cedrus)	-	-	C,F	-	C,F	-	-	-	F	-	F	-
Chamaecyparis	-	F	C,F	-	-	-	-	-	C,F	-	-	-
Cryptomeria	-	-	-	-	-	C,F	-	-	C,F	-	-	-
Fir	-	F	C,F	-	C,F	C,F	F	C,F	C,F	C,F	F	F
Hemlock	-	C,F	C,F	-	F	-	F	C,F	-	C,F	F	-
Juniper	F	C,F	C,F	F	C,F	C,F	C,F	C,F	C,F	C,F	F	F
Leyland cypress	-	-	-	-	C,F	-	-	C,F	-	-	-	-
Pine	F	C,F	C,F	F	C,F	C,F	C,F	C,F	F	C,F	F	F
Spruce	-	F	C,F	-	F	C,F	F	C,F	C,F	C,F	F	F
Yew	F	C,F	C,F	F	F	-	C,F	C,F	C,F	C,F	F	F
Broadleaf Evergreens	-	C,F	C,F	-	C,F	C,F	C,F	-	C,F	C,F	-	-
Azalea	F	C,F	C,F	F	C,F	C,F	C,F	C,F	F	-	F	F
Barberry	F	C,F	C,F	F	-	C,F	F	C,F	C,F	-	F	-
Bayberry	-	-	C,F	-	-	-	F	-	-	-	-	-
Boxwood	F	C,F	C,F	F	C,F	C,F	C,F	C,F	F	-	F	F
Camellia	-	-	C,F	F	C,F	C,F	F	C,F	-	-	-	-
Euonymus	F	C,F	C,F	F	C,F	-	F	C,F	-	-	F	-
Holly	F	C,F	C,F	-	C,F	C,F	C,F	C,F	C,F	-	F	-
Leucothoe	-	-	-	F	C,F	-	C,F	-	-	-	-	-
Magnolia (Southern)	F	F	C,F	F	-	C,F	F	C,F	-	-	F	-
Mahonia	-	-	C,F	-	-	C,F	-	C,F	-	-	-	-
Mountain laurel	-	-	-	-	-	-	C,F	-	C,F	-	F	-
Osmanthus	-	C,F	-	F	F	C,F	F	-	-	-	-	-
Pittosporum	-	C,F	C,F	F	C,F	C,F	C,F	-	C,F	-	-	-
Pyracantha	F	C,F	C,F	F	C,F	C,F	F	C,F	C,F	-	F	-
Rhododendron	F	C,F	C,F	F	C,F	C,F	C,F	C,F	-	-	F	F

Table 5.8 - Guide for Herbicide Selection - Narrowleaf and Broadleaf Evergreens (continued)

	OH 2	Segment	Pendulum G	Princep	Ronstar G	Rout	Fuerte	Snapshot	SureGuard	Surflan	trifluralin	Tower	FreeHand
Narrowleaf Evergreens													
Arborvitae	-	C,F	C,F	F	-	C,F	C,F	-	C,F	F	F	C,F	C,F
Cedar (Cedrus)	-	-	-	-	C,F	-	C,F	-	-	-	-	-	-
Cryptomeria	-	-	C,F	-	-	-	C,F	-	-	C,F	-	-	-
Chamaecyparis	C,F	-	C,F	-	C,F	C,F	-	F	-	-	-	-	-
Fir	-	C,F	C,F	-	-	-	C,F	F	C,F	F	F	C,F	C,F
Hemlock	-	C,F	C,F	F	F	-	C,F	-	C,F	-	F	C,F	C,F
Juniper	C,F	C,F	C,F	F	C,F	C,F	C,F	C,F	C,F	C,F	F	C,F	C,F
Leyland cypress	-	C,F	C,F	-	-	-	-	-	-	-	-	-	C,F

Table 5.8 - Guide for Herbicide Selection - Narrowleaf and Broadleaf Evergreens (continued)

	OH 2	Segment	Pendulum G	Princep	Ronstar G	Rout	Fuerte	Snapshot	SureGuard	Surflan	trifluralin	Tower	FreeHand
Narrowleaf Evergreens (continued)													
Pine	C,F	C,F	C,F	F	C,F	C,F	C,F	F	C,F	F	F	C,F	-
Spruce	C,F	C,F	C,F	F	F	C,F	C,F	F	C,F	F	F	C,F	C,F
Yew	C,F	C,F	C,F	F	F	-	C,F	F	C,F	F	F	C,F	C,F
Broadleaf Evergreens													
Aucuba	-	-	C,F	-	-	-	-	-	-	-	-	-	-
Azalea	C,F	C,F	C,F	-	C,F	C,F	C,F	C,F	-	F	F	C,F	C,F
Barberry	C,F	C,F	C,F	F	C,F	C,F	C,F	C,F	-	C,F	F	C,F	C,F
Bayberry	-	-	-	-	-	-	-	-	-	-	-	-	-
Boxwood	C,F	C,F	C,F	-	C	C,F	C,F	C,F	-	C,F	F	C,F	C,F
Camellia	C,F	C,F	C,F	-	C,F	-	C,F	C,F	-	-	F	C,F	C,F
Euonymus	C,F	C,F	C,F	-	C,F	C,F	C,F	C,F	-	C,F	F	C,F	-
Holly	C,F	C,F	C,F	F	C,F	C,F	C,F	C,F	-	C,F	F	C,F	C,F
Leucothoe	-	-	C,F	F	C	-	-	-	-	F	-	C,F	-
Magnolia (Southern)	-	C,F	C,F	-	C	-	C,F	C,F	-	F	-	C,F	-
Mahonia	C,F	-	-	F	C,F	C,F	C,F	C,F	-	F	-	-	C,F
Mountain laurel	-	-	C,F	-	-	-	-	-	-	F	F	-	-
Osmanthus	-	C,F	C,F	F	C	C,F	-	-	-	F	-	C,F	-
Pittosporum	C,F	C,F	-	-	C,F	C,F	C,F	C,F	-	-	F	-	-
Pyracantha	C,F	C,F	C,F	-	C,F	C,F	C,F	C,F	-	C,F	F	-	-
Rhododendron	C,F	C,F	C,F	-	C,F	C,F	C,F	C,F	-	C,F	F	C,F	-

[1]This table should be used only as a guide. A 'C' indicates the herbicide is registered for use on that species when container-grown. An 'F' indicates the herbicide is registered for use on that species when field-grown or planted in landscapes. Check the herbicide label for special considerations such as variety, plant growth stage, rate adjustment, or application precautions prior to application.

Table 5.9 - Guide for Herbicide Selection - Deciduous Trees and Shrubs[1]

Tolerant Species	Acclaim	Barricade	BroadStar	Casoron	Devrinol	Fortress	Pennant	Ornamec	Gallery	Goal	Kerb	Lontrel
Deciduous Trees												
Amelanchier	-	-	-	-	-	-	-	-	-	-	-	-
Ash	-	-	C,F	F	F	C,F	F	C,F	F	F	F	-
Beech	-	-	-	-	-	-	F	-	-	-	F	-
Birch	-	-	C,F	F	F	C,F	C,F	C,F	F	F	F	-
Cherry	-	-	-	-	F	-	F	-	F	F	F	-
Crabapple	-	C,F	C,F	F	F	C,F	F	-	F	F	F	-
Dawn redwood	-	-	-	-	-	-	-	-	-	-	-	-
Dogwood	-	C,F	C,F	F	C,F	C,F	C,F	C,F	-	F	F	F
Elm	-	-	C,F	F	-	-	-	-	F	-	F	-
Ginkgo	-	-	C,F	-	-	-	F	-	-	-	F	-
Goldenchain tree	-	-	-	F	F	-	-	-	-	-	-	-
Goldenrain tree		-	-	-	-	-	-	-	-	-	-	-

Table 5.9 - Guide for Herbicide Selection - Deciduous Trees and Shrubs[1] (continued)

Tolerant Species	Acclaim	Barricade	BroadStar	Casoron	Devrinol	Fortress	Pennant	Ornamec	Gallery	Goal	Kerb	Lontrel
Deciduous Trees (continued)												
Hawthorn	F	C,F	-	F	F	-	-	-	-	-	F	-
Honeylocust	-	-	-	F	F	-	F	C,F	-	-	F	-
Linden	-	-	-	F	-	-	-	-	F	-	F	-
Magnolia	F	F	C,F	F	-	C,F	F	C,F	-	-	F	-
Maple	F	C,F	C,F	F	F	C,F	C,F	C,F	F	F	F	F
Oak	-	C,F	C,F	F	F	C,F	C,F	C,F	F	F	F	F
Pear	-	C,F	-	F	F	-	F	-	F	F	-	-
Poplar	-	-	C,F	F	-	-	F	-	-	F	F	-
Redbud	-	-	C,F	-	-	-	-	C,F	-	F	-	-
Russian Olive	-	-	-	F	-	-	F	C,F	-	F	-	-
Sourgum *(Nyssa)*	-	-	-	-	-	-	-	-	-	-	-	-
Sourwood *(Oxydendron)*	-	C,F	-	-	-	C,F	-	-	-	-	-	-
Sweetgum	-	-	C,F	-	-	C,F	F	C,F	F	F	F	-
Sycamore	-	-	C,F	-	-	-	-	-	F	F	F	F
Tulip tree	-	-	-	-	-	-	F	-	-	F	-	-
Walnut	F	-	C,F	-	F	-	-	-	-	F	F	-
Willow	F	-	-	F	-	C,F	F	C,F	F	-	F	-
Zelkova	-	-	-	-	-	-	-	-	-	-	-	-
Deciduous Shrubs												
Abelia	-	C,F	C,F	-	C,F	C,F	C,F	-	-	-	-	-
Cotoneaster	-	C,F	C,F	F	C,F	-	C,F	C,F	C,F	-	F	-
Crape myrtle	-	C,F	C,F	-	C,F	-	F	C,F	-	F	-	-
Deutzia	-	-	-	F	-	-	-	-	-	-	-	-
Euonymus	-	C,F	C,F	F	C,F	C,F	C,F	-	-	-	F	-
Flowering quince	-	-	-	F	-	-	-	C,F	-	-	F	-
Forsythia	-	C,F	C,F	F	C,F	-	C,F	-	-	-	F	-
Hibiscus	-	C,F	-	-	C,F	-	F	-	C,F	-	-	-
Honeysuckle		C,F	C,F	F	F	-	F	-	-	-	-	-
Hydrangea	F	C,F	-	-	-	-	F	-	-	-	-	-
Hypericum	-	-	-	-	F	-	F	-	-	-	-	-
Lilac	-	-	C,F	F	-	-	F	C,F	F	F	F	-
Nandina	F	C,F	-	F	C,F	C,F	F	-	C,F	-	-	-
Photinia	F	C,F	C,F	F	C,F	C,F	F	C,F	C,F	-	-	-
Privet	F	C,F	-	F	C,F	-	C,F	C,F	-	-	F	-
Rose	F	C,F	C,F	F	C,F	-	F	C,F	F	-	F	-
Spirea	-	C,F	-	F	-	C,F	F	C,F	-	-	-	F
Viburnum	F	C,F	C,F	-	F	C,F	C,F	F	-	-		
Vitex	-	-	-	-	-	-	-	-	-	-	-	-
Weigela	F	C,F	C,F	F	-	-	F	C,F	-	-	-	-
Witchhazel *(Hamamelis)*	-	-	-	-	-	-	-	-	-	-	-	-

Table 5.9 - Guide for Herbicide Selection - Deciduous Trees and Shrubs[1] (continued)

Tolerant Species	OH 2	Segment	Pendulum G	Princep	Ronstar G	Rout	Fuerte	Snapshot	SureGuard	Surflan	Treflan	Tower	FreeHand
Deciduous Trees													
Amelanchier (serviceberry)	-	-	-	-	-	-	-	-	-	-	-	-	-
Ash	-	C,F	C,F	-	F	-	C,F	-	F	-	F	F	C,F
Beech	-	-	-	-	-	-	-	-	-	-	-	-	-
Birch	C,F	C,F	C,F	-	F	-	C,F	C,F	F	-	F	-	C,F
Cherry	-	C,F	C,F	-	-	-	C,F	F	F	F	F	-	C,F
Crabapple	-	C,F	C,F	F	F	-	C,F	-	F	-	F	-	C,F
Dawn redwood	-	C,F	-	-	-	-	-	-	-	-	-	-	-
Dogwood	C,F	C,F	C,F	F	C,F	C,F	C,F	C,F	F	-	F	F	C,F
Elm	-	C,F	C,F	F	-	-	-	F	-	-	-	F	C,F
Ginkgo	-	C,F	C,F	-	C	-	C,F	F	F	C,F	-	-	-
Goldenchain tree	-	-	-	-	-	-	-	-	-	-	-	-	-
Goldenrain tree	-	-	-	-	-	-	-	-	-	F	-	-	-
Hawthorn	C,F	C,F	C,F	-	-	-	C,F	-	-	-	-	F	C,F
Honeylocust	-	C,F	C,F	F	-	-	-	F	-	-	F	-	C,F
Linden	-	C,F	C,F	-	-	-	-	-	-	-	-	-	-
Magnolia	C,F	C,F	C,F	-	C,F	C,F	C,F	-	-	F	-	F	C,F
Maple	C,F	C,F	C,F	-	F	C,F	C,F	F	F	F	F	F	C,F
Oak	C,F	C,F	C,F	F	C,F	C,F	C,F	F	F	C,F	F	-	C,F
Pear	-	C,F	C,F	-	-	-	C,F	F	F	F	-	F	-
Poplar	-	C,F	C,F	-	-	-	C,F	-	F	-	-	-	-
Redbud	C,F	-	-	-	-	-	C,F	C,F	F	-	F	-	C,F
Russian olive	-	-	C,F	F	F	C,F	-	F	-	-	-	-	-
Sourgum *(Nyssa)*	-	-	C,F	-	-	-	-	-	-	-	-	-	-
Sourwood *(Oxydendron)*	-	C,F	-	-	-	-	C,F	C,F	-	-	-	-	C,F
Sweetgum	-	C,F	C,F	-	-	-	C,F	F	F	C,F	F	-	-
Sycamore	-	C,F	C,F	-	-	-	C,F	F	F	-	F	-	-
Tulip tree	-	C,F	C,F	-	-	-	-	-	-	-	F	-	-
Walnut	-	C,F	C,F	-	-	-	C,F	F	F	-	F	F	C.F
Willow	-	C,F	C,F	-	-	-	-	F	-	-	F	-	-
Zelkova	-	-	-	-	-	-	-	-	-	-	-	-	C,F
Deciduous Shrubs													
Abelia	C,F	C,F	C,F	-	-	C,F	C,F	C,F	-	F	-	-	C,F
Cotoneaster	C,F	C,F	C,F	F	C,F	C,F	C,F	C,F	-	C,F	F	-	C,F
Crape myrtle	-	C,F	C,F	-	-	-	C,F	F	-	C,F	-	F	C,F
Deutzia	-	C,F	C,F	-	-	-	-	F	-	-	F	-	C,F
Euonymus	C,F	C,F	C,F	-	C,F	C,F	C,F	C,F	-	C,F	F	-	C,F
Flowering quince	-	C,F	-	-	-	-	-	-	-	-	-	-	C,F
Forsythia	C,F	C,F	C,F	-	C,F	C,F	C,F	C,F	-	F	F	-	C,F
Hibiscus	-	C,F	C,F	-	-	C,F	-	C,F	-	F	-	-	C,F
Honeysuckle	C,F	-	C,F	-	C,F	C,F	C,F	C,F	-	-	F	-	-
Hydrangea	C,F	C,F	C,F	-	-	-	-	-	-	-	-	F	C,F

Table 5.9 - Guide for Herbicide Selection - Deciduous Trees and Shrubs[1] (continued)

Tolerant Species	OH 2	Segment	Pendulum G	Princep	Ronstar G	Rout	Fuerte	Snapshot	SureGuard	Surflan	Treflan	Tower	FreeHand
Deciduous Shrubs													
Hypericum	C,F	-	-	-	-	C,F	-	-	-	-	-	-	-
Lilac	-	C,F	C,F	-	F	-	-	-	F	C,F	F	-	-
Nandina	-	C,F	C,F	-	-	C,F	-	C,F	-	C,F	-	F	C,F
Photinia	C,F	C,F	C,F	-	C	C,F	C,F	C,F	-	C,F	-	-	C,F
Privet	C,F	C,F	C,F	-	C,F	C,F	C,F	C,F	-	C,F	F	-	C,F
Rose	-	C,F	-	-	C,F	-	C,F	F	-	F	F	F	C,F
Spirea	C,F	C,F	C,F	-	-	C,F	-	C,F	-	-	F	F	C,F
Viburnum	-	C,F	C,F	-	C	C,F	C,F	C,F	-	C,F	F	C,F	C.F
Vitex	-	C,F	C,F	-	-	-	-	-	-	-	-	-	-
Weigela	-	C,F	C,F	F	-	C,F	C,F	F	-	F	F	-	C,F
Witchhazel *(Hamamelis)*	-	-	-	-	-	-	-	-	-	-	-	-	-

[1]This table should be used only as a guide. A 'C' indicates the herbicide is registered for use on that species when container-grown. An 'F' indicates the herbicide is registered for use on that species when field-grown or planted in landscapes. Check the herbicide label for special considerations such as variety, plant growth stage, rate adjustment, or application precautions prior to application.

Table 5.10 - Guide to Weeds Which May Be Controlled by Preemergence Herbicides Approved for Use in Ornamentals

Weed	Barricade	BroadStar, SureGuard	Casoron	Devrinol	Fortress	FreeHand	Pendulum	Pennant	Gallery	Goal	Kerb	Specticle	Dismiss
Monocot weeds													
Annual bluegrass	G	P-F	G	G	G	G	G	F	P	F	G	E	-
Barnyardgrass	G	-	G	G	-	-	G	G	-	F	F	-	P
Bermudagrass	N	N	P	N	N	N	N	N	N	N	N	N	N
Cheat	-	-	-	-	-	-	-	-	-	-	-	-	-
Crabgrass	G	F-G	G	G	G	G	G	G	P	F	F	E	P
Doveweed	P	G	-	-	-	G	P	G	N	-	-	P	-
Fall panicum	-	-	G	G	-	G	G	G	-	-	F	-	P
Foxtails	G	F-G	G	G	-	G	G	G	-	F	F	-	P
Goosegrass	G	-	G	G	-	G	G	G	-	F	-	G	P
Johnsongrass (seedling)	-	F	G	G	-	-	G	G	-	-	F	-	-
Microstegium	G	-	-	-	-	-	G	-	-	-	-	G	-
Orchardgrass, fescue	N	N	G	N	N	N	N	N	N	N	G	P	N
Quackgrass	-	-	G	N	-	N	-	N	-	-	G	-	-
Small grains (volunteer)	-	-	-	G	-	-	-	-	-	-	G	-	-
Stinkgrass	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow Nutsedge	N	N	G	P	N	F-G	N	F-G	N	-	N	N	F
Broadleaf Weeds													
Artemisia (wild chrysanthemum)	-	-	G	N	-	-	-	-	-	-	-	-	-
Bittercress	P-F	G	-	F	G	F-G	P-F	P	G	G	-	G	-
Canada thistle	-	-	-	N	-	-	-	-	-	-	-	-	-

Table 5.10 - Guide to Weeds Which May Be Controlled by Preemergence Herbicides Approved for Use in Ornamentals (continued)

Weed	Barricade	BroadStar, SureGuard	Casoron	Devrinol	Fortress	FreeHand	Pendulum	Pennant	Gallery	Goal	Kerb	Specticle	Dismiss
Broadleaf weeds													
Carpetweed	G	-	G	G	-	G	G	F	-	-	-	E	G
Chamberbitter	P	G	-	-	-	F	F	P	P-F	-	-	G	-
Chickweed	G	F-G	G	G	-	G	G	F	G	F	G	G	-
Cutleaf evening primrose	P	-	G	G	-	-	P	P	F	F	-	-	-
Dandelion	-	-	G	-	-	-	-	-	-	-	-	-	-
Dock	-	-	G	-	-	-	-	-	-	-	-	-	-
Dodder	-	-	G	-	-	-	-	-	-	-	-	-	-
Dogfennel	-	-	G	-	-	G	-	-	G	-	-	-	-
Eclipta	P	G	-	P	-	F-G	P	P	G	F	-	F	-
Filaree	-	-	-	F	-	-	-	-	-	-	-	-	-
Galinsoga (quickweed)	-	-	-	F	-	F	N	G	G	G	P	-	F
Groundsel, common	-	G	G	F	-	F	P	P	F	G	-	G	-
Henbit (deadnettle)	-	-	G	G	-	-	-	G	G	G	-	G	-
Horseweed (marestail)	-	-	G	N	-	-	-	P	F	G	-	G	-
Knotweed	-	-	-	G	-	-	-	-	-	G	-	P	-
Lambsquarters	-	E	G	F	-	-	F	P	G	G	F	F-G	G
Long-Stalk Phyllanthus	F	G	-	-	-	F	F	P	P-F	-	-	G	-
Morningglory	-	G	G	N	-	-	P	N	P	G	-	P	-
Mulberry weed	F-G	G	-	-	-	G	F-G	F-G	G	-	-	-	-
Mustard	-	-	-	N	-	-	-	-	-	G	-	-	-
Nightshade	-	-	-	N	-	-	P	G	-	G	-	-	-
Pigweed	-	G	G	F	-	G	F	G	G	G	F	-	G
Poison Ivy	N	-	-	N	-	-	N	N	N	N	-	-	-
Prickly lettuce	-	-	-	G	-	-	-	-	-	G	-	-	-
Prickly sida	-	E	G	P	-	-	-	P	-	-	-	-	-
Purslane	-	-	G	G	-	-	F	F	G	G	G	-	G
Pusley, Florida	-	-	-	-	-	-	-	-	-	-	-	-	-
Ragweed	P	E	G	P	-	-	N	N	G	F	P	F-G	P
Red sorrel	-	-	G	-	-	-	-	-	-	-	-	-	-
Shepherds' purse	-	-	-	P	-	-	N	-	G	G	-	-	-
Smartweed	-	-	G	P	-	-	-	P	G	G	F	-	G
Sowthistle	-	G	-	G	-	F	F	-	-	G	-	G	-
Spurge, prostrate (spotted)	G	G	-	P	-	G	G	P	F	F	-	F-G	-
Tassel flower	N	G	-	-	-	F-G	N	N	F	-	-	-	-
Velvetleaf	-	G	-	N	-	-	G	P	F	G	P	-	-
Veronica (speedwell)	-	-	-	-	-	-	-	-	-	G	-	-	-
Virginia copperleaf	-	P-F	-	-	-	-	-	-	-	-	-	-	-
Wild aster	-	-	-	-	-	-	-	-	-	-	-	-	-
Wild carrot	-	-	G	-	-	-	-	-	-	-	-	-	-
Yellow woodsorrel *(Oxalis)* from seed	G	G	G	N	-	G	G	P	F	G	-	G	-

Table 5.10 - Guide to Weeds Which May Be Controlled by Preemergence Herbicides Approved for Use in Ornamentals (continued)								
	OH2	Princep	Ronstar	Rout	Snapshot	Surflan	Tower	Treflan
Monocots								
Annual bluegrass	G	G	F	G	G	G	-	-
Barnyardgrass	G	G	G	G	G	G	G	G
Bermudagrass	N	P	N	N	N	N	N	N
Cheat	-	-	-	-	-	-	-	-
Crabgrass	G	F	G	G	G	G	G	G
Doveweed	P-F	-	P-F	P-F	N	N	G	N
Fall panicum	G	F	-	G	G	G	G	G
Foxtails	G	F	G	G	G	G	G	G
Goosegrass	G	G	G	G	G	G	G	G
Johnsongrass (seedling)	G	P	-	G	G	G	P	G
Microstegium	-	-	G	-	-	G	-	-
Orchardgrass, fescue	N	F	N	N	N	N	N	N
Quackgrass	N	F	-	N	N	N	N	N
Small grains (volunteer)	G	-	-	G	-	-	-	-
Stinkgrass	-	-	-	-	-	-	-	-
Yellow Nutsedge	N	N	N	N	N	N	F-G	N
Broadleaf Weeds								
Artemisia (wild chrysanthemum)	-	-	-	-	-	-	-	-
Bittercress	G	-	G	G	G	G	-	F
Canada thistle	N	N	N	N	-	N	-	N
Carpetweed	-	-	-	-	-	-	-	-
Chamberbitter	G	-	G	G	F	G	-	N
Chickweed	F	G	N	F	G	F	-	G
Cutleaf evening primrose	G	F	G	G	G	F	-	-
Dandelion	G	-	-	G	-	-	-	-
Dock	-	-	-	-	-	-	-	-
Dodder	-	-	-	-	-	-	-	-
Dogfennel	-	F	P	G	G	G	-	-
Eclipta	F	-	P	G	F-G	F-G	-	-
Filaree	-	-	-	-	-	-	-	-
Galinsoga (quickweed)	G	G	G	G	G	N	-	N
Groundsel, common	G	G	F	G	F-G	P	-	-
Henbit (deadnettle)	G	G	G	G	G	G	-	-
Horseweed (marestail)	G	-	G	G	G	-	-	-
Knotweed	G	-	-	G	-	-	-	-
Lambsquarters	G	G	G	G	G	G	P	F
Long-Stalk Phyllanthus	G	-	G	G	F	F	-	P
Morningglory	G	F	P	G	-	N	N	N
Mulberry weed	G	-	F-G	G	F-G	G	-	P
Mustard	G	G	-	G	-	-	-	-
Nightshade	G	G	-	G	G	P	-	P
Pigweed	G	G	G	G	-	F	-	F

Table 5.10 - Guide to Weeds Which May Be Controlled by Preemergence Herbicides Approved for Use in Ornamentals (continued)

	OH2	Princep	Ronstar	Rout	Snapshot	Surflan	Tower	Treflan
Broadleaf Weeds								
Poison Ivy	N	N	N	N	N	N	N	N
Prickly lettuce	G	G	-	G	-	-	-	-
Prickly sida	-	G	-	-	-	P	P	P
Purslane	G	G	G	G	G	F	-	F
Pusley, Florida	-	-	-	-	-	-	-	-
Ragweed	-	G	P	G	G	N	P	N
Red sorrel	-	-	-	-	-	-	-	-
Shepherds'purse	G	G	G	G	-	N	-	N
Smartweed	G	G	-	G	-	P	P	P
Sowthistle	G	F	-	G	-	-	-	-
Spurge, prostrate (spotted)	G	G	F	G	G	G	-	-
Tassel flower	G	-	N	G	P-F	P-F	-	N
Velvetleaf	-	P	F	G	G	P	N	P
Veronica (speedwell)	G	-	-	G	-	-	-	-
Virginia copperleaf	P	-	-	P	F	-	-	-
Wild aster	-	-	-	-	-	-	-	-
Wild carrot	-	-	-	-	-	-	-	-
Yellow woodsorrel (Oxalis) from seed	G	-	G	G	G	F	-	-
Wild aster	N	-	N	-	N	-	G	N
Wild carrot	N	-	N	-	N	-	G	N
Yellow woodsorrel (Oxalis) from seed	N	N	N	G	N	-	G	N

G = good control, F = fair, P = poor, N = no control, and - = no information.

Table 5.11 - Guide to Weeds Which May Be Controlled by Postemergence Herbicides Approved by Use in Ornamentals

Weed	Acclaim	Basagran	Envoy	Finale	Lontrel	Ornamec	Reward	Roundup	Segment
Monocots									
Annual bluegrass	N	N	G	G	N	P	G	G	N
Bamboo	-	-	-	P	N	-	-	F	-
Barnyardgrass	-	N	G	G	N	G	G	G	G
Bermudagrass	F	N	G	F	N	G	P	G	G
Cheat	-	N	-	-	N	-	-	G	-
Crabgrass	G	N	G	G	N	G	G	G	G
Doveweed	N	-	N	G	N	N	-	F	N
Fall panicum	-	N	G	G	N	G	G	G	G
Foxtails	G	N	G	G	N	G	G	G	G
Goosegrass	G	N	G	G	N	G	G	G	G
Johnsongrass (seedling)	-	N	G	-	N	G	-	G	G
Microstegium	G	-	G	G	N	G	-	G	G

Table 5.11 - Guide to Weeds Which May Be Controlled by Postemergence Herbicides Approved by Use in Ornamentals

Weed	Acclaim	Basagran	Envoy	Finale	Lontrel	Ornamec	Reward	Roundup	Segment
Monocots									
Orchardgrass, fescue	N	N	F	P	N	F	F	G	F
Quackgrass	P	N	G	P	N	G	-	G	G
Small grains (volunteer)	-	N	-	-	N	G	-	G	G
Stinkgrass	-	N	-	-	N	-	-	G	-
Yellow Nutsedge	N	F	N	F	N	N	F	G	N
Broadleaf Weeds									
Artemisia (wild chrysanthemum)	N	-	N	-	F	N	-	F	N
Bittercress	N	G	N	-	N	N	G	G	N
Canada thistle	N	-	N	-	G	N	F	G	
Carpetweed	N	-	N	-	-	N	G	G	N
Chickweed	N	-	N	G	-	N	G	G	N
Cutleaf evening primrose	N	N	N	G	-	N	-	F	N
Dandelion	N	-	N	G	F	N	-	G	N
Dock	N	-	N	-	-	N	-	G	N
Dodder	N	-	N	-	-	N	-	G	N
Dogfennel	N	N	N	-	-	N	F	G	N
Eclipta	N	G	N	G	E	N	-	G	N
Filaree	N	-	N	-	-	N	-	G	N
Galinsoga (quickweed)	N	-	N	-	-	N	G	G	N
Groundsel, common	N	F	N	G	G	N	G	G	N
Henbit (deadnettle)	N	-	N	G	-	N	G	G	N
Horseweed (marestail)	N	N	N	G	F	N	F	G	N
Knotweed	N	-	N	-	-	N	-	G	N
Lambsquarters	N	F	N	G	P	N	F	G	N
Morningglory	N	P	N	-	N	N	G	F	N
Mustard	N	-	N	G	-	N	G	G	N
Nightshade	N	N	N	-	F	N	G	G	N
Pigweed	N	P	N	G	P	N	G	G	N
Poison Ivy	N	-	N	-	-	N	P	G	N
Prickly lettuce	N	-	N	G	-	N	G	G	N
Prickly sida	N	G	N	-	-	N	F	G	N
Purslane	N	-	N	G	-	N	G	G	N
Pusley, Florida	N	-	N	-	-	N	-	G	N
Ragweed	N	G	N	G	E	N	G	G	N
Red sorrel	N	-	N	G	-	N	F	G	N
Shepherds' purse	N	-	N	G	-	N	G	G	N
Smartweed	N	G	N	G	F	N	F	G	N
Sowthistle	N	-	N	-	F	N	-	G	N
Spurge, prostrate (spotted)	N	N	N	G	-	N	G	G	N
Velvetleaf	N	G	N	G	-	N	-	G	N
Veronica (speedwell)	N	-	N	-	-	N	-	G	N

G = good control, F = fair, P = poor, N = no control, and - = no information.

Floral Crops: Diseases

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The conditions under which many floral and foliage crops are produced, i.e., high humidity, low light intensity, and frequent watering, are favorable for the development of fungal and bacterial diseases. If insects are uncontrolled in the greenhouse, viruses can become a major problem. Nematodes may be introduced on infected plant material or unsterilized soil.

There are three principles in the management of floral crop health. The first principle is to prevent pathogens from entering production systems. Applications of this principle include use of disease-free propagating materials, noncontaminated or decontaminated containers, soil-less media and irrigation water, etc. The second principle is to create environments that are working against pathogens. Some common practices of this principle are to (i) use of disease-resistant or tolerant plant species and varieties, (ii) remove diseased plants and planting materials from production beds once they are noticed, to reduce disease potential and dissemination risk, (iii) irrigate crops in early morning instead of evening to shorten the wet period on foliage that is essential for many pathogen germination, infection, and growth, and (iv) use of biopesticides such as Actino-Iron. The third principle is to control the disease when it does arise. The keys to successfully implementing this principle include early detection of a disease, correct diagnosis of its cause and selection of the right chemicals. Fungicides should be only used for fungal diseases, so should bactericides for bacterial diseases, oomyceticides for downy mildew, Phytophthora and Pythium diseases. The rest of this section provides general recommendations for control of major floral crop diseases. It is important that growers carefully consult and strictly follow the label when applying a fungicide, bactericide, oomyceticide or nematicide for disease control.

Table 6.1 - Common Diseases and Chemical Control Options

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
African Violet Botrytis blight (Gray mold)	Decree 0.7-1.5 lb; fenhexamid	Spray 7- to 14-day intervals.
	Pageant (38%) 12.0-18.0 oz; pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
African Violet Phytophthora root rot	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt phosphite	Apply every 7 days.
	Banol (66.5%) 20.0-30.0 fl oz; propamocarb hydrochloride	Treat soil at 3-week to 3-month intervals.
	Disarm (40.3% SC) 1.0-6.0 fl oz fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz; ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Stature (43.5% SC) 6.0-13.0 fl oz; dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Segway (34.5% SC) 2.0-6.0 fl oz; cyazoflamid	Apply at 14- to 28-day intervals.
	Subdue Maxx 0.5-1.0 fl oz; mefenoxam	Apply in 100 gal of water over 400-800 sq ft (1.0 pt/sq ft). For soil depth greater than 4 inches apply 1.5-2.0 pts solution/sq ft. Repeat at 1- to 2-month intervals. Irrigate to thoroughly wet soil after application. For Subdue 5G do not apply rate of 9 oz more often than once every 6 weeks.
African Violet Powdery mildew	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Apply at 7- to 14-day intervals.
	Systhane (40% WSP) 4 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal; neem oil	Apply every 14 days.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
Ageratum Botrytis blight (Gray mold)	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Apply at 7- to 14-day intervals.
	Decree 0.70-1.5 lb fenhexamid	Spray 7- to 14-day intervals.

Table 6.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Ageratum Botrytis blight (Gray mold) (continued)	Exotherm (Termil) 3.5 oz/1000 sq ft; chlorothalonil	Fumigate every 7 to 14 days.
	Pageant (38%) 12.0-18.0 oz; pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Ageratum Powdery mildew	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Apply at 7- to 14-day intervals.
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal; neem oil	Apply every 14 days.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
Ageratum Root Rot *(Pythium)*	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt phosphite	Apply every 7 days.
	Banol (66.5%) 20.0-30.0 fl oz; propamocarb hydrochloride	Treat soil at 3-week to 3-month intervals.
	Disarm (40.3% SC) 1.0-6.0 fl oz; fluoxastrobin	Apply at 14- to 28-day intervals.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz; ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Stature (43.5% SC) 6.0-13.0 fl oz; dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Segway (34.5% SC) 2.0-6.0 fl oz; cyazoflamid	Apply at 14- to 28-day intervals.
	Subdue Maxx 0.5-1.0 fl oz; mefenoxam	**Drench at seeding** (soil 2-3 inches deep). Mix Subdue with 100 gal of water and apply 1 pt of solution/sq ft. **Transplanting** mix 0.5-2.0 fl oz with 100 gal of water and apply 1 pt solution/sq ft or 1.5-2.0 pt for soil depth greater than 4 inches. Do not apply rates of 1.5-2.0 fl oz more often than once every six weeks.
	Terrazole (35% WP) 3.0-10.0 oz; etridiazole	Apply on 400 sq ft or saturate the soil medium, such as 1/2 pt/6-inch container.
Ageratum Root rot *(Rhizoctonia)*	Chipco 26019 (50% WP) 0.4 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Apply 1.0- to 2.0 pt/sq ft every 14 days.
	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed.
	Hurricane (48%) 1.5 oz; fludioxonil and mefenoxam	Drench to completely wet root zone at 21- to 28-day intervals
	Medallion (50% WP) 1 packet; fludioxonil	Drench at 3- to 4-week intervals.
	Pageant (38%) 12.0 to 18.0 oz; pyraclostrobin and boscalid	Drench to completely wet root zones at 7- to 14-day intervals
	Palladium (63.5% WDG) 2.0 to 4.0 oz Cyprodinil and fludioxonil	Apply at 7- to 14-day intervals
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals
Annual Vinca (Madagascar periwinkle) Phytophthora blight	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt phosphite	Apply every 7 days.
	Disarm (40.3% SC) 1.0-6.0 fl oz; fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Spray plants at a 28-day interval.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz; ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.

Table 6.1 - Common Diseases and Chemical Control Options (continued)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Annual Vinca (Madagascar periwinkle) Phytophthora blight (continued)	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Subdue Maxx 0.5-1.0 fl oz; mefenoxam	**Drench at seeding** (soil 2 to 3 inches deep). Mix Subdue with 100 gal of water and apply 1 pt of solution/sq ft. **Transplanting** mix 0.5-2.0 fl oz with 100 gal of water and apply 1 pt solution/sq ft or 1.5- 2.0 pt for soil depth greater than 4 inches. Do not apply rates of 1.5-2.0 fl oz more often than once every six weeks.
Azalea (Rhododendron) Botrytis blight (Gray mold)	Broadform 4.0 to 8.0 fl oz fluopyram and trifloxystrobin	Spray at 7 to 14 day intervals.
	Chipco 26019 (50% WP) 1.0-2.0 lb; iprodione	Spray every 10 to 14 days.
	Daconil Weather Stik 2.0 pt Concorde (54% SST) 1.3 pt; chlorothalonil	Spray every 7 to 10 days during wet weather. Apply at early bloom.
	Exotherm (Termil) 3.5 oz/1000 sq ft chlorothalonil	Fumigate every 7 to 14 days.
	Pageant (38%) 12.0-18.0 oz; pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Azalea Cylindrocladium root rot	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Drench Cleary 3336 on the surface of growing medium to prevent disease development. Repeat at 2- to 4-week intervals during disease pressure.
	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply every 14 to 21 days
	Dithane Rainshield or Fore Rainshield, 1.5 lb; Junction (15% DF); 1.5 lb mancozeb	Apply in a full coverage spray every 7 to 10 days while flowers are opening spray ground under bushes and into open flowers.
	Pageant (38%) 12.0 to 18.0 oz; pyraclostrobin and boscalid	Apply every 7 to 14 days
	Spectro TM (90% WDG) 1.0 to 2.0 lb chlorothalonil and thiophanate-methyl	Apply every 14 days
	Terragard, 50 W; triflumizole	Soil drench 6.0-8.0 oz or 1-1 1/3 tps/gal on propagation beds. On established plants apply a drench at 6.0-12.0 oz or 1.0-2.0 tsp/gal.
	Torque (38.7%) 4.0 to 10.0 fl oz; tebuconazole	Apply every 14 to 21 days
Azalea Ovulinia flower blight	Daconil Weather Stik 2.0 pt Concorde (54% SST) 1.1 pt; chlorothalnil	Spray every 7 to 10 days. Apply at new leaf emergence.
	Strike (25% WDG) 8.0-16.0 oz; triadimefon	Begin applications at the expanded bud stage.
	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Apply as flowers open. Repeat every 4 to 6 days as needed during disease periods.
	Dithane Rainshield or Fore Rainshield, 1.5 lb; Junction (15% DF); 1.5 lb mancozeb	Apply in a full coverage spray every 7 to 10 days while flowers are opening also spray ground under bushes.
Azalea Powdery mildew	Banner Maxx 2.0-4.0 fl oz; propiconazole	Apply at 2- to 3-week intervals.
	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Cygnus (50%) 1.6-3.2 oz; Kresoxim-methyl	Apply every 10 to 14 days.
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Apply to run-off when mildew first appears.
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal; neem oil	Apply every 14 days.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days

Table 6.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Azalea Phytophthora shoot blight	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Aliette (80% WDG) 2.5-5.0 lbs; fosetyl-Al	Apply as a spray to wet, repeat at monthly intervals.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Apply every 7 days.
	Disarm (40.3% SC) 1.0-6.0 fl oz; fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Spray plants at a 28-day interval.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz; ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
Azalea Phytophthora root and crown rot	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Aliette (80% WDG) 0.4-0.8 lb; fosetyl-Al	Apply as a drench with 100 gal of water/400 sq ft (2 pt solutions/ sq ft) or 0.5-0.8 lb (8.0-12.8 oz)/cubic yard of potting soil at transplanting.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Apply every 7 days.
	Banol (66.5%) 20.0-30.0 fl oz; propamocarb hydrochloride	See African Violet.
	Disarm (40.3% SC) 1.0-6.0 fl oz; fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz; ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Stature (43.5% SC) 6.0-13.0 fl oz; dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Segway (34.5% SC) 2.0-6.0 fl oz; cyazoflamid	Apply at 14- to 28-day intervals.
	Subdue Maxx 0.6-1.3 fl oz; mefenoxam	Apply 1.0 pt solution/sq ft. For soil depth greater than 4 inches apply 1.5-2.0 pts solution/sq ft.
	Terrazole (35% WP) 8.0 oz; etridiazole	Container & Bed grown Plants: Mix 8 oz with 100 gal of water/400 sq ft or apply in sufficient amount to saturate the soil mixture such as 0.5 pt/6-inch pot. Irrigate immediately with additional water equal to at least half the volume of the fungicidal drench for improved soil penetration of the fungicide. Repeat at 4-week intervals if necessary.
Azalea Septoria leaf spot	Cleary 3336-F 12.0-16.0 fl oz or 1 tsp/gal thiophanate methyl	Repeat at a 10- to 14-day interval throughout the growing season.
Bedding various flowering plants	Soil Gard (12% G) 1.0-1.5 lb/cubic yd microbial / (biocontrol)	Mix with soilless media before seeding/plants.
Bedding Damping-off, *Rhizoctonia, Pythium*	Captan (50% WP) 2.0-4.0 lb; captan	Apply at 7- to 10-day intervals.
	Terrazole (35% WP) 3.5-10.0 oz; etradiazole	Apply at 4- to 12-week intervals.
Begonia Botrytis flower spot (Gray mold)	Broadform 4.0 to 8.0 fl oz fluopyram and trifloxystrobin	Spray at 7 to 14 day intervals.
	Cleary 3336-F 12.0-16.0 fl oz; thiophanate methyl	Spray every 10 to 14 days.
	Exotherm (Termil) 3.5 oz/1000 cu ft; chlorothalonil	Fumigate every 7 to 14 days.
	Dithane Rainshield or Fore Rainshield, 1.5 lb; Junction (15% DF)1.5 lb; mancozeb	Apply in a full coverage spray every 7 to 10 days while flowers are opening spray ground under bushes and into open flowers.
	Pageant (38%) 12.0-18.0 oz; pyraclostrobin and boscalid	Apply every 7 t o14 days as needed

Table 6.1 - Common Diseases and Chemical Control Options (continued)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Begonia Powdery mildew	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Rubigan 3.0-5.0 fl oz; fernarimol	Apply at 10- to 14-day intervals.
	Strike (25% WDG) 2.0-4.0 oz	Spray every 7 to 14 days. Follow label instructions. Spray triadimefon to run-off when mildew first appears.
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal; neem oil	Apply every 14 days.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
Begonia Pythium root rot	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Aliette (80% WDG) 1.25-4.0 lb; fosetyl-Al	Apply as a foliar spray. Do not exceed one application every 30 days.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Apply every 7 days.
	Banol (66.5%) 20.0-30.0 fl oz; propamocarb hydrochloride	See African Violet.
	Disarm (40.3% SC) 1.0-6.0 fl oz; fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Terrazole (35% WP) 3.0-10.0 oz; etridiazole	Apply on 400 sq ft or saturate the soil medium, such as 0.5 pt/6-inch container.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz; ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz; cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz; dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Subdue Maxx 0.6-1.3 fl oz; mefenoxam	See African Violet.
Black-eyed Susan (rudbeckia) Septoria leaf spot	Daconil WeatherStik 2.0 pt Concord (54% SST) 2.0 pt; chlorothalonil	Apply at 7- to 10-day intervals.
Black-eyed Susan Downy mildew	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Apply every 7 to 10 days.
	Disarm (40.3% SC) 1.0-6.0 fl oz; fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Spray plants at a 28-day interval if necessary.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz; ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
Cactus Root rot *(Rhizoctonia)*	Cleary 3336-F 12.0-16.0 fl oz; thiophanate methyl	Apply as drench (1.0-2.0 pt/sq ft).
	Chipco 26019 (50% WP) 0.4 lb; iprodione	Apply 1.0-2.0 pt/sq ft every 14 days.
	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed.
	Hurricane (48%) 1.5 oz; fludioxonil and mefenoxam	Drench to completely wet root zone at 21- to 28-day intervals
	Pageant (38%) 12.0 to 18.0 oz; pyraclostrobin and boscalid	Drench to completely wet root zones at 7- to 14-day intervals
	Palladium (63.5% WDG) 2.0 to 4.0 oz Cyprodinil and fludioxonil	Apply at 7- to 14-day intervals
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals

Table 6.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Caladium Various tuber rots	Cleary 3336-F 12.0-16.0 fl oz 2.0 tsp/gal Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Dip tubers in solution prior to planting.
	Chipco 26019 (50% WP) 0.4 lb Sextant (23.3%) 1.0 lb; iprodione	Dip tubers in solution prior to planting.
Caladium Pythium root rot	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Banol (66.5%) 20.0-30.0 fl oz; propamocarb hydrochloride	Treat soil every 3 weeks to 3 months.
	Disarm (40.3% SC) 1.0-6.0 fl oz; fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz; ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz; cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz; dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Subdue Maxx 0.5-1.0 fl oz; mefenoxam	See African Violet.
Calendula powdery mildew rust	Banner Maxx 2.0-4.0 fl oz; propiconazole	Apply every 14 to 21 days.
	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Rubigan 3.0-5.0 fl oz; fernarimol	Apply at 10- to 14-day intervals.
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Apply as a spray at 14- to 21-day intervals.
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal; neem oil	Apply every 14 days.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
Calibrachoa Phytophthora crown rot	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Apply every 7 days.
	Banol (66.5%) 20.0-30.0 fl oz; propamocarb hydrochloride	Treat soil at 3-week to 3-month intervals.
	Disarm (40.3% SC) 1.0-6.0 fl oz; fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz; ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Subdue Maxx 0.5-1.0 fl oz; mefenoxam	Apply in 100 gal of water over 400-800 sq ft (1.0 pt/sq ft). For soil depth greater than 4 inches apply 1.5-2.0 pts solution/sq ft. Repeat at 1- to 2-month intervals. Irrigate to thoroughly wet soil after application. For Subdue 5G do not apply rate of 9 oz more often than once every 6 weeks.
Calibrachoa Black root rot (thielaviopsis)	Cleary 3336-F 12.0-16.0 fl oz; thiophanate methyl	Drench at 1.0-2.0 pts/sq ft.
Carnation (Dianthus) Alternaria leaf spot and petal blight	Daconil Weather Stik 1.4 pt Concorde (54% SST) 1.4 pt; chlorothalonil	Apply every 7 to 14 days.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Apply as a spray every 10 to 14 days.
	Maneb 80 (80% WP) or Maneb Plus Zinc F4 Fungicide (37% F) 1.0-1.5 lb; maneb	Begin when new growth starts. Repeat weekly.

Table 6.1 - Common Diseases and Chemical Control Options (continued)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Carnation Botrytis flower spot (Gray mold)	Chipco 26019 (50% WP) Sextant (23.3%) 1.0-2.5 lb; iprodione	Spray every 10 to 14 days.
	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Spray every 7 to 14 days.
	Exotherm (Termil) 3.5 oz/1000 cu ft; chlorothalonil	Fumigate every 7 to 14 days.
	Pageant (38%) 12.0-18.0 oz; pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Carnation Fusarium stem and root rot	Cleary 3336-F, 12.0 to 16.0 fl oz; Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Heavy spray or drench during cool, moist conditions.
Carnation Rhizoctonia stem rot	Chipco 26019 0.4 lb iprodione	Apply 1.0-2.0 pt/sq ft every 14 days.
	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed.
	Pageant (38%) 12.0 to 18.0 oz; pyraclostrobin and boscalid	Apply at 7- to 14-day intervals
	Palladium (63.5% WDG) 2.0 to 4.0 oz Cyprodinil and fludioxonil	Apply at 7- to 14-day intervals
	Terraclor (75% WP) 0.5 lb; pentachloronitrobenzene	Apply 1.0 pt of solution/sq ft or 100 gal to 800 to 1000 sq ft.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals
Chrysanthemum Botrytis blight (Gray mold)	Broadform 4.0 to 8.0 fl oz fluopyram and trifloxystrobin	Spray at 7 to 14 day intervals.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Apply every 10 to 14 days.
	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Spray every 10 to 14 days under normal weather.
	Cygnus (50%) 1.6-3.2 oz; Kresoxim-methyl or 0.75 tsp/gal; thiophanate methyl	Apply every 10 to 14 days.
	Daconil Weather Stik 2.0 pt Concorde (54% SST) 2.0 pt; chlorothalonil	
	Pageant (38%) 12.0-18.0 oz; pyraclostrobin and boscalid	Apply every 7 to 14 days as needed
Chrysanthemum Bacterial blight	Camelot 3.0 pt copper salts	Apply every 7 days.
Chrysanthemum Powdery mildew	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Rubigan 3.0-5.0 fl oz; fenarimol	Apply at 10- to 14-day intervals.
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Spray to run-off when mildew first appears.
	Triact 70 0.5-1.0 gal; neem oil	Apply every 14 days.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
Chrysanthemum Puccinia horiana white rust	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Control of this rust consists of avoiding wetting of the foliage when watering and spraying with Bayleton when disease is first observed. If not controlled, cut back plants to the ground, gather all plant material and debris and incinerate. Spray Bayleton to run-off when rust first appears.
	Systhane (40%WSP) 4.0 oz myclobutanil	Apply at 10- to 14-day intervals.
Chrysanthemum Mycosphaerella ray blight	Banner Maxx 2.0-4.0 fl oz; propiconazole	Apply at 14-day intervals.
	Daconil Weather Stik 1.4 pt Concorde (54% SST) 1.4 pt; chlorothalonil	Apply at transplant of cuttings.
	Chipco 26019 (50% WP) 1.0-2.0 lb or 1.0-2.0 tbsp/gal Sextant (23.3%) 1.0-2.5 lb; iprodione	Apply as a spray every 10 to 14 days.

Table 6.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Chrysanthemum Pythium root rot	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Apply at 7-day intervals.
	Banol (66.5%) 20.0-30.0 fl oz; propamocarb hydrochloride	Treat soil every 3 weeks to 3 months.
	Disarm (40.3% SC) 1.0-6.0 fl oz; fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz; ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Subdue Maxx 0.5-1.0 fl oz; mefenoxam	See African Violet.
	Terrazole (35% WP) 4.0 oz; etridiazole	Retreat bedding plants with etridiazole at 4- to 8-week intervals. Retreat container plants at 4- to 12-week intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz; cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz; dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
Chrysanthemum Rhizoctonia root rot	Captan (50% WP) 2.0-4.0 lb; captan	Apply at 7- to 10-day intervals.
	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Apply 1.0-2.0 pt/sq ft every 14 days.
	Chipco 26019 (50% WP) 0.4 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Apply 1.0-2.0 pt/sq ft every 14 days.
	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed.
	Hurricane (48%) 1.5 oz; fludioxonil and mefenoxam	Drench to completely wet root zone at 21- to 28-day intervals
	Pageant (38%) 12.0 to 18.0 oz; pyraclostrobin and boscalid	Drench to completely wet root zones at 7- to 14-day intervals
	Medallion (50% WP) 1 packet; fludioxonil	Drench at 3- to 4-week intervals.
	Palladium (63.5% WDG) 2.0 to 4.0 oz; Cyprodinil and fludioxonil	Apply at 7- to 14-day intervals
	Soil Gard (12% G) 1.0-1.5 lb/cubic yd microbial / (biocontrol)	Mix with soilless media before seeding/plants.
	Terrazole (35% WP) 3.5-10.0 oz; etradiazole	Apply at 4- to 12-week intervals.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals
Chrysanthemum Septoria leaf spot	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Apply at weekly intervals when a new shoot growth begins. Cover lower leaf surfaces completely. Apply thiophanate methyl at 10- to 14-day intervals.
	Daconil Weather Stik 1.4 pt; chlorothalonil	Spray chlorothalonil every 7 to 14 days. Apply at transplanting of cuttings.
Cineraria Powdery mildew *(Erysiphe cichoracearum)*	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Strike (25% WDG) 2.0-4.0 oz or 0.5-1.0 tsp/gal; triadimefon	Spray to run-off when mildew first appears.
	Triact 70 0.5-1.0 gal; neem oil	Spray every 14 days.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
Cyclamen Botrytis leaf blight (Gray mold)	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb	Spray every 10 to 14 days.
	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Apply every 10 to 14 days and reduce humidity.
	Pageant (38%) 12.0-18.0 oz; pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Daylily Leaf streak	Cleary 3336-F, 12.0 to 16.0 fl oz; Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Repeat at 7- to 14-day intervals.
	Systhane (40% WSP) 4.0 oz; myclobutanil	

Table 6.1 - Common Diseases and Chemical Control Options (continued)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Daylily Rust	Synthane (40% WSP) 4.0 oz; myclobutanil	Repeat every 7 to 14 days.
	Daconil Weather Stik 2.0 pt Concorde (54% SST) 1.4 pt; chlorothalonil	
	Banner Maxx 2.0-4.0 fl oz; propiconazole	Apply at 2- to 3-week intervals.
	Heritage 1.0-4.0 oz; azoxystrobin	Apply every 1 to 4 weeks.
Foliage Plants Pythium root rot	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Aliette (80% WDG) 0.4-0.8 lb; fosetyl-Al	Apply as a drench with 100 gal of water/400 sq ft (2.0 pt solutions/sq ft) or 0.5-0.8 lb (8.0-12.8 oz)/cu yd of potting soil at transplanting.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Spray every 7 days.
	Banol (66.5%) 20.0-30.0 fl oz; propamocarb hydrochloride	Treat soil every 3 weeks to 3 months.
	Disarm (40.3% SC) 1.0-6.0 fl oz; fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz; ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Subdue Maxx 0.5-1.0 fl oz; mefenoxam	
	Terrazole (35% WP) 12.0 oz; etridiazole	Use well-drained growing medium, sanitation, above ground benches. Avoid overhead watering. Drench at 4-week intervals.
Geranium Botrytis leaf blight (Gray mold)	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Spray every 10 to 14 days.
	Compass 2.0-4.0 oz	Spray every 7- to 14 days.
	Decree 0.7-1.5 lb; fenhexamid	Spray at 7- to 14-day intervals.
	Pageant (38%) 12.0-18.0 oz; pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Geranium Bacterial blight		Purchase clean stock plants. Practice good sanitation procedures.
	Camelot 3.0 pt; copper salts	Apply every 7 days.
Geranium Pythium blackleg or black rot	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Chipco 26019 (50% WP) 0.4 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Apply 1.0-2.0 pt/sq ft every 14 days.
	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Apply as a drench or heavy spray (1.0-2.0 pt/sq ft) after transplanting into containers or propagation beds.
	Disarm (40.3% SC) 1.0-6.0 fl oz; fluoxastrobin	Apply at 14- to 28-day intervals.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz; ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz; cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz; dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Terrazole (35% WP) 3.0-10.0 oz; etridiazole	Apply 0.5 pt/6-inch container. Sterilize rooting media, pots, and benches with steam-flow sanitation program.

Table 6.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Geranium Rhizoctonia root and stem rot	Chipco 26019 (50% WP) 0.4 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Apply 1.0-2.0 pt/sq ft every 14 days.
	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Apply as a drench or heavy spray (1.0-2.0 pt/sq ft) after transplanting into containers or propagation beds.
	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed.
	Hurricane (48%) 1.5 oz; fludioxonil and mefenoxam	Drench to completely wet root zone at 21- to 28-day intervals.
	Pageant (38%) 12.0 to 18.0 oz; pyraclostrobin and boscalid	Drench to completely wet root zones at 7- to 14-day intervals.
	Palladium (63.5% WDG) 2.0 to 4.0 oz Cyprodinil and fludioxonil	Apply at 7- to 14-day intervals.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals.
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals.
Geranium Rust	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Daconil Weather Stik 1.4 pt Concorde (54% SST) 1.4 pt; chlorothalonil	Apply during cool, moist conditions.
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Spray at first sign of disease.
	Triact 70 0.5-1.0 gal; neem oil	Apply every 14 days.
Geranium Powdery mildew	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Cygnus (50%) 1.6-3.2 oz; Kresoxim-methyl	
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Spray to run-off when mildew first appears.
	Systhane (40% WP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal; neem oil	Apply every 14 days.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
Gerbera Botrytis blight (Gray mold)	Cleary 3336-F, 12.0 to 16.0 fl oz; Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Spray every 10 to 14 days to run-off.
	Decree 0.7-1.5 lb; fenhexamid	Apply at 7- to 14-day intervals.
	Pageant (38%) 12.0-18.0 oz; pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Gerbera Powdery mildew *(Erysiphe cichoracearum)*	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Strike (25% WDG) 2.0-4.0 oz or 0.5-1.0 tsp/gal; triadimefon	Spray to run-off when mildew first appears.
	Triact 70 0.5-1.0 gal; neem oil	Apply every 14 days.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
Gerbera Root/stem rot (non-water molds)	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed.
	Medallion (50% WP) 1 packet; fludioxonil	Drench at 3- to 4-week intervals.
	Pageant (38%) 12.0 to 18.0 oz; pyraclostrobin and boscalid	Apply at 7- to 14-day intervals
	Palladium (63.5% WDG) 2.0 to 4.0 oz Cyprodinil and fludioxonil	Apply at 7- to 14-day intervals
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals

Table 6.1 - Common Diseases and Chemical Control Options (continued)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Gerbera Root/stem rot (Pythium and Phytophthora)	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Apply every 7 days.
	Disarm (40.3% SC) 1.0-6.0 fl o;z fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz; ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz; cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz; dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Terrazole (35% WP) 3.0-10.0 oz; etridiazole	Apply as a drench at 0.5 pt/6-inch pot at 4- to 12-week intervals.
Gladiolus Botrytis blight	Daconil Weather Stick 2.0 pts Concorde (54% SST) 1.4 pt; chlorothalonil	Apply as a spray with a sticker-spreader on a 10-day interval.
	Cleary 3336-F, 12.0 to 16.0 fl oz; Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Apply as a spray plus sticker-spreader just as first flowers show color. Repeat at 10- to 14-day intervals.
	Dithane Rainshield or Fore Rainshield, 1.5 lb; Junction (15% DF) 1.5 lb; mancozeb	Apply at a 7- to 14-day interval.
	Pageant (38%) 12.0-18.0 oz; pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Gerbera Fusarium basal rot *(Fusarium oxysporium F. gladioli)*	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Soak cleaned corms for 15 to 30 minutes in a warm dip (80˚ to 85°F.) within 48 hours of digging. Dry corms after treatment.
Gerbera Leaf and flower spot *(Curvularia lunata)*	Cleary 3336-F, 12.0 to 16.0 fl oz; Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Apply as a spray with a sticker-spreader on a 10-day interval.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Spray every 10 to 14 days.
	Maneb 80 (80% WP) 1.5 lb; maneb	Begin when flower spikes develop. Repeat 2 to 3 times at weekly intervals.
Impatiens Rhizoctonia stem rot	Chipco 26019 (50% WP) 1.0-2.0 lb iprodione	Do not use iprodione as a drench treatment on Impatiens. Apply as a foliar spray on a 7- to 14-day interval.
	Cleary 3336-F 12.0-16.0 fl oz or 1.0 tsp/2 gal water Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Apply as a drench or heavy spray at the rate of 1.0-2.0 pts/sq ft.
	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed
	Pageant (38%) 12.0 to 18.0 oz; pyraclostrobin and boscalid	Apply at 7- to 14-day intervals
	Palladium (63.5% WDG) 2.0 to 4.0 oz; Cyprodinil and fludioxonil	Apply at 7- to 14-day intervals
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals
Impatiens necrotic spot virus	Transmitted by thrips feeding	See insect control section on thrips control.
Impatiens Downy mildew	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; Phosphite Pagent (38.0%WDG) 4.0-18.0 oz; Pyraclostrobin + boscalid Stature (43.5% SC) 6.0--13.0 fl oz; dimethomorph	Apply at 10- to14-day intervals
	Fenstop 7.0-14.0 fl oz; fenamidone Segway (34.5%SC) 3.5 fl oz; cyazoflamid	Spray with protection of plants up to 4 weeks.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz; ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Subdue Maxx 1.0 fl oz	Spray or drench with control up to 3 months.
Impatiens Soft rot		Disinfect tools when cutting rhizomes. Avoid overwatering. Rotate with restistant plants if damage is severe.

Table 6.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Kalanchoe Botrytis blight	Decree 0.7-1.5 lb; fenhexamid	Spray at 7- to 14 day intervals.
	Pageant (38%) 12.0-18.0 oz; pyraclostrobin and boscalid	Apply every 7 to 14 days as needed
Impatiens Powdery mildew		See African violet.
Leucanthemum Phytophthora root rot	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Apply every 7 days.
	Banol (66.5%) 20.0-30.0 fl oz; propamocarb hydrochloride	Treat soil at 3-week to 3-month intervals.
	Disarm (40.3% SC) 1.0-6.0 fl oz; fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz; ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz; pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz; cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz; dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Subdue Maxx 0.5-1.0 fl oz; mefenoxam	Apply in 100 gal of water over 400-800 sq ft (1.0 pt/sq ft). For soil depth greater than 4 inches apply 1.5-2.0 pts solution/sq ft. Repeat at 1- to 2-month intervals. Irrigate to thoroughly wet soil after application. For Subdue 5G do not apply rate of 9 oz more often than once every 6 weeks.
Leucanthemum Rhizoctonia root rot	Chipco 26019 (50% WP) 0.4 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Apply 1.0–2.0 pt/sq ft every 14 days.
	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed.
	Hurricane (48%) 1.5 oz; fludioxonil and mefenoxam	Drench to completely wet root zone at 21- to 28-day intervals
	Medallion (50% WP) 1 packet; fludioxonil	Drench at 3- to 4-week intervals.
	Pageant (38%) 12.0 to 18.0 oz; pyraclostrobin and boscalid	Drench to completely wet root zones at 7- to 14-day intervals
	Palladium (63.5% WDG) 2.0 to 4.0 oz Cyprodinil and fludioxonil	Apply at 7- to 14-day intervals
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14 day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals
Lily Botrytis blight	Chipco 26019 (50% WP) 1.0-2.0 lb; iprodione	Spray every 10 to 14 days.
	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Spray every 10 to 14 days.
	Daconil Weather Stik 2.0 pt Concorde (54% SST) ;chlorothalonil	Spray every 7 to 14 days. Apply at prebloom.
	Decree 0.7-1.5 lb; fenhexamid	Apply at 7- to 14-day intervals.
	Exotherm (Termil) 3.5 oz/1000 cu ft; chlorothalonil	Fumigate every 7 to 14 days.
	Dithane Rainshield or Fore Rainshield, 1.5 lb; Junction (15% DF) 1.5 lb; mancozeb	Spray at a 7- to 14-day interval.
	Pageant (38%) 12.0-18.0 oz; pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Lily Penicillium and Fusarium bulb rot	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz thiophanate methyl	Soak cleaned bulbs for 15 to 30 minutes in warm dip (80˚ to 85°F), preferably within 48 hours after digging.
Lily Root rot complex *(Pythium* spp. and *Rhizoctonia solani)*	See Chrysanthemum.	

Table 6.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Narcissus Bulb rot	See Gerbera Fusarium basal rot.	
Pansy Botrytis blight	Broadform 4.0 to 8.0 fl oz fluopyram and trifloxystrobin	Spray at 7 to 14 day intervals.
	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Apply every 10 to 14 days.
	Daconil Weather Stik 2.0 pt; chlorothalonil	Spray every 7 to 10 days.
	Decree 0.7-1.5 lb; fenhexamid	Spray at 7- to 14-day intervals.
	Fore Rainshield NT Fore WSP Rainshield Dithane T/O Rainshield NT Dithane WF Junction (15% DF) 1.5 lb; mancozeb	
	Pageant (38%) 12.0-18.0 oz; pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Pansy Root rot *(Rhizoctonia)*	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed.
	Medallion (50% WP) 1 packet; fludioxonil	Drench at 3- to 4-week intervals.
	Pageant (38%) 12.0 to 18.0 oz; pyraclostrobin and boscalid	Apply at 7- to 14-day intervals
	Palladium (63.5% WDG) 2.0 to 4.0 oz Cyprodinil and fludioxonil	Apply at 7- to 14 day intervals
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals
Pansy *Sclerotinia, Fusarium*, and *Thielaviopsis*	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Apply as a drench at 1.0-2.0 pts/sq ft.
	Pageant (38%) 12.0 to 18.0 oz; pyraclostrobin and boscalid	Apply every 7 to 14 days
	Palladium (62.5% WDG) 2.0 to 4.0 oz cyprodinil and fludioxonil	Apply at 7- to 14-da intervals
Pansy Phytophthora root/crown rot	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Apply every 7 days.
	Banol (66.5%) 20.0-30.0 fl oz; propamocarb hydrochloride	Treat soil at 3-week to 3-month intervals.
	Disarm (40.3% SC) 1.0-6.0 fl oz; fluoxastrobin	Apply at 14- to 28-day intervals.
	FenStop 7.0-14.0 fl oz; fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz; ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
	Pageant (38.0% WDG) 4.0-18.0 oz pyraclostrobin + boscalid	Apply at 7- to 14-day intervals, but not to petunias and impatiens.
	Segway (34.5% SC) 2.0-6.0 fl oz; cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz; dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
	Subdue Maxx 0.5-1.0 fl oz; mefenoxam	Apply in 100 gal of water over 400 to 800 sq ft (1.0 pt/sq ft). For soil depth greater than 4 inches apply 1.5-2.0 pts solution/sq ft. Repeat at 1- to 2-month intervals. Irrigate to thoroughly wet soil after application. For Subdue 5G do not apply rate of 9 oz more often than once every 6 weeks.

Table 6.1 - Common Diseases and Chemical Control Options (continued)

Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Petunia Phytophthora root/ crown rot	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Apply every 7 days.
	Subdue Maxx 0.5-1.0 fl oz; mefenoxam	Apply in 100 gal of water over 400-800 sq ft (1.0 pt/sq ft). For soil depth greater than 4 inches apply 1.5-2.0 pts solution/sq ft. Repeat at 1- to 2-month intervals. Irrigate to thoroughly wet soil after application. For Subdue 5G do not apply rate of 9 oz more often than once every 6 weeks.
	FenStop 7.0-14.0 fl oz fenamidone	Drench 1.0-2.0 pt/sq ft and repeat at a 28-day interval if necessary.
	Banol (66.5%) 20.0-30.0 fl oz; propamocarb hydrochloride	Treat soil at 3-week to 3-month intervals.
	Adorn (39.5%) 1.0-4.0 fl oz; fluopicolide	Apply at 14- to 28-day intervals but no more than twice per crop cycle.
	Disarm (40.3% SC) 1.0-6.0 fl oz; fluoxastrobin	Apply at 14- to 28-day intervals.
	Segway (34.5% SC) 2.0-6.0 fl oz; cyazoflamid	Apply at 14- to 28-day intervals.
	Stature (43.5% SC) 6.0-13.0 fl oz; dimethomorph	Apply at 10- to 14-day intervals. Constant agitation required.
Petunia Fungus root rot *(Rhizoctonia* and *Fusarium)*	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed.
	Hurricane (48%) 1.5 oz; fludioxonil and mefenoxam	Drench to completely wet root zone at 21- to 28-day intervals
	Pageant (38%) 12.0 to 18.0 oz; pyraclostrobin and boscali	Drench to completely wet root zones at 7- to 14-day intervals
	Palladium (63.5% WDG) 2.0 to 4.0 oz Cyprodinil and fludioxonil	Apply at 7- to 14-day intervals
	Terrazole (35% WP) 3.5-10.0 oz; etridiazole	Apply every 4 to 12 weeks.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals
Petunia Botrytis blight	Broadform 4.0 to 8.0 fl oz; fluopyram and trifloxystrobin	Spray at 7 to 14 day intervals.
	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Apply every 10 to 14 days.
	Daconil Weather Stik 2.0 pt; chlorothalonil	Spray every 7 to 10 days.
	Decree 0.7-1.5 lb; fenhexamid	Spray at 7- to 14-day intervals.
	Dithane Rainshield or Fore Rainshield, 1.5 lb; Junction (15% DF) 1.5 lb; mancozeb	
	Pageant (38%) 12.0-18.0 oz; pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Poinsettia Botrytis blight	Broadform 4.0 to 8.0 fl oz fluopyram and trifloxystrobin	Spray at 7 to 14 day intervals.
	Chipco 26019 (50% WP) 1.0-2.0 lb; iprodione	Spray every 10 to 14 days.
	Cleary 3336-F, 12.0 to 16.0 fl oz; Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Spray every 10 to 14 days.
	Daconil Weather Stik 2.0 pt Concorde (54% SST) 1.4 pt; chlorothalonil	
	Exotherm (Termil) 3.5 oz/1000 cu ft; chlorothalonil	Fumigate every 7 to 14 days. Do not apply when foliage is wet or when temperature is above 75°F.
	Pageant (38%) 12.0-18.0 oz; pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Poinsettia Root rot complex *(Rhizoctonia solani, Pythium* spp., and *Thielaviopsis basicola)*	Cleary 3336-F, 12.0 to 16.0 fl oz; Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl + Terrazole (35% WP) 3.0-10.0 oz or 0.5 pt/6-inch pot; etridiazole	Cleary 3336 will not control Pythium. However, a mixture of Cleary 3336 and Terrazole applied every 4 weeks will prevent root rot caused by most soil-borne fungi.
	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed.
	Hurricane (48%) 1.5 oz; fludioxonil and mefenoxam	Drench to completely wet root zone at 21- to 28-day intervals
	Pageant (38%) 12.0 to 18.0 oz; pyraclostrobin and boscali	Drench to completely wet root zones at 7- to 14-day intervals
	Palladium (63.5% WDG) 2.0 to 4.0 oz Cyprodinil and fludioxonild	Apply at 7- to 14-day intervals
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals

Table 6.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Poinsettia Rhizoctonia leaf blight	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed.
	Fungo 50 AGC 12.0-16.0 oz Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Spray every 10 to 14 days.
	Medallion (50% WP) 1-2 packet; fludioxonil	Spray only before bract formation and at 7- to 10-day intervals in greenhouses and closed structures.
	Pageant (38%) 12.0 to 18.0 oz; pyraclostrobin and boscalid	Apply at 7- to 14-day intervals
	Palladium (63.5% WDG) 2.0 to 4.0 oz Cyprodinil and fludioxonil	Apply at 7- to 14-day intervals
	Terraguard 50W 4.0-8.0 oz; triflumizole	Controls Rhizoctonia as a drench at 3- to 4-week intervals.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals
Rose Botrytis blight, black spot	Broadform 4.0 to 8.0 fl oz fluopyram and trifloxystrobin	Spray at 7 to 14 day intervals.
	Cleary 3336-F, 12.0 to 16.0 fl oz; Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Apply as a spray at 10- to 14-day intervals.
	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Apply as a spray at 10- to 14-day intervals.
	Cygnus (50%) 1.6-3.2 oz; Kresoxim-methyl	
	Daconil Weather Stik 2.0 pt Concorde (54% SST) 1.3 pt; chlorothalonil	Repeat at 7- to 14-day intervals.
	Decree 0.7-1.5 lb; fenhexamid	Apply every 7 to 14 days.
	Torque (38.7) 4.0 to 10.0 fl oz; tebuzonazole	Apply every 14 to 21 days as needed
Rose Powdery mildew	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Cygnus (50%) 1.6-3.2 oz; Kresoxim-methyl	
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Spray to run-off when mildew first appear.
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Terraguard 50W 4.0-16.0 oz; triflumizole	Apply at 7- to 14-day intervals as needed. Use higher rate on existing initial infection.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
Snapdragon Botrytis blight	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	
	Daconil Weather Stik 2.0 pt Concorde (54% SST) 1.4 pt; chlorotholonil	Repeat on a 7- to 14-day interval.
	Decree 0.7-1.5 lb; fenhexamid	Apply every 7 to 14 days.
	Exotherm (Termil) 3.5 oz/1000 cu ft; chlorothalonil	Fumigate every 7 to 14 days.
	Fungo 50 AGC 12.0-16.0 oz Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	Spray every 10 to 14 days.
	Pageant (38%) 12.0-18.0 oz; pyraclostrobin and boscalid	Apply every 7 to 14 days as needed
Snapdragon Downy mildew	Alude 1.0-2.0 qt Vital 2.0-4.0 pt; phosphite	Apply every 7 days.
	Micora (23.3%) 8.0 fl oz; mandipropamid	Apply every 7 to 14 days
	Orvego (46.2%) 14.0 fl oz; ametoctradin and dimethomorph	Apply at 10 to 14 day intervals
Snapdragon Rust	Banner Maxx, 2-4 fl oz propiconazole	Apply every 14 to 21 days.
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Spray to run-off when rust first appears.
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal; neem oil	Apply every 14 days.
	Cygnus (50%) 3.2-6.4 oz; Kresoxim-methyl	

Table 6.1 - Common Diseases and Chemical Control Options (continued)		
Plant Disease	Fungicide & Formulation; Rate/100 gal	Remarks
Snapdragon Powdery mildew	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Cygnus (50%) 1.6-3.2 oz; Kresoxim-methyl	
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Spray to run-off when mildew first appears.
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Triact 70 0.5-1.0 gal; neem oil	Apply every 14 days.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days
Snapdragon Rhizoctonia root rot	Chipco 26019 (50% WP) 0.4 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Apply 1.0-2.0 pt/sq ft every 14 days.
	Cleary 3336-F, 12.0 to 16.0 fl oz; thiophanate methyl	
	Empress (23.3%) 2.0 to 6.0 fl oz; Pyraclostrobin	Repeat application at 7- to 28-day intervals as needed.
	Hurricane (48%) 1.5 oz; fludioxonil and mefenoxam	Drench to completely wet root zone at 21- to 28-day intervals
	Medallion (50% WP) 1 packet; fludioxonil	Drench at 3- to 4-week intervals.
	Pageant (38%) 12.0 to 18.0 oz; pyraclostrobin and boscalid	Drench to completely wet root zones at 7- to 14-day intervals
	Palladium (63.5% WDG) 2.0 to 4.0 oz; Cyprodinil and fludioxonil	Apply at 7- to 14-day intervals
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7- to 14-day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply at 14- to 28-day intervals
Tulip Botrytis blight (Gray mold)	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb; iprodione	Spray every 10 to 14 days.
	Dithane Rainshield or Fore Rainshield, 1.5 lb; Junction (15% DF) 1.5 lb; mancozeb	Spray at a 7- to 14-day interval.
	Pageant (38%) 12.0-18.0 oz; pyraclostrobin and boscalid	Apply every 7 t o14 days as needed
Tulip Fusarium and Penicillium bulb rot	Cleary 3336-F 12.0-16.0 fl oz Fungo 50 AGC 12.0-16.0 oz; thiophanate methyl	Soak cleaned bulbs for 15 to 30 minutes in warm dip (80˚ to 85°F). Dry bulbs after treatment.
Zinnia Alternaria blight	Chipco 26019 (50% WP) 1.0-2.0 lb Sextant (23.3%) 1.0-2.5 lb iprodione	Spray every 10 to 14 days.
	Dithane Rainshield or Fore Rainshield, 1.5 lb; Junction (15% DF) 1.5 lb; mancozeb	Spray every 10 to 14 days.
	Maneb 80 (80% WP) or Maneb Plus Zinc F4 Fungicide (37%) 1.0-1.5 lb; maneb	Spray every 10 to 14 days.
Zinnia Bacterial blight		Purchase clean stock plants. Practice good sanitation procedures.
Zinnia Powdery mildew	Concert II (41.4%) 22.0 to 35.0 fl oz propiconazole and chlorothalonil	Apply at 14 to 21 day intervals
	Cygnus (50%) 1.6-3.2 oz; Kresoxim-methyl	Apply at 10- to 14-day intervals.
	Daconil Weather Stik 1.4 pt; chlorothalonil	Treat at 7- to 10-day intervals at first sign of disease.
	Rubigan 3.0-5.0 fl oz; fenarimol	Spray every 10 to 14 days.
	Strike (25% WDG) 2.0-4.0 oz; triadimefon	Spray every 7- to 10 days.
	Systhane (40% WSP) 4.0 oz; myclobutanil	Apply at 10- to 14-day intervals.
	Terraguard 50W 4.0-8.0 oz; triflumizole	Foliar spray at weekly intervals.
	Triact 70 0.5-1.0 gal; neem oil	Apply every 14 days.
	Trinity (19.2%) 8.0 to 12.0 fl oz; triticonazole	Apply at 7 to 14 day intervals
	Tourney (50% WDG) 1.0 to 4.0 oz; metconazole	Apply every 14 to 28 days

Floral Crops: Organic Controls for Insect Pests

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Table 6.2 - Organic Chemicals, Predators, and Pathogens

Product	Insects Controlled	Remarks
Products or pathogens		
Azadirachtin	Beetles, aphids, caterpillars, others	Sold under various trade names
Bacillus thuringiensis	Leaf-feeding caterpillars	Known as Bt, sold under many trade names. A strain of this bacterium controls fungus gnats.
Beauveria bassiana	Beetles, aphids, others	Various trade names
Burkholderia spp. strain A396	Aphids, leafhoppers, stinkbugs, thrips	Sold as Venerate
Capsicum oleoresin extract, garlic and soybean oils	Thrips and mites	Sold as Captiva Prime
Chromobacterium subtsugae strain PRRA4-1	Caterpillars, whiteflies, aphids, thrips, azalea lacebug, lygus and mites	Sold as Grandevo. See label for rates for specific pests.
Entomopathogenic nematodes *(Steinernema* and *Heterorhabditis)*	Fungus gnats, shore flies, western flower thrips, root mealybugs, borers, root feeders	Rates are on product label; soil temperature should exceed 60 F. Apply late in the day, irrigate immediately. Available commercial products: Nemasys, NemaShield, and others.
Entomopathogenic fungi *Beauveria bassiana, Metarhizium anisopliae* (Met52EC), *Isaria fumosorosea* (NoFly WP)	Whiteflies, thrips, aphids, mealybugs, fungus gnats, vine weevils, psyllids, plant bugs, beetles, leafhoppers	See label for proper material for target pest. Beauvaria is sold under several trade names. Follow label for mixing directions, application timing and intervals and if a foliar spray or drench. NoFly WP can be applied with a cold fogger.
Garlic juice	Repels a wide variety of insects	Sold as Garlic Barrier
GS-omega/kappa-Hxtx-Hv1a peptide	Aphids, mites, thrips, whiteflies, lepidopterans	Sold as Spear-T or Spear-Lep
Insecticidal soap	Works well on soft bodied insects, in particular aphids, mites, lacebugs, mealybugs	This product is sold under many trade names and is a fatty acid soap.
Isaria fumosorosea Apopka Strain 97	Aphids, thrips, whiteflies, weevils, psyllids, leafminers, spider mites, mealybugs	See label. Foliar and soil applications.
Kaolin clay	Beetles, aphids, caterpillars, others	Various trade names
Paecilomyces fumosoroseus Strain FE 9901	Whiteflies, aphids and thrips	Sold as NoFly
Pyrethrins	Broad spectrum, works on a wide variety of insects and mites.	Usually sold mixed with other botanical insecticides. Some formulations combined with canola oil. Some products are labeled for flowers, fruits, vegetables, and herbs. Check label prior to applying.
Spinosad	Many insect pests, including thrips, caterpillars, and leaf beetles	Entrust is for organic production.
Predators		
Lady beetles	Feed on aphids and other soft bodied insects	Lady beetles may leave to find other prey. *Cryptolaemus* for mealybug, *Delphastus* for whitefly. *Stethorus* for spider mites.
Lacewings	Aphids, scales, mealybugs, other soft bodied insects	Immature are called aphid lions. Several *Chrysoperla* species being sold, including *C. rufilabris*.
Predatory bugs	thrips	*Orius insidiousus* for all stages of western flower thrips
Predatory midges	Aphids, thrips, fungus gnat larvae	*Aphidoletes aphidimiza* for aphids
Predatory mites	Whitefly, spider mites, thrips, fungus gnat larvae	*Amblyseius swirskii* for whiteflies and thrips; *Phytoseilus persimilis* for red and 2-spotted spider mites; *Hypoaspis* for fungus gnat larvae; *Amblyseius californicus* for 2-spotted spider mite and carmine mite; *Amblyseilus cucumeris* for western flower thrips; *Amblyseius andersoni* for red and 2-spotted spider mites.
Parasitic wasps	Leafminers, whiteflies	*Diglyphus isaea* for leafminers; *Encarsia formosa* and *Eretmocerus eremicus* for whiteflies; *Aphidius colemani* for aphids.
Rove beetle	Fungus gnat larvae	Rove beetle for fungus gnat larvae

Table 6.3 - Organic Controls, Predators and Pathogens

UPDATED List of Commercial Suppliers and Insectaries/Laboratories selling predators and parasitoids for augmentative biocontrol

*The following table was completed using information from the 2015 Directory of Least-Toxic Pest Control Products, published on The IPM Practitioner Magazine (https://www.birc.org/Final2015Directory.pdf). There are more companies/suppliers offering beneficial arthropods and are not included in this table. Appearance on this table does not reflect endorsement by VCE.

**Companies might offer additional products, besides the ones listed in this table. Check the respective company's website for a complete list of products, prices and availability.

Company Name*	City	State	Products**	Website for Ordering
A-1 Unique	Citrus Height	California	Lacewings, Lady beetles	https://organiccontrol.com/welcome-a1-unique/
Arbico Organics	Oro Valley	Arizona	Lacewings, Lady beetles	https://www.arbico-organics.com/
Associates Insectaries	Santa Paula	California	Lady beetles	https://www.associatesinsectary.com/
Beneficial Insectaries	Redding	California	Parasitic wasps, Lacewings, Predatory mites	https://www.insectary.com/
BFG Supply	Burton	Ohio	Lacewings	https://www.bfgsupply.com/
Biobee	Salisbury	Maryland	Parasitic wasps, Lacewings, Lady beetles, Predatory mites	https://biobee.us/
Biobest	Romulus	Michigan	Parasitic wasps, Lady beetles	https://www.biobestgroup.com/
Bioline Agrosciences	Oxnard	California	Parasitic wasps, Lacewings, Predatory mites	https://www.biolineagrosciences.com/
Bioworks	Victor	New York	Parasitic wasps, Lacewings, Predatory mites	https://bioworksinc.com/
Buglogical	Tucson	Arizona	Lacewings, Lady beetles	https://www.buglogical.com/
Evergreen Grower Supply	Clackamas	Oregon	Parasitic wasps, Lacewings	https://www.evergreengrowers.com/
Garden Alive	Lawrenceburg	Indiana	Lacewings, Lady beetles	https://www.gurneys.com/garden-salive
Greenmethods	Redding	California	Parasitic wasps, Lacewings, Lady beetles	https://greenmethods.com/
IPM Laboratories Inc.	Locke	New York	Parasitic wasps, Lacewings, Lady beetles	https://www.ipmlabs.com/
Koppert	Howell	Michigan	Parasitic wasps, Lacewings, Lady beetles, Predatory mites	https://www.koppertus.com/
Kunafin	Quemado	Texas	Lacewings	https://www.kunafin.com/
Natural Pest Control	Orangevale	California	Lacewings, Lady beetles	https://www.natpestco.com/
Nature's Control	Medford	Oregon	Parasitic wasps, Lacewings, Lady beetles	https://naturescontrol.com/opencart/
Organic Control	Harbor City	California	Lacewings	https://www.organiccontrol.com/
Peaceful Valley	Grass Valley	California	Lacewings, Lady beetles	https://www.groworganic.com/
Planet Natural	Bozeman	Montana	Lacewings, Lady beetles	https://www.planetnatural.com/
Rincon-Vitova Insectaries	Ventura	California	Parasitic wasps, Lacewings, Lady beetles	https://www.rinconvitova.com/
Tip Top	Westlake Village	California	Parasitic wasps, Lacewings, Lady beetles	https://tiptopbiocontrol.com/

Floral Crops: Insects

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Many insecticide and miticide formulations are available to growers, but specific uses may be quite limited for any one crop, and plant varieties vary greatly in susceptibility to chemical injury. Your local Extension faculty may be able to help you obtain the technical information you need.

■ Proper Use of Pesticides

Insecticides are poisonous, and their use in the greenhouse can present a serious danger to both the applicator and plant material if handled carelessly or improperly. Restricted pesticides must be applied only by certified pesticide applicators.

In order to use a pesticide safely and effectively, the product label should be read thoroughly before using. By law, pesticides must be used in accordance with label directions.

Effective application of pesticides depends on: proper timing, favorable treatment conditions of temperature, humidity, moisture, and time of day; plant condition; and thorough coverage, especially the undersides of leaves and in dense or low-growing foliage. Thorough wetting is especially important on waxy foliage and waxy insects such as mealybugs and scales. Most insecticides do not act efficiently at temperatures below 50˚F, and may cause plant injury if used when the temperature is above 90˚F, especially when coupled with high humidity. Overhead irrigation or watering should be avoided for at least 12 hours after applying pesticide treatments. Plants should be well watered, with foliage allowed to dry, before applying chemicals.

Non-chemical control methods should not be overlooked, particularly preventative measures such as making sure not to introduce infested plants into propagation and production areas. Weeds and excess plants left around can harbor pests and may be sources of infestation. Parasites (*Encarsia formosa* for whiteflies) and predators (*Cryptolaemus montrouzieri* for mealybugs) can be introduced for biological control. Others are listed in the Organic Controls chapter.

PLANT INJURY

Phytotoxicity is a term referring to plant injury caused by chemicals, particularly pesticides. Greenhouse plants seem to be especially prone to this problem, in part because of the wide variety of plants often grown or held in one common area. Signs of phytotoxicity include: 1) tip or marginal burn of leaves; 2) chlorosis in spots, at tips, or on margins of the leaves; 3) leaf distortion, including curling, twisting, or cupping; 4) stunting or growth reduction in the size of entire plants or certain parts; and 5) abnormal or excessive growth of certain plant parts. Flower parts and bracts are especially sensitive. Treatments may cause root injury resulting in decline, stunting, and damage to older leaves.

The following suggestions will reduce phytotoxic potential:

1) Do not apply pesticides to plants under stress; 2) Avoid spraying under extremely hot, sunny, or humid conditions; 3) Apply sprays in the mornings between 6:00 a.m. and 10:00 a.m; 4) Avoid treating when temperature extremes or severe fluctuations are likely; 5) Apply pesticides when foliage is dry and conditions are conducive to drying; 6) Use wettable powders rather than emulsifiable concentrates; 7) Do not mix pesticides without prior experience; check compatibility; 8) Keep nozzles of aerosols or mist blowers at least 18-24" from plants being treated; 9) Never spray insecticides in equipment that has been used for applying herbicides (tanks, pumps, hoses, guns); 10) Clean sprayer, tank, pump, hose, and gun after each use; 11) Do not let spray mixes stand in the sprayer; do not expose spray concentrates to extreme heat or freezing; 12) Read **ALL** of the label directions every time you use each pesticide.

FORMULATIONS AND APPLICATION METHODS

Pesticides are available in various formulations: as concentrates for spraying, granular soil treatments, or aerosols. In some cases, only one or a few application methods may be registered for use of a specific pesticide.

Dilute sprays are applied with pressurized tank sprayers or high-pressure powered spraying machines. Formulations to be used may be wettable powders (WP), emulsifiable concentrates (E or EC), soluble powders (SP), liquids or liquid concentrates (L, LC), or flowables (F). Wettable powders are less likely to cause phytotoxicity problems.

Concentrate sprays are applied with motor-driven or electric mist sprayers and deliver droplets 5 to 20 times as concentrated as dilute sprayers.

Rates of application from aerosol bombs, generators, and foggers are based on air volume in closed greenhouses in terms of amount of pesticide/cubic feet. It is important to close the greenhouse tightly for the recommended length of time followed by adequate prescribed ventilation.

COMPATIBILITY AND COVERAGE

Mixing different formulations such as wettable powders and emulsifiable concentrates is not recommended. Never mix herbicides or fungicides.

For especially waxy foliage, the addition of a wetting agent or spreader-sticker may be desirable when applying sprays. However, it is unnecessary if two or more pesticides are added together, since a greater amount of wetting agent or emulsifier will be present in the tank. The use of two (2) or more emulsifiable concentrates mixed together in the same quantity of water results in twice as much or more solvent applied to the plants and may cause plant injury. Read the pesticide label carefully for compatibility statements and mixing precautions. Highly alkaline water (pH 8.0 or higher) may cause rapid breakdown of many pesticide chemicals.

SAFETY AND TOXICITY

Pesticides are readily absorbed through the skin, as well as being poisonous by ingestion, by inhalation, or by contact in the eyes. Penetration of the skin occurs immediately on contact and is most hazardous when handling undiluted concentrates. It is essential to wear protective clothing, proper gloves, boots, and adequate face shields and respirators or gas masks as directed on the label. Frequent changes to clean clothing and protective devices are essential. With some chemicals, potential eye damage warrants a danger or warning category on the label even though oral and dermal toxicities are in the caution range.

SPECIAL PRECAUTIONS FOR POLLINATORS

Some insecticides may be acutely or chronically toxic to bees. Read the label for special precautions. Certain labels contain special precaution section titled "Protection of Pollinators". A bee hazard icon may warn applicators of special application restrictions to protect pollinators.

How to Use These Recommendations

Once the pest problem has been identified, consult Table 6.4. Find the pest or pest group (arranged alphabetically) to determine which control measures are available, the formulations that are registered, and remarks. Then consult Table 6.5 for specific use and precautionary information on the control measure chosen. Be sure to check the potential phytotoxicity statements. If in doubt about a crop, treat a small sample area. Observe sprayed plants for several days for indications of plant injury.

After using the recommendations here, read and follow the directions on the pesticide label prior to mixing and application.

Table 6.4 - Guide to Pesticide and Formulations Recommended by Pest or Pest Group

Pesticide	Signal Word	Foliar Spray	Aerosol	Smoke Fog Vapor	Soil	Remarks[1]
Aphids (https://www.pubs.ext.vt.edu/444/444-220/444-220.html)						
Abamectin	warning	0.15EC	—	—	—	See label
Acephate	caution	75SP, 97	3A	—	—	Aerosol is labeled for most crops. See label for phytotoxicity
Acetamiprid	caution	70WSP, 30SG	—	—	—	See label
Afidopyropen	caution	0.83DC	—	—	—	Do not reapply within 7 days of last application
Azadirachtin	caution	EC	—	—	—	All crops
Beauveria bassiana	caution	22WF, ES	—	—	—	All crops
Bifenazate + Abamectin	caution	EC	—	—	—	See label
Clothianidin	caution	50WDG	—	—	—	See label
Cyantraniliprole	warning	—	—	—	SC	See label. Soil drench or irrigation system application
Cyclaniliprole	caution	EC	—	—	—	See label
Cyfluthrin	warning	20WP	—	—	—	See label
Dinotefuran	caution	20SG	—	—	20SG, 2G	Soil application as drench, granules
Fenoxycarb	caution	25WP	0.6A	—	—	All crops
Fenpropathrin	warning	2.4EC	1A	—	—	See label
Flonicamid	caution	SG	—	—	—	See label for rate range
Flupyradifurone	caution	1.67SC	—	—	—	See label; only one application per crop cycle
Fluvalinate	caution	2AF	—	—	—	All crops; see label for phytotoxicity
Imidacloprid	caution	II	—	—	1%G,60WP	See label
Insecticidal soap	warning	—	—	—	—	See label
Kinoprene	warning	II	—	—	—	All crops
Pymetrozine	caution	50WG	—	—	—	All crop; spray and drench applications
Pyrethrins	caution	—	A	—	—	See label
Pyrifluquinazon	caution	—	—	—	—	See label
Pyriproxyfen	caution	.86L	—	—	—	See label
Spinetoram + Sulfoxaflor	caution	SC	—	—	—	See label for precautions and restrictions
Spirotetramat	caution	240SC	—	—	240SC	Soil application as drench
Thiamethoxam	caution	25WG	—	—	25WG	See label
Tolfenpyrad	warning	EC	—	—	—	See label for phytotoxicity
Ultra-fine oil	caution	—	—	—	—	See label

Table 6.4 - Guide to Pesticide and Formulations Recommended by Pest or Pest Group						
Pesticide	Signal Word	Foliar Spray	Aerosol	Smoke Fog Vapor	Soil	Remarks[1]
Caterpillars, Cutworms, Loopers, Armyworms						
Acetamiprid	caution	70WSP, 30SG	—	—	—	See label for pest species
Azadirachtin	caution	EC	—	—	—	All crops
Bacillus thuringiensis (BT)	caution	WP	—	—	—	Consult label of this and other brands of BT available for specific pest uses.
Bifenthrin	warning	.667F	A	—	—	Greenhouse-grown ornamentals
Chlorantraniliprole	caution	1.67SC	—	—	—	See labels for crops. Drench applications.
Chlorfenapyr	caution	2S	—	—	—	All crops
Cyantraniliprole	warning	SC	—	—	—	See label
Cyclaniliprole	caution	EC	—	—	—	See label
Cyfluthrin	warning	20WP	—	—	—	See label
Diflubenzuron	caution	25WSB	—	—	—	Armyworm listed on label
Fenoxycarb	caution	—	0.6A	—	—	See label
Fenpropathrin	warning	2.4EC	1A	—	—	For beet armyworm; see label
Fluvalinate	caution	2AF	—	—	—	All crops
Methoxyfenozide	caution	EC	—	—	—	See label
Novaluron	caution	10SC	—	—	—	Armyworm listed on label
Permethrin	caution	3.2EC	—	—	—	All crops
Pyrethrins	caution	EC	—	—	—	See label
Pyridalyl	caution	35WP	—	—	—	See label for insect species
Spinosad	caution	11.6SC	—	—	—	All crops
Spinetoram + Sulfoxaflor	caution	SC	—	—	—	See label for precautions and restrictions
Tebufenozide	caution	2S	—	—	—	All crops
Tolfenpyrad	warning	EC	—	—	—	See label for phytotoxicity. For early instars only.
Centipedes (see Millipedes) (https://www.pubs.ext.vt.edu/ENTO/ENTO-43/ENTO-43.html)						
Bifenthrin	warning	.667F	—	—	—	See label
Cyclamen Mite						
Abamectin	warning	0.15EC	—	—	—	See label
Bifenazate + Abamectin	warning	FP	—	—	—	See label
Chlorfenapyr	caution	2S	—	—	—	All crops
Fenazaquin	warning	200SC	—	—	—	All crops
Fenpyroximate	caution	EC	—	—	—	See label
Spiromesifen	caution	4F	—	—	—	Also labeled for broad mite
Spirotetramat	caution	240SC	—	—	240SC	Soil application as drench
Fungus Gnats (Adults)						
Bifenthrin	caution	—	A	—	—	All crops
Cyfluthrin	warning	20WP	—	—	—	
Fenpropathrin	warning	—	1A	—	—	All crops
Fluvalinate	caution	22.3F	—	—	—	See label
Insecticidal soap	warning	—	—	—	—	See label, formulations vary
Permethrin	caution	3.2EC	—	—	—	See label for sensitive plants
Ultra-fine oil	caution	—	—	—	—	See label

Table 6.4 - Guide to Pesticide and Formulations Recommended by Pest or Pest Group						
Pesticide	Signal Word	Foliar Spray	Aerosol	Smoke Fog Vapor	Soil	Remarks[1]
Fungus Gnats (Larvae) (https://www.pubs.ext.vt.edu/3104/3104-1579/3104-1579.html)						
Acetamiprid	caution	70WSP, 30SG	—	—	—	See label
Azadirachtin	caution	EC	—	—	—	All crops
Bacillus thuringiensis (BT)	non-toxic	—	—	—	AS	All crops
Chlorfenapyr	caution	2S	—	—	—	All crops
Cyfluthrin	warning	20WP	—	—	—	See label
Cyromazine	caution	75WP	—	—	—	All crops
Diflubenzuron	caution	—	—	—	25WSB	See label
Dinotefuran	caution	20SG	—	—	20SG	Soil application as drench
Fenpropathrin	warning	—	1A	—	—	All crops
Fenoxycarb	caution	25WP	—	—	—	All crops
Flupyradifurone	caution	1.67SC				See label. Only one application per crop cycle
Imidacloprid	caution	II	—	—	1%G	
Kinoprene	warning	II	—	—	—	All crops
Pyriproxyfen	caution	.86EC	—	—	—	See label
Steinernema feltiae	non toxic	—	—	—	—	See label
Thiamethoxam	caution	25WG	—	—	25WG	See label
Leafminers						
Abamectin	warning	0.15EC	—	—	—	Flower crops, foliage plants
Acetamiprid	caution	70WSP, 30SG	—	—	—	See label
Azadirachtin	caution	EC	—	—	—	All crops
Bifenthrin	warning	.667F	A	—	—	See label
Cyantraniliprole	warning	SC	—	—	—	See label
Cyclaniliprole	caution	EC	—	—	—	See label
Cyfluthrin	warning	20WP	—	—	—	See label
Cyromazine	caution	75WP		—	—	All crops
Diflubenzuron	caution	25WSB	—	—	—	See label
Dinotefuran	caution	20SG	—	—	20SG	Soil application as drench
Fenpropathrin	warning	—	1A	—	—	All crops
Fenoxycarb	caution	25WP	—	—	—	Lepidopterous leaf miners only all crops
Isaria fumosorosea	non toxic	—	—	—	—	See label
Novaluron	caution	10SC	—	—	—	Serpentine, citrus leafminers only
Permethrin	caution	3.2EC	—	—	—	Chrysanthemum only
Spinosad	caution	11.6SC	—	—	—	All crops
Thiamethoxam	caution	25WG	—	—	25WG	See label
Leafrollers						
Acephate	caution	75SP, 97	3A	—	—	Labeled on roses
Bifenthrin	warning	.667 F	A	—	—	Greenhouse-grown ornamentals
Cyfluthrin	warning	20WP	—	—	—	See label
Fenpropathrin	warning	—	1A	—	—	All crops

Table 6.4 - Guide to Pesticide and Formulations Recommended by Pest or Pest Group						
Pesticide	Signal Word	Foliar Spray	Aerosol	Smoke Fog Vapor	Soil	Remarks[1]
Mealybugs (Foliar)						
Acephate	caution	75SP, 97	3A	—	—	Labeled on foliage plants, orchids, anthuium, cacti, poinsettia
Acetamiprid	caution	70WSP, 30SG	—	—	—	See label
Afidopyropen	caution	0.83DC	—	—	—	Do not reapply within 7 days of last application
Azadirachtin	caution	EC	—	—	—	All crops
Beauveria bassiana	caution	22WP, ES	—	—	—	All crops
Bifenthrin	warning	667F	A	—	—	Greenhouse-grown ornamentals
Buprofezin	caution	70WSP	—	—	—	All crops
Clothianidin	caution	50WDG	—	—	—	See label
Cyfluthrin	warning	20WP	—	—	—	See label
Dinotefuran	caution	20SG	—	—	20SG, 2G	Soil application as drench, granule
Fenoxycarb	caution	—	0.6A	—	—	See label
Fenpropathrin	warning	2.4EC	1A	—	—	See label
Flonicamid	caution	SG	—	—	—	See label for rate range
Flupyradifurone	caution	1.67SC	—	—	—	See label. Only on application per crop cycle
Fluvalinate	caution	22.3F	—	—	—	See label
Isaria fumosorosea	non toxic	—	—	—	—	See label
Imidacloprid	caution	II	—	—	1%G	See label
Insecticidal soap	warning	—	—	—	—	Concentration varies with formulation; see label
Kinoprene	warning	II	—	—	—	See label
Permethrin	caution	3.2EC	—	—	—	See label for sensitive plants
Pyrethrins	caution	—	A	—	—	See label
Pyrifluquinazon	caution	—	—	—	—	See label
Spinetoram + Sulfoxaflor	caution	SC	—	—	—	See label for precautions and restrictions
Spirotetramat	caution	240SC	—	—	240SC	Soil application as drench
Thiamethoxam	caution	25WG	—	—	25WG	See label
Tolfenpyrad	warning	EC	—	—	—	See label for phytotoxicity
Mealybugs (Root)						
Kinoprene	warning	II	—	—	—	All crops
Millipedes						
Bifenthrin	warning	.667F	—	—	—	See label
Scale Insects						
Acephate	caution	75SP, 97	3A	—	—	See crops listed on label
Acetamiprid	caution	70WSP, 30SG	—	—	—	See label
Azadirachtin	caution	EC	—	—	—	All crops
Buprofezin	caution	70WSP	—	—	—	All crops
Cyantraniliprole	warning	SC	—	—	—	See label. Soft scales only.
Cyclaniliprole	caution	EC	—	—	—	See label
Cyfluthrin	warning	20WP	—	—	—	See label directions
Dinotefuran	caution	20SG	—	—	20SG, 2G	Soil application as drench, granules
Fenoxycarb	caution	25WP	0.6A			All crops, soft scales only
Fenpropathrin	warning	—	1A	—	—	See label
Flonicamid	caution	SG	—	—	—	See label for rate range
Imidacloprid	caution	II	—	—	1%G	See label
Insecticidal soap	warning	—	—	—	—	Formulations vary; see label

Table 6.4 - Guide to Pesticide and Formulations Recommended by Pest or Pest Group						
Pesticide	Signal Word	Foliar Spray	Aerosol	Smoke Fog Vapor	Soil	Remarks[1]
Scale Insects continued						
Kinoprene	warning	II	—	—	—	All crops
Pyriproxyfen	caution	.86EC	—	—	—	See label
Spinetoram + Sulfoxaflor	caution	SC	—	—	—	See label for precautions and restrictions
Thiamethoxam	caution	25WG	—	—	25WG	Labeled for soft scales
Tolfenpyrad	warning	EC	—	—	—	See label for phytotoxicity
Shore Flies						
Azadirachtin	caution	EC	—	—	—	All crops
Cyromazine	caution	75WP	—	—	—	All crops
Diflubenzuron	caution	—	—	—	25WSB	See label
Fenoxycarb	caution	25WP	0.6A	—	—	All crops
Pyriproxyfen	caution	.86EC	—	—	—	See label
Slugs, Snails						
Metaldehyde	caution	—	—	—	bait	All crops
Sowbugs						
Cyfluthrin	warning	20WP	—	—	—	See label
Spider Mites (https://www.pubs.ext.vt.edu/444/444-221/444-221.html)						
Abamectin	warning	0.15EC	—	—	—	See label
Acequinocyl	caution	15SC	—	—	—	See label. Two-spotted spider mite.
Azadirachtin	caution	70	—	—	—	All crops
Bifenazate	caution	50SP	—	—	—	All crops
Bifenthrin	warning	.667 F	A	—	—	Greenhouse-grown ornamentals.
Chlorfenapyr	caution	2S	—	—	—	All crops
Clofentezine	caution	5SC	—	—	—	All crops
Cyflumetofen	caution	1.67SC	—	—	—	See label
Etoxazole	caution	5WDG	—	—	—	See label for resistance management
Fenazaquin	warning	200SC	—	—	—	All crops.
Fenpropathrin	warning	2.4EC	1A	—	—	See label
Fenpyroximate	warning	5SC	—	—	—	Labeled for other mite species
Fluvalinate	caution	22.3F	—	—	—	See label
Hexythiazox	caution	50DF	—	—	—	See label
Insecticidal soap	warning	25EC	—	—	—	Formulations vary; see label
Pyrethrins	caution	—	A	—	—	See label
Pyridaben	danger	75WP	—	—	—	See label
Spinosad	caution	SC	—	—	—	See label for rate range
Spiromesifen	caution	4F	—	—	—	See label for species
Spirotetramat	caution	240SC	—	—	240SC	Soil application as drench
Ultra-fine oil	caution	—	—	—	—	See label for rate
Springtails (https://www.pubs.ext.vt.edu/ENTO/ENTO-23/ENTO-23.html)						
Bifenthrin	warning	.667F	—	—	—	See label
Thrips (https://www.pubs.ext.vt.edu/444/444-281/444-281.html)						
Abamectin	caution	0.15EC	—	—	—	All crops
Acephate	caution	75WP, 97	3A	—	—	All crops

Table 6.4 - Guide to Pesticide and Formulations Recommended by Pest or Pest Group						
Pesticide	Signal Word	Foliar Spray	Aerosol	Smoke Fog Vapor	Soil	Remarks[1]
Thrips (https://www.pubs.ext.vt.edu/444/444-281/444-281.html) continued						
Acetamiprid	caution	70WSP, 30SG	—	—	—	See label
Azadirachtin	caution	EC	—	—	—	All crops
Beauvaria bassiana	caution	22WP, EC	—	—	—	All crops
Bifenthrin	warning	.667 F	—	—	—	See label
Chlorfenapyr	caution	2S	—	—	—	All crops
Cyantraniliprole	warning	SC	—	—	—	See label
Cyclaniliprole	caution	EC	—	—	—	See label
Cyfluthrin	warning	20WP	—	—	—	See label
Dinotefuran	caution	20SG	—	—	20SG, 2G	Soil application as drench, granules
Fenoxycarb	caution	25WP	A	—	—	All crops
Fenpropathrin	warning	—	1A	—	—	
Flonicamid	caution	SG	—	—	—	See label for rate range
Fluvalinate	caution	2AF	—	—	—	All crops
Imidacloprid	caution	II	—	—	1%G,60WP	See label
Isaria fumosorosea	non toxic	—	—	—	—	See label
Lambda-cyhalothrin	caution	10WSP	—	—	—	All crops
Novaluron	caution	10SC	—	—	—	See label for listed species
Pyridalyl	caution	35WP	—	—	—	See label for special instructions
Pyrifluquinazon	caution	1.80SC	—	—	—	See label. Chili thrips only.
Spinetoram + Sulfoxaflor	caution	SC	—	—	—	See label for precautions and restrictions
Spinosad	caution	11.6SC	—	—	—	All crops
Spirotetramat	caution	240SC	—	—	240SC	Soil application as drench
Thiamethoxam	caution	25WG	—	—	25WG	See label
Tolfenpyrad	warning	EC	—	—	—	See label for phytotoxicity
Whiteflies (https://www.pubs.ext.vt.edu/444/444-280/444-280.html)						
Abamectin	caution	0.15E	—	—	—	See label
Acephate	caution	75SP	3A	—	—	All crops
Acetamiprid	caution	70WSP, 30SG	—	—	—	See label
Afidopyropen	caution	0.83DC	—	—	—	Do not reapply within 7 days of last application
Azadirachtin	caution	EC	—	—	—	All crops
Beauvaria bassiana	caution	22WP, ES	—	—	—	See label
Bifenthrin	warning	.667 F	A	—	—	Greenhouse-grown ornamentals
Buprofezin	caution	70WSP	—	—	—	All crops
Clothianidin	caution	50WDG	—	—	—	See label
Cyantraniliprole	warning	SC	—	—	SC	See label. Foliar and soil applications
Cyclaniliprole	caution	EC	—	—	—	See label
Cyfluthrin	warning	20WP	—	—	—	See label
Diflubenzuron	caution	25WSB	—	—	—	See label
Dinotefuran	caution	20SG	—	—	20SG, 2G	Soil application as drench, granules
Fenazaquin	warning	200SC	—	—	—	All crops, see label for phtotoxicity
Fenoxycarb	caution	25WP	0.6A	—	—	All crops
Fenpropathrin	warning	2.4EC	1A	—	—	See label
Flonicamid	caution	SG	—	—	—	See label for rate range

Table 6.4 - Guide to Pesticide and Formulations Recommended by Pest or Pest Group						
Pesticide	Signal Word	Foliar Spray	Aerosol	Smoke Fog Vapor	Soil	Remarks[1]
Whiteflies (https://www.pubs.ext.vt.edu/444/444-280/444-280.html) continued						
Flupyradifurone	caution	1.67SC	—	—	—	See label. Only one application per crop cycle
Fluvalinate	caution	2F	—	—	—	All crops
Imidacloprid	caution	II	—	—	1%G, 60WP	See label
Insecticidal soap	caution	L	—	—	—	See label
Isaria fumosorosea	non toxic	—	—	—	—	See label
Kinoprene	caution	II	—	—	—	See label
Novaluron	caution	10SC	—	—	—	See label for listed species
Permethrin	caution	3.2EC	—	—	—	See label for sensitive plants
Pymetrozine	caution	50WG	—	—	—	All crops; spray and drench applications
Pyrethrins	caution	—	A	—	—	See label
Pyridaben	danger	75WP	—	—	—	See label
Pyrifluquinazon	caution	1.80SC	—	—	—	See label
Pyriproxyfen	caution	.86EC	—	—	—	See label
Spinetoram + Sulfoxaflor	caution	SC	—	—	—	See label for precautions and restrictions
Spiromesifen	caution	4F	—	—	—	See label for species
Spirotetramat	caution	240SC			240SC	Soil application as drench
Thiamethoxam	caution	25WG			25WG	See label
Tolfenpyrad	warning	EC	—	—	—	See label for phytotoxicity
[1]Be sure to check precautions for phytotoxicity for each pesticide in table.						

Table 6.5 - Guide to Pesticide Usage Cross Reference to Other Common Trade Names

Pesticide	Formulation	50 Gal	10 Gal	3 Gal	Precautions & Remarks
Abamectin (Avid) aphids, leafminers, eriophyid and spider mites, thrips, whiteflies	0.15EC	2.0-4.0 fl oz	0.75-1.5 T	0.75-1.5 t	Generic products exist. See label. See label for rate. 12-hr REI. SIGNAL WORD - WARNING
Acephate (Orthene) aphids, leafroller, mealybugs, scale crawler, thrips, whitefly	75SP	See label for rates	See label for rates	See label for rates	Repeated applications may cause phytoxicity. See label for rate and species list. Generics exist. 24-hr REI. SIGNAL WORD - CAUTION
Acephate (1300 Orthene TR) aphids, leafroller, mealybugs, scale crawler, thrips, whitefly	12% aerosol	—	—	—	Apply 5-10 seconds/100 sq ft. Do not use under high temperature and humidity conditions or where gas heating systems are unvented. See label for sensitive plant list. 24-hr REI. SIGNAL WORD - CAUTION
Acequinocyl (Shuttle) spider mites	15SC	3.2-6.4 fl oz	1.25-2.5 T	1.25-2.5 t	Do not use on miniature roses or impatiens. Use low rate on standard roses. See label for resistance management. 12-hr REI. SIGNAL WORD - CAUTION
Acetamiprid (Tristar) aphids, mealybug, leafhopper, whiteflies, thrips, scales, fungus gnat larvae, leafminers, caterpillars	70WSP, 30SG	See label for rates	See label for rates	See label for rates	See label for restrictions. 70WSP in water soluble packets. 12-hr REI. SIGNAL WORD - CAUTION
Afidopyropen (Ventigra) aphids, whiteflies	0.83DC	See label for rates	See label for rates	See label for rates	See label for resistance management, restrictions, and precautions. 12-hr REI. SIGNAL WORD - CAUTION
Azadirachtin (Azatin, Aza-Direct and others) aphids, caterpillars, leafminers, mealybugs, thrips, whiteflies	various	See label for rates	See label for rates	See label for rates	Product is available at several concentrations and sold under many trade names. 4-hr REI. SIGNAL WORD - CAUTION
Bacillus thuringiensis subsp. israelensis (Gnatrol) fungus gnats	AS	1.0-4.0 pts	3.0-13.0 oz	2.0-8.0 T	4-hr REI. SIGNAL WORD - CAUTION
Bacillus thuringiensis subsp. kurstaki (Dipel) caterpillars, loopers, budworm, omnivorous leafroller, armyworm	various	See label for rates	See label for rates	See label for rates	Many formulations exist. Use full coverage foliar spray when larvae are small. Use lower rate for light infestations. 4-hr REI. SIGNAL WORD - CAUTION
***Beauveria bassiana* strain GHA** (BotaniGard, Mycotrol) aphids, mealybugs, thrips, whiteflies	22WP, ES	See label for rates	See label for rates	See label for rates	A mycoinsecticide.
***Beauveria bassiana* strain PPRI 5339** (Velifer) aphids mealybugs, mites, thrips, whiteflies	Oil dispersion	1.5-6.5 fl oz	_	_	12-hr REI. SIGNAL WORD - CAUTION
Bifenazate + Abamectin (Sirocco) spider mites	50SP	1.0-2.0 oz	_	_	Do not use in successive applications. See label for rate. 12-hr REI. SIGNAL WORD - CAUTION
Bifenthrin (Attain) armyworms, caterpillars, mealybugs, leafrollers, plant bugs, scale, mites, whiteflies	0.5%/A	1 lb can/3000 sq ft			Generic products exist. See label for total release directions. 12-hr REI. SIGNAL WORD - CAUTION

Abbreviations: AF - aquaflow; W, WP - wettable powder; E, EC - emulsifiable concentrate; L - liquid; ME - microencapsulated; SP - sprayable or soluble powder; SC - spray concentrate; D - Dust; G - granular; A - aerosol; F - fog; SG - smoke generator; V - vapor; lb - pound; pt - pint; oz - ounce; fl oz - fluid ounce; cu ft - cubic feet; c - cup; T - tablespoon; t - teaspoon; gal - gallon(s)

Useful Equivalents 1 lb WP/100 gal = 1 T/1 gal; 2.0 T = 1 fl oz; 1 pt EC/100 gal = 1 t/1 gal; 16 fl oz = 1 pt; 3 t = 1 T; 2 pt = 1 qt

Table 6.5 - Guide to Pesticide Usage Cross Reference to Other Common Trade Names continued

Pesticide	Formulation	50 Gal	10 Gal	3 Gal	Precautions & Remarks
Bifenthrin (Talstar) whiteflies, mealybugs, spider mites, leafroller, armyworms	0.667F	4.0-20.0 oz	0.8-4.0 oz	2.0-6.0 t	Apply as full-coverage foliar spray. Repeat as necessary. Do not handle plants till dry. 12-hr REI. SIGNAL WORD - CAUTION
Buprofezin (Talus) leafhoppers, mealybugs, planthoppers, scales, whiteflies	70WSP	—	—	—	Sold in water-soluble bags. 12-hr REI. SIGNAL WORD - CAUTION
Chlorantraniliplore (Acelepryn) leaf-feeding caterpillars	1.6SC	—	—	—	See label for rates. Foliar spray or drench. 4-hr REI. SIGNAL leaf-feeding caterpillars WORD - CAUTION
Chlorfenapyr (Pylon) spider mites, cyclamen mites, thrips, caterpillars, foliar nematodes	2S Aerosol	1.3-2.6 fl oz	1.5-3.0 t	0.5-1.0 t	Labeled for greenhouse ornamentals. See label for thrips rate. 12-hr REI. SIGNAL WORD - CAUTION
Clofentezine (Novato) spider mites	5SC	1.0 oz	—	—	One application per crop cycle. Apply at first sign of mite activity. 12-hr REI. SIGNAL WORD - CAUTION
Clothianidin (Arena) aphid, mealybugs, whiteflies	50WDG	See label for rates	See label for rates	See label for rates	12-hr REI. SIGNAL WORD - CAUTION
Cyantraniliprole (Mainspring) Lace bugs, leaf-feeding caterpillars, soft scales, thrips and whiteflies	SC	—	—	—	See label for rates. Foliar spray or drench. 4-hr REI. SIGNAL WORD - WARNING
Cyclaniliprole (Sarisa) leaf-feeding caterpillars and beetles, leafminers, whiteflies	SC	—	—	—	See labels for rates. 4-hr REI. SIGNAL WORD - CAUTION
Cyclaniliprole + Flonicamid (Pradia) aphids, caterpillars, mealybugs, soft scales, psyllids, thrips	SC	5.0-8.7 fl oz	—	—	12-hr REI. SIGNAL WORD - CAUTION
Cyflumetofen (Sultan) spider mites	18.7SC	6.85 fl oz	—	—	See label. 12-hr REI. SIGNAL WORD - CAUTION
Cyfluthrin (Decathlon) caterpillars, lace bug, aphids, leafrollers, mealybugs, thrips, whiteflies, sowbugs	20WP	3.0-4.5 T	2.0-3.0 t	0.75-1.0 t	Addition of a spreader-sticker may improve control. 12-hr REI. SIGNAL WORD - WARNING
Cyfluthrin + Imidacloprid (Discus) aphids, mealybugs, caterpillars	EC	12-25 fl oz	—	—	See label for additional pest targets. 12-hr REI. SIGNAL WORD - CAUTION
Cyromazine (Citation) Leafminers, fungus gnats, shore flies	75WP	1.33 oz	—	—	Apply as foliar spray or drench; will not control adults. Sold in water-soluble pouches. SIGNAL WORD - CAUTION
Diflubenzuron (Adept, Dimilin) armyworms, fungus gnats, leafminers, shore flies, whiteflies	25SC	—	—	—	Read label before using as a drench. Under cover uses are registered. Sold in water soluble bags. Rates differ for foliar feeders. Do not use on poinsettia, hibiscus or Reiger begonia 12-hr REI. SIGNAL WORD - CAUTION

Abbreviations: AF - aquaflow; W, WP - wettable powder; E, EC - emulsifiable concentrate; L - liquid; ME - microencapsulated; SP - sprayable or soluble powder; SC - spray concentrate; D - Dust; G - granular; A - aerosol; F - fog; SG - smoke generator; V - vapor; lb - pound; pt - pint; oz - ounce; fl oz - fluid ounce; cu ft - cubic feet; c - cup; T - tablespoon; t - teaspoon; gal - gallon(s)

Useful Equivalents 1 lb WP/100 gal = 1 T/1 gal; 2.0 T = 1 fl oz; 1 pt EC/100 gal = 1 t/1 gal; 16 fl oz = 1 pt; 3 t = 1 T; 2 pt = 1 qt

Table 6.5 - Guide to Pesticide Usage Cross Reference to Other Common Trade Names continued

Pesticide	Formulation	50 Gal	10 Gal	3 Gal	Precautions & Remarks
Dinotefuran (Safari) aphids, scale, Japanese beetles, leafminers, mealybugs, thrips, whiteflies	20SG 2G	See label for rates	See label for rates	See label for rates	For foliar insects. Apply as foliar spray or soil applications as drenches. See label for scale species. See label for vegetable transplant use. Do not apply while bees are foraging, or to flowers where bees may forage (See "Bee advisory" box on label). 12-hr REI. SIGNAL WORD - CAUTION
Etoxazole (TetraSan, Beethoven)	5WDG Aerosol	See label for rates	—	—	Sold in water soluble packets. 12-hr REI. SIGNAL WORD - CAUTION
Fenazaquin (Magus) mites, whiteflies	200SC	6.0-12.0 fl oz	2.2-4.5 T	2.0 t -1.5 T	Maintain agitation during mixing. One application per crop cycle. Do not apply to roses. 12-hr REI. SIGNAL WORD - WARNING.
Fenoxycarb (Preclude) whiteflies, soft scales, fungus gnats, shore flies, lepidopterous leaf miners, and thrips	0.6A	5-10seconds/ 100 sq ft	—	—	WP sold in 1.0 oz pouches. Insect growth regulator. 12-hr REI. Signal Word - CAUTION
Fenpropathrin (Tame) aphids, beet armyworm, leafhoppers, mealybugs, mites, whiteflies, Japanese beetle	2.4EC, 1A Aerosol	2.67-8.0 oz	1.0-3.0 T	1.0-3.0 t	Aerosol formulation contains acephate. 24-hr REI. SIGNAL WORD - WARNING
Fenpyroximate (Akari) spider mites	5SC	8.0-12.0 oz	3.0-4.5 T	1.0-1.5 T	See label for resistance management. 12-hr REI. SIGNAL WORD - WARNING
Flonicamid (Aria) aphids, mealybugs, thrips, whiteflies	SG	See label for rates			Each packet contains 20g of product. Registered for greenhouse and interiorscapes. 12-hr REI. SIGNAL WORD - CAUTION
Flupyradifurone (Altus) aphids, mealybugs, whiteflies	1.67SC	—	See label for soil and foliar rates	—	Apply as a foliar spray or soil drench. 12-hr REI. SIGNAL WORD - CAUTION
Fluvalinate (Mavrik) aphids, thrips, mites, whiteflies, leaf-feeding caterpillars	2AF	2.0-5.0 fl oz	1.0 T-2.5 T	1.0 t-2.5 t	May repeat at 5- to 10-day intervals if needed. See label for precautions. 12-hr REI. SIGNAL WORD - CAUTION
Hexythiazox (Hexygon) spider mites	50DF	See label for rates	See label for rates	See label for rates	Rates differ for high- and low-volume applications. 12-hr REI. SIGNAL WORD - CAUTION
Imidacloprid (Marathon, various product names) aphids, thrips and whiteflies	1%G, 60 WP, II	See label for rates	See label for rates	See label for rates	Generic products exist. Do not over irrigate following application. Do not apply while bees are foraging, or to flowers where bees may forage (See "Bee advisory" box on label).12-hr REI. SIGNAL WORD - CAUTION
***Isaria fumosorosea* strain 97** (Ancora) **FE 9901** (NoFly) aphids, mealybugs, thrips, whiteflies	Oil suspension	—	—	—	See labels for rates and additional pest targets. 12-hr REI. SIGNAL WORD - CAUTION
Insecticidal soap (Various product names) aphids, mealybugs, mites, scale insects	50.5EC 25EC	4.0-10.0 pt 2.0 gal	0.8-2.0 pts 50.0 oz	8.0-20.0 T 15.0 oz	See label. Repeated applications of high rates may cause plant damage. Numerous formulations are available. 12-hr REI.

Abbreviations: AF - aquaflow; W, WP - wettable powder; E, EC - emulsifiable concentrate; L - liquid; ME - microencapsulated; SP - sprayable or soluble powder; SC - spray concentrate; D - Dust; G - granular; A - aerosol; F - fog; SG - smoke generator; V - vapor; lb - pound; pt - pint; oz - ounce; fl oz - fluid ounce; cu ft - cubic feet; c - cup; T - tablespoon; t - teaspoon; gal - gallon(s)

Useful Equivalents 1 lb WP/100 gal = 1 T/1 gal; 2.0 T = 1 fl oz; 1 pt EC/100 gal = 1 t/1 gal; 16 fl oz = 1 pt; 3 t = 1 T; 2 pt = 1 qt

Table 6.5 - Guide to Pesticide Usage Cross Reference to Other Common Trade Names continued

Pesticide	Formulation	50 Gal	10 Gal	3 Gal	Precautions & Remarks
Kinoprene (Enstar) aphids, fungus gnats, mealybugs, scales, whitefly	II	2.5-5.0 oz	2.5-5.0 t	0.75-1.5 t	See label for usage directions. Labeled for carnations, mums, roses. Foliage should be dry. Fogging rate - 1 oz/3,000 cu ft 4-hr REI. SIGNAL WORD - WARNING
	Fog				
Lambda-cyhalothrin (Scimitar) adult leaf miners, armyworms, brown soft scale, caterpillars, mealybugs, spider mites, thrips, whiteflies	GC	0.75-2.5 oz	—	—	Generic products exist. See label for rates. 24-hr REI. SIGNAL WORD - CAUTION
Metaldehyde (Deadline, Metarex) slugs, snails	3.25% pellets	1.0 lb/1,000 sq ft			Apply bait only to soil surface around plants, not foliage or other plant parts. 12-hr REI. SIGNAL WORD - CAUTION
***Metarhizium brunneum* strain F52** (Met52) weevils and thrips	Oil suspension	—	—	—	See labels for rates and additional pest targets. 4-hr REI. SIGNAL WORD - CAUTION
Methoxyfenozide (Intrepid) caterpillars	2F	See label for rates	See label for rates	See label for rates	4-hr REI. SIGNAL WORD - CAUTION
Novaluron (Pedestal) thrips, caterpillars, whiteflies, leafminers	10SC	3.0-4.0 fl oz	4.0-5.0 tsp	1.0-1.5 tsp	See label for precautions. Do not use on poinsettias. 12-hr REI. SIGNAL WORD - CAUTION
Permethrin (Perm-up, Astro) leafminers, caterpillars, aphids, fungus gnats, mealybugs	3.2EC	10.0 oz	2.0 oz	1.0 T	Apply as full-coverage foliar spray. Listed rate is for leafminers; lower rate for other pests. 12-hr REI. SIGNAL WORD - CAUTION
Pymetrozine (Endeavor) aphids, whiteflies	50SP	1.25-2.5 oz	—	—	Only sold in water soluble packets. 12-hr REI. spray and drench applications SIGNAL WORD - CAUTION
Pyrethrin (X-clude) aphids, scale, mealybugs, spider mites, whiteflies	Aerosol	Use 5-10 second application for each 100 sq ft	Use 5-10 second application for each 100 sq ft	Use 5-10 second application for each 100 sq ft	See label. NO - REI. SIGNAL WORD - CAUTION
Pyrethrins (Pyreth-It, Pyrethrum) **+ oils** (Pycana) aphids, scales, mealybugs, mites, whiteflies	EC	—	—	—	See labels for rates and additional pest targets. 12-hr REI. SIGNAL WORD - CAUTION
Pyridaben (Sanmite) mites, whiteflies	75WP	1.0-3.0 oz	—	—	Sold in 1 oz pouches. See label for dosage for specific pest. 12-hr REI. SIGNAL WORD - DANGER
Pyridalyl (Overture) thrips, caterpillars	35WP	4.0 oz	—	—	Only sold in water-soluble packets. 12-hr REI.. SIGNAL WORD - CAUTION
Pyrifluquinazon (Rycar) Aphids, leafhoppers, chili thrips, mealybugs, whiteflies	20SC	—	—	—	See label. 12-hr REI. SIGNAL WORD - CAUTION
Pyriproxyfen (Distance, Pyrigro, Fulcrum) whiteflies, fungus gnats, shoreflies, scale	0.86 EC	3.0-6.0 fl oz	0.5-1.0 fl oz	1.0-2.0 t	See label for restrictions on application per cropping cycle. Rate differs for scale. 12-hr REI. SIGNAL WORD - CAUTION

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Table 6.5 - Guide to Pesticide Usage Cross Reference to Other Common Trade Names continued

Pesticide	Formulation	50 Gal	10 Gal	3 Gal	Precautions & Remarks
Spinetoram + Sulfoxaflor (XXpire) aphids, lepidopterous larvae, mealybugs, plant bugs, thrips, whiteflies and scales	SC	1.0-1.75 oz	—	0.06-0.1 oz	12-hr REI. SIGNAL WORD - CAUTION
Spinosad (Conserve) thrips, spider mites, dipterous leafminers, dipterous gall midges, lepidopterous larvae, sawfly larvae, leaf-feeding beetles.	SC	3.0-11.0 fl oz	1.0-11.0 T	1.0-11.0 t	Compatible with IPM programs. See label for resistance management and rates for specific pests. 4-hr REI. SIGNAL WORD - CAUTION
Spiromesifen (Forbid, Judo, Savate) mites, whiteflies	4F	1.0-2.0 fl oz	1.2-2.4 t	0.38-0.75 t	See label for species and number of applications per season. Do not apply on geraniums, Peperomia, Dracoera, and 'Classy', 'Attache' or 'Vogue' varieties of roses. 12-hr REI. SIGNAL WORD - CAUTION
Spirotetramat (Kontos) aphids, whiteflies, mealybugs, spider mites	240SC	0.8 fl oz (25.0 ml)	0.2 fl oz (5.0 ml)	0.07 fl oz (2.0 ml)	See label for resistance management. Registered for vegetable transplants. Will not control heavy populations of spider mites. 24-hr REI. for sprays, no REI. for drench. SIGNAL WORD - CAUTION
Steinernema feltiae (Nemasys, NemaShield, others) gnats and thrips	Trays	—	—	—	See labels for rates and additional information.
Tebufenozide (Confirm) lepidopterous larvae	2E	2.0-8.0 oz	1.0-4.0 T	1.0-4.0 t	See label regarding spray adjuvants. 4-hr REI. SIGNAL WORD - CAUTION
Thiamethoxam (Flagship) aphids, whiteflies, mealybugs, soft scales	25WG	See label for rates	—	—	See label for rate directly to soil or media. 12-hr REI. SIGNAL WORD - CAUTION
	.22G	See label for rates	—	—	See label for granular product rate. 12-hr REI. SIGNAL WORD - CAUTION
Tolfenpyrad (Hachi-Hachi) aphids,leafhoppers, Lepidopteran early instars, scale, thrips, whitefly	15%EC	See label for rates	—	—	See label for phytotoxicity. Rate for cuttings (cut flowers) is lower than other plants. 12-hr REI. SIGNAL WORD - WARNING
Ultra-fine spray oil (Various product names) aphids, leafminers, whiteflies, mites, scales, mealybugs	6E	0.5-1.0 gal	13.0-26.0 oz	4.0-7.5 oz	Applicator should conduct phytoxicity tests. 4-hr REI. SIGNAL WORD - CAUTION

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Floral Crops: Weed Control in Greenhouses

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■ Nonchemical Control

Hand-weeding and good sanitation are the safest ways to control weeds in greenhouses. Remove weeds from plugs or liners prior to planting. Use media that are free of weed seed or have been temporarily sterilized using steam or other methods. For steam sterilization of media, mix should be maintained at 180˚F for at least 30 minutes. Some weed seed will not be controlled. Prevent weeds from flowering in and around the greenhouse. Allow the greenhouse to completely dry out between crops. Use concrete for the greenhouse floor. Clean up growing media that spill onto the floor.

■ Chemical Control

Most herbicides cannot be used in greenhouses due to the potential for chemical volatilization under high temperatures. Since greenhouses are enclosed structures, herbicide vapors are trapped around the crop and could cause severe injury. There are several herbicides that are registered for weed control under greenhouse benches. There are no preemergence herbicides registered for weed control in containers or flats located in a greenhouse. See the chapters on Home and Commercial Ornamentals for herbicides registered for annual and perennial flowers maintained outdoors.

Table 6.6 - Nonselective Herbicides Registered for Weed Control Under Greenhouse Benches

Chemical	Rate	Comments
Acetic Acid (Weed Pharm)	Rate Varies	Organic Control. For liverwort control, mix one part Weed Pharm to two parts water. For control of grasses and broadleaf weeds use full strength. Contact nonselective postemergence herbicide. Do not allow spray to contact desired plants.
Envoy Plus (clethodim)	0.5 fl oz + 1/3 fl oz nonionic surfactant/gal	Apply to weed foliage for control of annual bluegrass, crabgrass, bermudagrass, and other grassy weeds. Make sure that no ornamental grasses or other desired grasses are in the greenhouse. Will not control sedges or any broadleaf weed.
glufosinate	Finale XL T & O 0.5-3.2 fl oz/gal, Cheetah Pro 0.5-2.0 fl oz/gal)	Turn off air circulation fans during application. Contact nonselective herbicide with some systemic activity. No soil residual as it only has postemergence action. Do not allow spray to contact desired plants.
Glyphosate (Roundup ProMax or other labeled formulations)	1.0-2.0 fl oz/gal check label for rates	Remove desired vegetation from the greenhouse and turn off air circulation fans prior to application. Systemic postemergence herbicide for control of all weeds. No soil residual action.
Marengo (indaziflam)	0.21-0.42 fl oz/1,000 sq ft	Apply to the floor of greenhouses for preemergence weed control. Add a labeled postemergence herbicide if there are emerged weeds. Do not allow spray to contact desired plants.
Reward (diquat)	0.75 fl oz + labeled rate of a nonionic surfactant/gal	Avoid spray drift to crops. Contact postemergence herbicide for control of all weeds. No residual action. Apply beneath greenhouses benches.
Scythe (pelargonic acid)	3.0%-7.0% solution	Avoid spray drift to crops. Contact postemergence herbicide for control of all weeds. No residual action. Has an odor that dissipates over time.

Turf: Diseases

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Fungicides play an important role in the successful management of turfgrasses, especially throughout the transition zone where no grasses experience ideal growing conditions. However, the use of fungicides is only one part of successful management of diseases. Practicing sound cultural techniques, such as proper fertilization, irrigation, and mowing strategies, provides a stand of turf with a greater ability to withstand attack by pathogens. Additional information on proper cultural practices is available in the following link:

2024-25 Virginia Turfgrass Variety Recommendations: (https://www.pubs.ext.vt.edu/SPES/spes-617/spes-617.html)

Below are the most common fungicide active ingredients that are used for turfgrass management, along with diseases that they control.

Table 7.1 - Fungicides Labeled for Control of Various Turfgrass Diseases

Active Ingredient	Algae	Anthracnose	Brown Patch	Copper spot	Dead Spot	Dollar Spot	Fairy Ring	Gray Leaf Spot	Large Patch	Leaf Spot/Melting Out	Microdochium Patch (Pink Snow Mold)	Powdery Mildew	Pythium diseases	Red Thread	Rusts	Spring Dead Spot	Summer Patch	Take-all Patch	Typhula Blight (Gray Snow Mold)	Yellow Patch
azoxystrobin		*	*				*	*	*	*	*	*	*	*	*	*	*	*	*	*
boscalid					*	*														
chloroneb													*						*	
chlorothalonil	*	*	*	*		*		*		*	*			*	*				*	
cyazofamid													*							
difenoconazole		*	*			*	*	*	*	*	*	*		*	*		*	*		*
etridiazole													*							
fenarimol		*	*	*		*					*	*		*		*	*	*	*	
fludioxonil		*			*	*		*		*	*						*		*	*
fluopicolide + propamocarb													*							
fluazinam	*	*	*			*			*	*	*			*					*	
fluoxastrobin		*	*			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
flutolanil			*				*							*					*	*
flutriafol		*	*	*		*		*	*			*			*	*	*			
fluxapyroxad	*		*			*			*		*						*		*	
fosetyl-Al													*							
iprodione			*			*			*	*	*			*					*	
isofetamid						*										*				
mancozeb	*		*	*		*		*		*			*	*	*					
mefenoxam													*							
mefentrifluconazole		*				*	*									*	*	*		
metconazole		*	*			*	*	*	*		*			*		*	*		*	*
myclobutanil		*	*	*		*		*	*	*	*	*		*	*	*	*	*		
PCNB		*	*	*	*			*		*			*	*	*	*	*	*		
penthiopyrad		*	*			*			*	*		*		*					*	
phosphonates													*							
picarbutrazox													*							
polyoxin-D zinc salt		*	*				*	*	*	*	*			*					*	*
propamocarb													*							
propiconazole		*	*		*			*		*	*	*		*	*	*	*	*	*	*
prothioconazole		*	*			*	*	*	*		*					*	*	*		
pydiflumetofen						*	*				*					*				
pyraclostrobin		*	*		*	*	*	*	*	*	*	*	*	*	*		*	*	*	
tebuconazole		*	*	*		*		*	*		*	*		*	*	*	*	*	*	*
thiophanate-methyl		*	*	*	*	*		*	*	*				*		*	*	*		*
thiram			*	*		*				*	*			*	*				*	
triadimefon			*	*		*					*	*		*	*		*	*	*	
trifloxystrobin		*	*					*		*	*			*	*		*			
triticonazole	*	*	*			*		*	*	*	*			*	*		*	*	*	
vinclozolin			*			*				*	*			*					*	

These recomendations are not a substitute for pesticide labeling. **Always Read and Follow the Label**

Table 7.2 - Registered Trade Names of Common Active Ingredients Used for Control of Turfgrass Diseases by Professionals	
active ingredient	**Trade name(s)**
azoxystrobin	**Heritage*** (50WG, G, SC, TL, Action), Headway*, Headway G, Renown*, Briskway*, Posterity Forte*, Posterity XT*, QualiPro Strobe (2L, Pro, T, TM), Endow, Contend*, Union*
benzovindiflupyr	**Ascernity***, Contend*
boscalid	**Emerald**, Honor*, Encartis*
chloroneb	Andersons Fungicide V, Fungicide IX*
chlorothalonil	**Daconil** (Action*, Ultrex, WeatherStik, ZN), QualiPro Chlorothalonil, Docket, Echo Chlorothalonil, Enclave*, Pegasus, Primera One Chlorothalonil, Pro Solutions Thalonil, Concert II*, Instrata*, Legend, Renown*, Reserve*, Spectro 90*, Disarm C*, Vitalonil*, TM/C*, Encartis*
cyazofamid	**Segway,** Union*
difenoconazole	**Briskway***, Ascernity*, Contend*
etridiazole	**Terrazole 35WP,** Terrazole L
fenarimol	**Rubigan**
fluazinam	**Secure, Secure Action*,** Traction*
fludioxonil	**Medallion SC,** Medallion WDG, Instrata*
fluindapyr	**Kalida***
fluopyram	Resilia*
fluoxastrobin	**Fame** SC, Fame + C and Fame + T*, Fame G, Disarm 480SC, Disarm C*, Disarm G, Disarm M*
flutriafol	**Rayora**, Kalida*
fluxapyroxad	**Xzemplar** and Lexicon*
flutolanil	**Pedigree**
fosetyl-Al	**Signature Xtra Stressgard,** Chipco Signature, QualiPro Fosetyl-Al
iprodione	**26GT,** 26019 Flo, Iprodione Pro 2SE, Enclave*, Nufarm Iprodione, Primera One Iprodione, QualiPro Ipro 2SE, Raven, Interface*, 26/36*, Dovetail*, Nufarm TM+IP*
isofetamid	**Kabuto** and Tekken
mancozeb	**Fore** (Rainshield), Dithane, Junction*, Protect, Wingman
mandestrobin	**Pinpoint**
mefenoxam	**Subdue** MAXX, Subdue G, QualiPro Mefonoxam 2AQ
mefentrifluconazole	**Maxtima** and Navicon*
metconazole	**Tourney**
myclobutanil	**Eagle 20EW,** QualiPro Myclobutanil, Disarm M*, Lebanon Eagle G, Howard Johnson's Eagle G
PCNB	**Turfcide10G,** Turfcide 400, Andersons FFII
penthiopyrad	**Velista**
phosphonates	**Appear II,** Alude, AgriFos, Exel LG, Fiata, Fosphite, Fungi-Phite, K-Phite, Phorcephite, Phostrol, Primera Magellan, Quanta, Rampart, ReSyst
picarbutrazox	**Serata**
polyoxin-D zinc salt	**Affirm**
propamocarb	**Banol,** Stellar*, Resilia*
propiconazole	**Banner MAXX,** Andersons Prophesy, Kestrel, Lesco Spectator, Nufarm Propiconazole, PrimeraOne Propiconazole, ProPensity, Propiconazole Select, Strider, Propimax, QualiPro Propiconazole, Savvi, Headway*, Headway G, Instrata*, Concert*, Posterity Forte*, Posterity XT*, Contend*, Headway G
prothioconazole	**Densicor,** Resilia*

pydiflumetofen	**Posterity,** Posterity Forte*, Posterity XT*
pyraclostrobin	**Insignia** (SC and WG formulations), Honor*, PillarG*, Lexicon*, Navicon*, Aramax*, Pillar SC*
tebuconazole	**Torque,** Enclave*, QualiPro Tebuconazole, Mirage, Fame + T*, Clearscape, E-Scape, Strobe T*, Tekken*, Traction*
thiophanate-methyl	**3336** (WSP, FLO, Plus, G, DG Lite), 26/36*, Allban, Andersons Fluid Fungicide, Andersons Fungicide VII, Cavalier, Consyst*, Dovetail*, Fungicide IX*, Fungo, Lesco T-Storm, Lesco Twosome*, Nufarm TM+CTN*, Nufarm TM+IP*, Nufarm T-Methyl, Peregrine, PrimeraOne TM, QualiPro TM, QualiPro TM/C*, Spectro 90*, Systec, T-Bird, TM Select, Tee-1-Up*, Tee-Off, Topsin
thiram	**Spotrete,** Thiram Granuflo
triadimefon	**Bayleton** (Flo, 50DG, 50WSP, G), Andersons Bayleton G, Andersons Fungicide VII, Armada*, Tartan*
trifloxystrobin	**Compass,** Armada*, Tartan*, Interface*
triticonazole	**Trinity,** Triton WG, Triton FLO, Reserve*, PillarG*, Aramax*, Pillar SC*
vinclozolin	**Curalan,** Touche

*Product is a preformulation of at least two active ingredients. **BOLD** products are generally considered to be the most common trade name. It is possible that not all products labeled for use in turf are listed in this table. Products listed in this table are included in the Virginia Department of Agriculture and Consumer Services Approved Pesticide Database (http://www.kellysolutions.com/va/pesticideindex.htm). Always Read and Follow the Label. Many products have restrictions on site usage, yearly maximum use, application frequency, and/or personal protection equipment requirements. These recommendations are not a substitute for pesticide labeling.

Turfgrass: Insects

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The remarks column on this section contains information on suggested timing, pest thresholds, detection and monitoring techniques, and cultural and biological control recommendations for turfgrass professionals to maximize control effectiveness. Information on the Insecticide column proposes both the active ingredient and commercial insecticide, inside parenthesis, suggested to target the selected pest.

Caution: Be sure to consider drainage, slope, type of soil, weather, and general area use when spraying insecticides to avoid contamination of water sources and reduce exposure to non-target organisms. Avoid using treated areas immediately after application.

Note: Unless indicated otherwise, the following recommendations for amount of product are given for 1,000 sq ft of area and in per acre amounts as well. Formulations other than those indicated may have different rates. **Always follow directions on product labels, and make sure to follow the respective re-entry intervals for each applied insecticide.** To ensure even distribution of soil insecticides apply at least one half inch of water immediately after application in order to move the material through the thatch layer.

■ White Grubs

White grubs include larvae of Japanese beetle, May and June beetle, masked and European chafers, oriental beetle, green June beetle, and black turfgrass ataenius. White grubs can be managed by some entomopathogenic nematodes. Not all nematode species (named on the product label under the "Active Ingredients" section) available commercially will provide adequate control. Products with *Steinernema riobrave* should not be used for grub control. Products with *Heterohabditis bacteriophora* are more effective. Entomopathogenic (insect killing) nematode products should be applied only when the pest is present. Apply nematodes late in the day to avoid exposure to UV light damage. Irrigate the day before and immediately after application. Early spring treatments are usually not effective because soil temperatures should be at least 60°F or higher.

Beauvaria bassiana (white muscardine entomopathogenic fungus) products also provide effective control. Follow label instructions and water 0.5 inch immediately after application. Avoid fungicide applications for at least 4 days when using these products.

Insecticides available for grub management should be applied at the labeled rate and watered in with 0.25 to 0.5 inch of water. Most insecticides provide the best control when used against early instar (smaller) grubs present from early to mid August. Populations high enough to warrant treatment are ≥8 grubs/sq ft on well-maintained turf, and 4 to 6 grubs per square foot or higher on unthrifty turf. White grubs stop feeding in September or October, so control during fall may not prove successful. Spring treatments generally are not effective either.

Cultural management: Reducing the thatch layer to <0.5 inch will help increase the penetration of any treatment applied to turfgrass. Also, avoid applying grubicides when soil is saturated or waterlogged.

■ Green June Beetle Grub

The green June beetle grub comes up through the thatch layer at night to feed on the surface. Monitor in late July the same way as for other white grubs. To monitor for grubs, use a cup cutter and carefully check the thatch and area beneath it. As few as 3 to 5 grubs per square foot can cause significant damage to golf fairways and greens. Treatments applied in the late afternoon or early evening are better at targeting the nighttime surface-feeding grubs. Irrigate before application to attract the grubs to the surface.

■ Black Turfgrass Ataenius

Black turfgrass ataenius is the smallest white grub that attacks turfgrass in Virginia. This pest has two generations per year in Virginia. Adult beetles overwinter in the thatch layer of the rough next to fairways or in wooded lots. The overwintering adults become active from mid-April to early May about the time when spring crocus and red bud are in bloom. Applications targeting adults should not be watered in because the adults are in the thatch layer. First generation adults are actively laying eggs in July. Second generation adults begin emerging from late August through September. Spring applications targeting the early instar grubs of the first generation could be timed to when the black locust begins to bloom (May). Insecticides targeting second generation grubs could be applied from mid-July to early August before the grubs have matured to the third (and final) instar to avoid serious damage to the turfgrass. A degree day program (Wegner and Niemczyk 1981 in Haruo Tashiro, Turfgrass Insects of the United States and Canada) targets treatments to control the newly hatching first instar grubs. Based on a 55°F flight threshold, the program predicts that first generation eggs should begin to appear when 180-270 DD (degree days) have accumulated. Second generation eggs are expected to appear when 1,170-1,278 DD have accumulated, which coincides with the July blooming stage of Rose of Sharon. There are about 60-70 days between generations. Thresholds for black turfgrass ataenius are not firm but turf often shows damage at populations of 20 to 30 grubs per square foot, and populations of 50 per square foot can result in serious damage. However, damage often goes unnoticed in grass that is longer than 2.0 inches, properly fertilized, and not water-stressed. To monitor for grubs, use a cup cutter and carefully check the thatch and area beneath it.

Table 7.3 - Insecticides for White Grubs (larval stage)			
Insecticide	**Amount product per 1,000 sq ft**	**Amount product per acre**	**Remarks**
Bacillus thuringiensis var. galleriaei (grubGone! G)	37-55 oz	100-150 lb	Check label for details
Beauvaria bassiana	See label		Use 100 gal water/A. Multiple products. Check label for details.
chlorantraniliprole (Acelepryn 1.67SC)	0.184-0.367 oz	8.0-16.0 oz	Acelepryn 1.67SC: For residential, commercial, recreational turf, including golf courses and sod farms. Has moderate systemic activity. Acelepryn may be applied from early April to early September for preventative and early curative control of all major white grub species. Use higher rate for late August or early September applications due to fewer mid-instar grubs present at the time of application. Optimal results can be achieved if product is watered in (≥0.5 inch) immediately after application.
clothianidin (Arena 0.25G) (Arena 50WDG)	1.84-3.67 lb 0.147-0.294 oz	80.0-160.0 lb 6.4-12.8 oz	Arena 0.25G: Residential and nonresidential sites. Treatment should be followed by sufficient water to move active ingredient (AI) into soil.
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G) clothianidin (24.70%) and bifenthrin (12.30%) (Aloft GC SC)	1.8-3.6 lb 0.27- 0.44 fl. oz	80.0-160.0 lb 11.65-19.0 fl. oz	Aloft GC G and GC SC: **RESTRICTED USE.** Contact and systemic insect pest control for turf on residential and nonresidential sites including lawns, commercial, public, parks, recreational areas, athletic fields, golf courses and sod farms. For the granular formulation, apply enough water (≥0.5 inch) to release AI from carrier.
cyantraniliprole (Ference)	0.184 to 0.367 fl. oz	8 to 16 fl. oz	
deltamethrin (Deltagard G)	2.0-3.0 lb	87.0-131.0 lb	
dinotefuran (Zylam 20SG)	1.0 oz	2.7 lb	Zylam 20SG: Residential and nonresidential sites, including sod farms. Optimum control can be achieved when applications are made prior to or at egg hatch of the target pests followed by sufficient irrigation or rainfall to move AI through the thatch layer. The AI in Zylam is highly systemic and has a high water solubility. It is highly mobile and resistant to biodegradation. These physical traits make the AI a good candidate for leaching into the ground water, particularly where the water table is shallow and roots are permeable. Do not graze treated areas or use clippings from treated areas for feed or forage. Keep children and pets off areas until spray has dried. Do not apply to areas that are water logged or saturated or frozen.
entomopathogenic nematodes	See label		Various commercial products
imidacloprid (Merit 2F) (Merit 75WSP) (Merit 0.5G)	0.46–0.6 fl. oz 1.6 oz (1 packet)/ 8,250-11,000 sq ft 1.4-1.8 lb	1.25-1.6 pt 60.0-80.0 lb	Merit 2F, 75WSP and 0.5G: Residential and nonresidential sites. Merit 2F and 75WSP can be used on sod farms, **but not the 0.5G formulation**. Treatment should be followed by sufficient water to move AI into soil.

Table 7.3 - Insecticides for White Grubs (larval stage) (continued)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G) (Allectus GC)	 2.3-2.9 lb 2.3-2.9 lb	 100.0-125.0 lb 100.0-125.0 lb	Allectus G: Residential and nonresidential sites, **but not for use on golf courses or sod farms**. Allectus GC and GC SC: **RESTRICTED USE**. Golf courses and sod farms only. For best results for all products, water within 24 hours of treating to move AI through the thatch layer.
imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	 1.32-1.65 fl. oz	 3.6-4.5 pt	
tetraniliprole (Tetrino)	0.367-0.735 fl. oz	16-32 fl. oz	
thiamethoxam (Meridian 25WG)	 1.5-1.95 oz/5,000 sq ft	 12.7-17.0 oz	Meridian 25WG: Residential and nonresidential sites. Treatment should be followed by sufficient water to move AI into soil.
trichlorfon (Dylox 6.2G) (Dylox 420SL)	 3.0 lb 6.9 fl. oz	 130.0 lb 300.0 fl. oz	Dylox 6.2G, and 420SL: Residential, parks and golf course sites. For best results, thatch layer must be <0.5 inch at time of treatment. Apply immediately after mixing with water. AI breaks down within 9-15 minutes in high pH water (i.e. pH ≥9). Do not use treated area or clippings from treated areas for feed or forage.

Table 7.4 - Insecticides for Adults of Black Turfgrass Ataenius

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
Adult stage			
bifenthrin (Talstar EZ) (Talstar GC) (Talstar PL)	 1.15-2.3 lb 1.15-2.3 lb 1.15-2.3 lb	 50.0-100.0 lb 50.0-100.0 lb 50.0-100.0 lb	Residential and nonresidential sites.
lambda-cyhalothrin (Scimitar GC)	 0.24 fl. oz (7.0 mL) (use 2-10 gal water)	 10.0 fl. oz	**RESTRICTED USE**. Residential and nonresidential sites. For best results, water lightly after treating (≤0.5 inch) to move AI into thatch layer.
spinosad (Conserve SC Turf)	 1.2 fl. oz	 52.0 fl. oz	Residential and nonresidential sites.

■ Annual Bluegrass Weevil

Golf course greens and fairways planted in creeping bentgrass, *Agrostis stolonifera,* often become infested with annual bluegrass, *Poa annua.* These two grass species are the main hosts on which annual bluegrass weevil (ABW) adults and larvae feed.

In early spring around the time when *Forsythia* is in full bloom, ABW adults leave their overwintering sites in pine duff or other types of leaf litter and walk to annual bluegrass-infested bentgrass greens and fairways. The full bloom stage of the flowering dogwood typically marks the end of adult migration. The adults feed in the grass foliage above the thatch and can be easily detected upon close inspection. Two or three eggs are laid within leaf sheaths just above the crown. Newly hatched larvae feed within the leaf sheath and then move into the crown and roots where the most serious damage occurs. If unchecked, high populations of larger larvae (fourth and fifth instars) can kill the bentgrass, turning greens and fairways light brown despite adequate moisture and nutrients. The life cycle from egg to adult takes about 50-60 days in New England states, but may require fewer days in warmer southern states, including Virginia. Depending on location, ABW is capable of completing up to four generations per year. In the fall, ABW adults move from golf greens and fairways to overwinter sites.

The ABW egg is pale yellow to white and oblong in shape. It is about 0.03 in long by 0.01 in wide. The larva is legless, has a brown head and creamy white body, and is rounded at both ends. The larva passes through five instars (sheds its skin four times) before pupating. The first instar is about 0.03 in long, whereas the fifth instar is about 0.20 in. The newly emerged ABW adult is light tan; it then turns brown with small areas of yellow scales and hairs mottled throughout. The body eventually turns dark charcoal gray after the brown and yellow scales wear off. The length of the adult varies from 1/8 in – 5/32 in, and the antennae are elbowed and attached near the tip of the snout where the chewing mouthparts are located.

Adulticide products used widely are pyrethroids such as Scimitar and Talstar. Larvicide products such as Dylox, Conserve, Provaunt and Acelepryn have become popular ABW management tools. However, years of repeated exposure to pyrethroids in some New England states has caused some ABW populations to become resistant. Fortunately, ABW resistance to insecticides is not widespread yet here in Virginia.

Be on the alert from March through April to identify if ABW adults are on your course. Soap flushes on turf could be done to monitor for the presence of ABW adults. There is evidence that the soap will not damage the greens. It is recommended to mix one fluid ounce of any lemon-scent dishwasher soap for each gallon of water. Ideally, the flush will cover at least one-foot square area on the green. Doing soap flushes really early in the morning might underestimate the adult numbers. Target to do these soap flushes during the warmer time of the day. The ultimate goal is to detect the peak of adult activity on the greens; therefore weekly monitoring soap flushes may be necessary to properly time an insecticide application.

Immature ABW larvae could be detected in the field by conducting the salt float method from a turf soil core. It is recommended to mix one pound of common salt for each gallon of water. Once the turf soil plug is extracted, any green turf leaves should be removed to facilitate the inspection of the mixture. Using a container with a sealing lid, submerge the turf plug into the salt solution. Soil plug can be cut in multiple piece to increase surface area. To dislodge any immatures from the plug, the mixture should be shaken vigorously and let sit for at least a couple of minutes. The salt will aid to make any ABW immature present to float and easy to count. Counting first instar ABW immatures with this methods could be challenging due to how small those larvae are. The idea is to detect the presence of immatures to trigger the respective control strategy.

Table 7.5 - Insecticides for Annual Bluegrass Weevil

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
Larva stage			
chlorantraniliprole (Acelepryn 1.67SC)	0.275-0.46 fl. oz	12.0-20.0 fl. oz	Acelepryn 1.67SC: Residential, commercial, recreational turf, including golf courses and sod farms. Has moderate systemic activity. Apply ≥0.5 inch water immediately after application.
cyantraniliprole (Ference)	0.275 to 0.459 fl. oz	12 to 20 fl. oz	
dinotefuran (Zylam 20SG)	1.0 oz	2.7 lb	Zylam 20SG: Residential and nonresidential sites, including sod farms. Optimum control can be achieved when followed by sufficient irrigation or rainfall to move AI through the turf thatch layer. The AI in Zylam is highly systemic and has a high water solubility. It is highly mobile and resistant to biodegradation. These physical traits make the AI a good candidate for leaching into the ground water, particularly where the water table is shallow and roots are permeable. Caution must be taken when using this product. Do not graze treated areas or use clippings from treated areas for feed or forage. Keep children and pets off areas until spray has dried. Do not apply to areas that are water logged or saturated or frozen.
imidacloprid (Merit 2F) (Merit 75WSP) (Merit 0.5G)	0.46-0.6 fl. oz 1.6 oz (1 packet) /8,250-11,000 sq ft 1.4-1.8 lb	1.25-1.6 pt 60.0-80.0 lb	Merit 2F, 75WSP, 0.5G: Residential and nonresidential sites (check labels for details). Merit 2F and 75WSP can be used on sod farms, **but not the 0.5G formulation**. Treatment should be followed by sufficient water to move AI into soil.
indoxacarb (Provaunt)	0.275 oz	12.0 oz	Provaunt: Residential and nonresidential sites. Label specifies lawn, golf courses, and other recreational turfgrass areas. For best results, do not water or mow for 24 hours after treating. If grass is maintained at a mowing height >1.0 inch, then consider using the higher application rate if pest pressure is high.
tetraniliprole (Tetrino)	0.367-0.735 fl. oz	16-32 fl. oz	

Table 7.5 - Insecticides for Annual Bluegrass Weevil (continued)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
Larva stage			
spinosad (Conserve SC)	1.2 fl. oz	52.0 fl. oz	Conserve SC: Residential and nonresidential sites
Larva and Adult stage			
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G)	1.8-3.6 lb	80.0-160.0 lb	Aloft GC G and GC SC: **RESTRICTED USE.** Contact and systemic insect pest control on residential and nonresidential sites. For the granular formulation, apply enough water (≥0.5 inch) to release AI from carrier.
clothianidin (24.70%) and bifenthrin (12.3%) (Aloft GC SC)	0.27-0.44 fl. oz	11.65-19.0 fl. oz	
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus GC)	1.7-2.9 lb	75.0-125.0 lb	Allectus GC and GC SC: **RESTRICTED USE.** Contact and systemic insect pest control for golf courses and sod farms only. For the granular formulation, apply enough water (≥0.5 inch) to release AI from carrier.
imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	0.9-1.65 fl. oz	2.3-4.5 pt	
trichlorfon (Dylox 420SL [larvae]) (Dylox 420SL [adults])	5.2-6.9 fl. oz 6.9 fl. oz	225.0-300.0 fl. oz 300.0 fl. oz	Dylox 420SL: Residential and nonresidential sites (check label for details). Apply immediately after mixing with water. AI breaks down within 9-15 minutes in high pH water (i.e., pH ≥9). Do not use treated area or clippings from treated areas for feed or forage.
Adult stage			
bifenthrin (Check other labels of Talstar products for annual bluegrass weevil)	0.25-5.0 oz	10.9-21.8 oz	Residential and nonresidential sites (check label for details).
lambda-cyhalothrin (Scimitar GC)	0.24 fl. oz (7.0 mL)	10.0 fl. oz	**RESTRICTED USE.** Residential and nonresidential sites (check label for details). For best results, apply at recommended rates in 2-10 gals water/1,000 sq. ft. A nonionic wetting agent, penetrant, or similar adjuvant is recommended at label rates. Lightly irrigate after application with ≤0.5 inch water to move Scimitar GC into thatch layer.

■ Sod Webworm

Sod webworm damage is most severe during hot droughty conditions in mid- to late summer. Other contributing factors on turf are most noticeable in high-maintenance conditions and where grass is kept short. Two generations per year occur in Virginia. Initial damage symptoms are brown patches of turfgrass about 5-6 inches in diameter. Upon close inspection the leaves have been chewed back. If unchecked, these brown patches will increase in size and eventually kill the turf. For flushing larvae from thatch, mix 3-4 tablespoons of dishwashing liquid in 2 gallons of water. Pour evenly over 1 square yard of turf. Watch the area for 10 minutes, counting the sod webworm caterpillars as they rise to the surface. Sod webworm densities of 15 per square yard warrant treatment. Young larvae, which are most susceptible to treatment, can be expected in turf about 2 weeks after adults are present, usually late June and again in early September. Unfortunately, by the time damage is noticeable, the larvae are not susceptible to Bt products because they are getting ready to pupate. Spring and early summer treatments may be effective against the larvae that have overwintered. Do not mow for 1 to 3 days after treatment.

Cultural management: Plant endophyte enhanced fescue and ryegrass. Damage is seldom noticeable in turf more than 2.5 inches in height.

Table 7.6 - Insecticides for Sod Webworm

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
acephate (Orthene Turf, Tree, and Ornamental 97 Spray)	0.4-0.8 oz (use minimum 1-15 gal water)	1.0-2.0 lb	**Golf courses and sod farms only**. For best results, treat when insects appear. Repeat application may be necessary, but do not treat at more than 1-week intervals. Do not graze or provide livestock treated grass.

Table 7.6 - Insecticides for Sod Webworm (continued)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
azadirachtin (Azatrol EC)	≤1.3 fl. oz (use 1-2 gal water)	≤57.0 oz (use 40-100 gal water)	Residential and nonresidential sites (check label for details). The most vulnerable pest stages are the early larval stages when populations are established, but before damage is noticeable. Avoid watering and mowing for 12 to 24 hours after treating, and repeat as needed every 7 days.
Bacillus thuringiensis var. kurstaki (Dipel Pro DF)	See label		Check label for details.
beta-cyfluthrin (Tempo Ultra GC)	0.13-0.27 fl. oz (4.0-8.0 mL)	6.0-12.0 fl. oz	Residential and nonresidential sites, **but not for use on golf courses, sod farms, and sod grown for seed** (check label for details). Do not water or mow for 24 hours after treating.
bifenthrin (Talstar EZ) (Talstar GC) (Talstar PL)	 1.15 lb 1.15 lb 1.15 lb	 50.0 lb 50.0 lb 50.0 lb	Residential and nonresidential sites (check labels for details). For all granular treatments, water ≤0.1 inch immediately after treatment to release/activate AI from granule.
chlorantraniliprole (Acelepryn 1.67SC)	0.046-0.092 fl. oz	2.0-4.0 fl. oz	Acelepryn 1.67SC: For residential, commercial, recreational turf, including golf courses and sod farms. Has moderate systemic activity. Provides excellent curative control of caterpillars (larvae) in turf. For optimal control, delay watering or mowing for 24 hours after application. If turf is maintained at >1 inch in height, higher rates may be required during periods of high pest pressure.
clothianidin (Arena 0.25G) (Arena 50WDG)	 0.3-0.4 lb 0.3-0.4 lb	 120-160 lb 9.6-12.8 oz	Residential and nonresidential sites (check labels for details). For best results, treat just prior to egg laying or to early instar larvae of target pests. Treatment should be followed by sufficient water to move AI into soil.
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G) clothianidin (24.70%) and bifenthrin (12.30%) (Aloft GC SC)	 0.3-0.4 lb 0.27- 0.44 fl. oz	 80.0-160.0 lb 11.65-19.0 fl. oz	Aloft GC G and GC SC: **RESTRICTED USE**. Contact and systemic insect pest control for turf on residential and nonresidential sites, including lawns, commercial public, parks, recreational areas, athletic fields, golf courses, and sod farms. For the granular formuation, apply enough water (≥0.5 inch), to release AI from the carrier.
cyantraniliprole (Ference)	0.046 to 0.367 fl. oz	2-16 fl. oz	
deltamethrin (Deltagard G)	2.0-3.0 lb	87.0-131.0 lb	Check label for details.
dinotefuran (Zylam 20SG)	1.0 oz	2.7 lb	Zylam 20SG: Residential and nonresidential sites, including sod farms. Optimum control can be achieved when followed by sufficient irrigation or rainfall to move AI through the turf thatch layer. The AI in Zylam is highly systemic and has a high water solubility. It is highly mobile and resistant to biodegradation. These physical traits make the AI a good candidate for leaching into the ground water, particularly where the water table is shallow and roots are permeable. Caution must be taken when using this product. Do not graze treated areas or use clippings from treated areas for feed or forage. Keep children and pets off areas until spray has dried. Do not apply to areas that are water logged or saturated or frozen.
entomopathogenic nematodes		100 million-1 billion	Check label for details.

Table 7.6 - Insecticides for Sod Webworm (continued)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G) (Allectus GC) imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	 1.2-2.9 lb 1.2-2.9 lb 0.67-1.65 fl. oz	 50.0-125.0 lb 50.0-125.0 lb 1.8-4.5 pt	Allectus G: Residential and nonresidential sites, **but not for use on golf courses or sod farms**. Allectus GC and GC SC: **RESTRICTED USE**. Golf courses and sod farms only. For all products, water within 24 hours of application to move the AI through the thatch layer. Avoid mowing after treating until irrigation or rainfall has occurred.
indoxacarb (Provaunt)	0.046-0.092 oz	2.0-4.0 oz	Residential and nonresidential sites. Label specifies lawns, golf courses, and other recreational turfgrass areas. For best results, do not water or mow for 24 hours after treating. If grass is maintained at a mowing height >1.0 inch, then consider using the higher application rate if pest pressure is high.
lambda-cyhalothrin (Scimitar GC)	0.24 fl. oz (7.0 mL) (use 2-10 gal water)	5.0-10.0 fl. oz	Scimitar GC: **RESTRICTED USE**. Residential and nonresidential sites. Water lightly after treating (≤0.5 inch) to move AI into thatch layer.
spinosad (Conserve SC)	0.25 fl. oz	10.0 fl. oz	Residential and nonresidential sites. For best results, treat during the late afternoon or early evening, and do not water or mow for 12 to 24 hours after treating.
tetraniliprole (Tetrino)	0.367-0.735 fl. oz	16-32 fl. oz	
trichlorfon (Dylox 6.2G) (Dylox 420SL)	2.0 lb 4.6-6.9 fl. oz	87.0 lb 200.0-300.0 fl. oz	Dylox 6.2G, and 420SL: Residential, parks, and golf course sites. Water lightly after treating to move AI into thatch layer. For best results using Dylox 420SL, do not water after treating. Apply immediately after mixing with water. AI breaks down within 9-15 minutes in high pH water (i.e. pH ≥9). Do not use treated area or clippings from treated areas for feed or forage.

■ Chinch Bug

Chinch bugs are piercing-sucking insects that have two generations per year in Virginia. Chinch bugs can cause significant damage to turf when found in densities of 15 to 20 immature bugs (nymphs) per square foot. Damage usually occurs to turf in sunny areas with a heavy thatch layer that is somewhat droughty. Initial damage symptoms are small patches of turf that are yellow. As patches increase in size, the center turns brown with the expanding border of dead and dying grass with new grass turning from yellowish green to green, respectively. Areas planted with fine (red) fescue are especially at risk to chinch bugs. Chinch bugs may be sampled by floatation. Drive a 4-inch diameter cylinder with open ends on both sides into the turf. Then pour in water at a rate that maintains the water level in the cylinder about 1 inch above the turfgass for 5 to 10 minutes. Chinch bugs will float to the surface where they can be easily counted. Another scouting method is to use the soap flush (previously described under the ABW section), aiming to disturb chinch bugs, forcing them to move to the surface of the turf. Insecticide treatment is often effective, but because chinch bugs are highly mobile, the area may be quickly recolonized. Do not mow or water the turf for 2 to 3 days after treatment. If the entomopathogenic fungus *Beauvaria bassiana* is used as a control measure, do not apply fungicides immediately before or after application (see product label).

Cultural management: Plant endophyte enhanced fescue and ryegrass. Reduce the use of fine (red) fescue in sunny areas, reduce thatch, and avoid spring fertilization with high nitrogen content.

Table 7.7 - Insecticides for Chinch Bug

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
acephate (Orthene Turf, Tree, and Ornamental 97 Spray)	0.9-1.5 oz (use 1-15 gal water to obtain good coverage).	2.5-4.0 lb	**Golf courses and sod farms only**. Water lightly (≤0.5 inch) after treating. Do not graze or provide livestock treated grass.
Beauvaria bassiana	See label		Use 100 gal water/A. Check label for details.
beta-cyfluthrin (Tempo Ultra GC)	0.27 fl. oz (8.0 mL)	12.0 fl. oz	Residential and nonresidential sites, **but not for use on golf courses, sod farms, and sod grown for seed** (check label for details). For best results, water turf immediately after treating to move AI into thatch layer.

Table 7.7 - Insecticides for Chinch Bug (continued)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
bifenthrin (Talstar EZ) (Talstar GC) (Talstar PL)	 2.3-4.6 lb 2.3-4.6 lb 2.3-4.6 lb	 100.0-200.0 lb 100.0-200.0 lb 100.0-200.0 lb	Residential and nonresidential sites. For all granular treatments, water ≤0.25 inch immediately after treating to release/activate AI from granule.
chlorantraniliprole (Acelepryn 1.67SC)	0.184-0.46 fl. oz	8.0-20.0 fl. oz	Acelepryn 1.67SC: For residential, commercial, recreational turf, including golf courses, and sod farms. Has moderate systemic activity. For suppression of chinch bugs.
clothianidin (Arena 0.25G) (Arena 50WDG)	 0.3-0.4 lb 0.3-0.4 lb	 120.0-160.0 lb 9.6-12.8 oz	Residential and nonresidential sites. For best results, apply enough water to move AI to where target insects are active.
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G) clothianidin (24.70%) and bifenthrin (12.30%) (Aloft GC SC)	 1.8-3.6 lb 0.27-0.44 fl. oz	 80.0-160.0 lb 11.65-19.0 fl. oz	Aloft GC G and GC SC: **RESTRICTED USE.** Contact and systemic insect pest control for turf on residential and nonresidential sites, including lawns, commercial public, parks, recreational areas, athletic fields, golf courses, and sod farms. For the granular formulation, apply enough water (≥0.5 inch), to release AI from the carrier.
cyantraniliprole (Ference)	0.184 to 0.459 fl. oz	8-20 fl. oz	
deltamethrin (Deltagard G)	 2.0-3.0 lb	 87.0-131.0 lb	Residential and nonresidential sites. Use higher rates for subsurface pests and/or for extended residual control.
imidacloprid Merit 2F	0.6 fl. oz	1.6 pt	
Merit 0.5 G	1.8 lb	80 lb	
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G) (Allectus GC) imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	 1.7-2.9 lb 1.7-2.9 lb 0.9-1.65 fl. oz	 75.0-125.0 lb 75.0-125.0 lb 2.3-4.5 pt	Allectus G: Residential and nonresidential sites, **but not for use on golf courses or sod farms.** Allectus GC and GC SC: **RESTRICTED USE.** Golf courses and sod farms only.
permethrin (Astro)	0.4 to 0.8 fl. oz	17 to 35 fl oz	
lambda-cyhalothrin (Scimitar GC)	 0.47 fl. oz (14.0 mL) (use 2-10 gal water)	 20.0 oz	**RESTRICTED USE.** Residential and nonresidential sites. For best results, water lightly after treating (≤0.5 inch) to move AI into thatch layer.
tetraniliprole (Tetrino)	0.367-0.735 fl. oz	16-32 fl. oz	
thiamethoxam (Meridian 25WG)	 1.5-1.95 oz/5,000 sq ft	 12.7-17.0 oz	Residential and nonresidential sites. For suppression of chinch bugs.
trichlorfon (Dylox 420SL)	6.9 fl. oz	300.0 fl. oz	Residential, parks, and golf course sites. Check label for details. Apply immediately after mixing with water. AI breaks down within 9-15 minutes in high pH water (i.e. pH ≥9). Do not use treated area or clippings from treated areas for feed or forage.

■ Billbugs

Billbugs have one generation per year here in Virginia. Effective control can be obtained by a single early-season treatment for adults in early April. Visually monitor for active adults during early April to predict when and where to treat; and where problems might arise later in the season (billbug adults can often be seen crossing paved areas adjacent to turf). Damage from billbug larvae is often misdiagnosed as drought stress, white grub or chinch bug damage, or late spring greening. To recognize billbug damage, pull on the grass stems. They will break off near the crown and emit a fine sawdust-like frass (insect excrement) that has been packed inside the stems from larval feeding. If damage is severe, pull back the sod from the soil and you should find distinct patches of yellowish sawdust-like frass. Larval treatments should be applied if there are 6 to 8 larvae per square foot. Billbug adults can be detecting by mixing one fluid ounce of dishwashing liquid in one gallon of water, and pouring this mixture evenly over 1 square foot of turf (soap flush method). Watch the area for 10-15 minutes, observing the billbugs as they rise to the surface.

Cultural management: Plant endophyte enhanced fescue and ryegrass in addition to other turf varieties (ryegrass and bluegrass) that are resistant to billbug feeding.

Table 7.8 - Insecticides for Billbugs (e.g., bluegrass billbug, hunting billbug)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
Grub/larval stage			
chlorantraniliprole (Acelepryn 1.67SC)	0.184-0.46 fl. oz	8.0-20.0 fl. oz	Acelepryn 1.67SC: For residential, commercial, recreational turf, including golf courses, and sod farms. Has moderate systemic activity.
clothianidin (Arena 0.25G) (Arena 50WDG)	0.2-0.4 lb 0.2-0.4 lb	80.0-160.0 lb 6.4-12.8 oz	Residential and nonresidential sites. For best results, apply enough water to move AI to where target insects are active.
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G) clothianidin (24.70%) and bifenthrin (12.30%) (Aloft GC SC)	1.8-3.6 lb 0.27-0.44 fl. oz	80.0-160.0 lb 11.65-19.0 fl. oz	Aloft GC G and GC SC: **RESTRICTED USE.** Contact and systemic insect pest control for turf on residential and nonresidential sites, including lawns, commercial public, parks, recreational areas, athletic fields, golf courses, and sod farms. For the granular formuation, apply enough water (≥0.5 inch), to release AI from the carrier.
cyantraniliprole (Ference)	0.184 to 0.367 fl. oz	8 to 16 fl. oz	
dinotefuran (Zylam 20SG)	1.0 oz	2.7 lb	Zylam 20SG: Residential and nonresidential sites, including sod farms. Optimum control can be achieved when applications are made prior to or at egg hatch of the target pests followed by sufficient irrigation or rainfall to move AI through the turf thatch layer. The AI in Zylam is highly systemic and has a high water solubility. It is highly mobile and resistant to biodegradation. These physical traits make the AI a good candidate for leaching into the ground water, particularly where the water table is shallow and roots are permeable. Caution must be taken when using this product. Do not graze treated areas or use clippings from treated areas for feed or forage. Keep children and pets off areas until spray has dried. Do not apply to areas that are water logged or saturated or frozen.
imidacloprid (Merit 2F) (Merit 75WSP) (Merit 0.5G)	0.46-0.6 oz 1.6 oz (1 packet) /8,250-11,000 sq ft 1.4-1.8 lb	1.25-1.6 pt 60.0-80.0 lb	Merit 2F, 75WSP, and 0.5G: Residential and nonresidential sites (check label for details). Merit 2F and 75WSP can be used on sod farms, **but not the 0.5G formulation**. Treatment should be followed by sufficient water to move AI into soil.

Table 7.8 - Insecticides for Billbugs (e.g., bluegrass billbug, hunting billbug) (continued)			
Insecticide	**Amount product per 1,000 sq ft**	**Amount product per acre**	**Remarks**
Grub/larval stage			
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G) (Allectus GC)	 1.7-2.9 lb 1.7-2.9 lb	 75.0-125.0 lb 75.0-125.0 lb	Allectus G: Residential and nonresidential sites, **but not for use on golf courses or sod farms**. Allectus GC: **RESTRICTED USE**. Golf courses and sod farms only.
tetraniliprole (Tetrino)	0.367-0.735 fl. oz	16-32 fl. oz	
thiamethoxam (Meridian 25WG)	1.5-1.95 oz/5,000 sq ft	12.7-17.0 oz	Residential and nonresidential sites.
Adult stage			
beta-cyfluthrin (Tempo Ultra GC)	 0.27 fl. oz (8.0 mL)	 12.0 fl. oz	Residential and nonresidential sites, but not for use on golf courses, sod farms, and sod grown for seed.
bifenthrin (Talstar EZ) (Talstar GC) (Talstar PL)	 1.15-2.3 lb 1.15-2.3 lb 1.15-2.3 lb	 50.0-100.0 lb 50.0-100.0 lb 50.0-100.0 lb	Residential and nonresidential sites.
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G) clothianidin (24.70%) and bifenthrin (12.30%) (Aloft GC SC)	 1.8-3.6 lb 0.27-0.44 fl. oz	 80.0-160.0 lb 11.65-19.0 fl. oz	Aloft GC G and GC SC: **RESTRICTED USE.** Contact and systemic insect pest control for turf on residential and nonresidential sites, including lawns, commercial public, parks, recreational areas, athletic fields, golf courses, and sod farms. For the granular formuation, apply enough water (≥0.5 inch), to release AI from the carrier.
deltamethrin (Deltagard G)	 2.0-3.0 lb	 87.0-131.0 lb	Residential and nonresidential sites.
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G) (Allectus GC) imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	 1.7-2.9 lb 1.7-2.9 lb 0.9-1.65 fl. oz	 75.0-125.0 lb 75.0-125.0 lb 2.3-4.5 pt	Allectus G: Residential and nonresidential sites, **but not for use on golf courses or sod farms.** Allectus GC; Allectus GC SC: **RESTRICTED USE.** Golf courses and sod farms only.
lambda-cyhalothrin (Scimitar GC)	 0.24 fl. oz (7.0 mL)(use 2-10 gal water)	 10.0 fl. oz	**RESTRICTED USE.** Residential and nonresidential sites. For best results, water lightly after treating (<0.5 inch) to move AI into thatch layer.

■ Fall Armyworm, Cutworms, and Other Armyworms

Monitoring and treatment strategies are similar for fall armyworm, cutworms, and other armyworms. A detergent drench flushing technique (or the soap flush method) is useful to determine if these caterpillars are present in turf. Mix one fluid ounce of dishwashing liquid in one gallon of water. Pour evenly over 1 square foot of turf. Watch the area for 10 minutes, observing the caterpillars as they rise to the surface.

Fall Armyworm has two to three generations per year in Virginia. Fall armyworm populations of 9 or more caterpillars per square yard may warrant treatment. Populations can reach damaging levels late in the season. Unlike other armyworms, the fall armyworm is a major pest of turfgrass. Damage appears as thinning of turf over a widespread area. Preferred hosts are bermudagrass, ryegrass, fescue, and bluegrass. All plant parts above ground are consumed.

Cutworms have from two to four generations per year in Virginia. Cutworm populations of 3 to 8 caterpillars per square yard may warrant treatment. Damage appears as small patches and sunken areas, especially on golf greens.

Most insecticides used for cutworms are stomach poisons because the larvae feed at night. Apply insecticides in the early evening for the best results. Unless specified on the label, do not water or mow for 24 hours after treating. Cutworms are highly mobile, so treated areas are likely to become re-infested from surrounding areas. Cultural management: Plant endophyte enhanced fescue and ryegrass. Turf more than 2.5 inches in height requires less treatment for cutworms. Cutworm populations can be reduced if grass clippings are removed during mowing because cutworm moths lay their eggs at the tip of grass blades. If using entomopathogenic nematodes, apply late in the day and water before and after application.

Armyworm: Up to three generations of armyworms occur per year in Virginia.

Larvae appear in April, late June, and August-September. Armyworms feed in groups on grass blades, causing skeletonizing by early instars and consumption of the whole leaf by later instars, resulting in circular patches of bare ground. Armyworms prefer cereal crops, so turf areas near farmland growing these crops are at higher risk; however, they typically are not a major pest of turfgrass.

Treat when armyworms are first detected. If using entomopathogenic nematodes, apply late in the day and water before and after application.

Table 7.9 - Insecticides for Fall Armyworm, Cutworms, and Armyworms

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
acephate (Orthene Turf, Tree, and Ornamental 97 Spray)	0.4-0.9 oz (use minimum 5 gal water)	1.0-2.5 lb	**Golf courses and sod farms only**. Do not graze or provide livestock treated grass.
azadirachtin (Azatrol EC)	≤1.3 fl. oz (use 1-2 gal water)	≤57.0 fl. oz (use 40-100 gal water)	Residential and nonresidential sites. The most vulnerable pest stages to azadirachtin are the early larval stages when populations are established, but before damage is noticeable. Avoid watering and mowing for 12 to 24 hours after treating, and repeat as needed every 7 days.
beta-cyfluthrin (Tempo Ultra GC)	0.14-0.27 fl. oz (4.0-8.0 mL)	6.0-12.0 fl. oz	Residential and nonresidential sites, **but not for use on golf courses, sod farms, and sod grown for seed**. Do not water or mow for 24 hours after treating.
bifenthrin (Talstar EZ) (Talstar GC) (Talstar PL)	 1.15 lb 1.15 lb 1.15 lb	 50.0 lb 50.0 lb 50.0 lb	Residential and nonresidential sites. For all granular treatments, water ≤0.1 inch immediately after treatment to release/activate AI from granule.
chlorantraniliprole (Acelepryn 1.67SC)	0.046-0.092 fl. oz	2.0-4.0 fl. oz	Acelepryn 1.67SC: For residential, commercial, recreational turf, including golf courses, and sod farms. Has moderate systemic activity. Provides excellent curative control of caterpillars (larvae) in turf. For optimal control, delay watering or mowing for 24 hours after application. If turf is maintained at >1 inch in height, higher rates may be required during periods of high pest pressure.

Table 7.9 - Insecticides for Fall Armyworm, Cutworms, and Armyworms (continued)

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
clothianidin (Arena 0.25G)	0.3-0.4 lb	120.0-160.0 lb	Residential and nonresidential sites. Apply enough water to move AI to where target insects are active.
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G) clothianidin (24.70%) and bifenthrin (12.30%) (Aloft GC SC)	1.8-3.6 lb 0.27-0.44 fl. oz	80.0-160.0 lb 11.65-19.0 fl. oz	Aloft GC G and GC SC: **RESTRICTED USE**. Contact and systemic insect pest control for turf on residential and nonresidential sites, including lawns, commercial public, parks, recreational areas, athletic fields, golf courses, and sod farms. For the granular formulation, apply enough water (≥0.5 inch), to release AI from the carrier.
Cyantraniliprole (Ference)	0.046 to 0.367 fl. oz	2.0-16.0 fl. oz	
deltamethrin (Deltagard G)	2.0-3.0 lb	87.0-131.0 lb	Check label for details.
dinotefuran (Zylam 20SG)	1.0 oz	2.7 lb	**For use on cutworm only.**
Entomopathogenic nematodes	See label		Check label for details.
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G) (Allectus GC imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	1.2-2.9 lb 1.2-2.9 lb 0.67-1.65 fl. oz	50.0-125.0 lb 50.0-125.0 lb 1.8-4.5 pt	Allectus G: Residential and nonresidential sites, **but not for use on golf courses or sod farms**. Allectus GC and GC SC: **RESTRICTED USE**. Golf courses and sod farms only For all products, water within 24 hours of application to move the AI through the thatch layer. Avoid mowing after treating until irrigation or rainfall has occurred.
indoxacarb (Provaunt)	0.046-0.092 oz	2.0-4.0 oz	Residential and nonresidential sites. Label specifies lawns, golf courses, and other recreational turfgrass areas. For best results, do not water or mow for 24 hours after treating. If grass is maintained at a mowing height >1 inch, then consider using the higher application rate if pest pressure is high.
lambda-cyhalothrin (Scimitar GC)	0.11-0.24 fl. oz (3.4-7.0 mL)(use 2-5 gal water)	5.0-10.0 fl. oz	Scimitar GC: **RESTRICTED USE**. Residential and nonresidential sites. For best results, do not water or mow for 12 to 24 hours after treating.
spinosad (Conserve SC)	0.25-1.2 fl. oz	10.0-52.0 fl. oz	Residential and nonresidential sites. For best results, do not water or mow for 12 to 24 hours after treating. Low and high rates are based on whether larvae are small or large, respectively.
tetraniliprole (Tetrino)	0.367-0.735 fl. oz	16-32 fl. oz	
trichlorfon (Dylox 420SL)	4.6-6.9 fl. oz	200.0-300.0 fl. oz	Residential, park, and golf course sites. For best results, do not water after treating. Apply immediately after mixing with water. AI breaks down within 9-15 minutes in high pH water (i.e. pH ≥9). Do not use treated area or clippings from treated areas for feed or forage.

■ Ants

Several ant species, including field ants, can become problematic in turfgrass. Ant will tunnel under the turf roots, and deposit the excavated soil at the entrance of each mound, disrupting root growth and influencing playability of the affected area. High infestations of ants might result in having several mounds, where the free movement of the golf ball will be impeded. Additionally, ants and their mounds will become nuisance once established in turfgrass nearby other structures, like buildings and cement paths and driveways. Check the label to make sure that the product is registered for imported fire ants.

Table 7.10 - Insecticides for Ants

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
bifenthrin (Talstar S)	1 fl. oz	40 fl. oz	For golf courses and sod farms. Use 10 gal for 1,000 sq. ft. For low volume of application, water down the product with at leas 0.25 inches of water after application.
dinotefuran (Zylam 20SG)	1 oz	2.7 lb	Apply when seeing foraging activity from ants.
indoxacarb (Advion Insect Granular)	1.15-4.6 lb	50.0-200.0 lb	Turfgrasses grown for golf courses (tee box areas, roughs, fairways, greens, and collars), residential complexes and other similar landscape turf areas. Not for use on turfgrass that is being grown for seed or on commercial sod farms.
lambda-cyhalothrin (Scimitar GC)	0.11-0.24 fl. oz (3.4-7.0 mL)(use 2-5 gal water)	5.0-10.0 fl. oz	Scimitar GC: **RESTRICTED USE**. Residential and nonresidential sites. For best results, do not water or mow for 12 to 24 hours after treating.
Thiamethoxam (Meridian 25WG)	3-4 oz	12.7-17 oz	Turfgrass on golf courses, residential lawns, commercial grounds and sod farms. Do not use for seed production.

■ Mole Crickets

Mole crickets generally are not major pests of turf. However, they can cause serious damage in turf from tunneling in and beneath the thatch layer of sandy soils. Adult control is difficult to achieve in the early spring because the adults are actively seeking mates and continually invading preferred grassy areas. Areas that experience heavy adult pressure in the spring may warrant treating with maximum labeled rates and additional applications immediately prior to peak egg hatch.

Summer treatments targeting the young mole cricket nymphs are usually more effective in knocking down populations. The smaller size of the young nymphs (relative to the adults) makes them much more susceptible to insecticides. In addition, given that the nymphs must actively feed close to the surface to grow and develop, their exposure to insecticides is greatly increased. Treatments applied later in the summer may warrant higher rates and additional applications to control larger nymphs and young adults.

It is important to realize that as soils dry out, mole cricket nymphs and adults will burrow down substantially into the soil profile to remain in contact with moist soil. This is why most insecticide labels for mole crickets stress the point that if the soil is dry at the time of application, sufficient irrigation (but well short of waterlogging the turf) must be done before treating to provide favorable conditions that will drive the nymphs and adults up to the surface. The efficacy of most treatments will be greatly improved if pretreatment watering is done.

Table 7.11 - Insecticides for Mole Crickets

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
acephate (Orthene Turf, Tree, and Ornamental 97 Spray)	0.8-1.4 oz (use 1-15 gal water)	2.0-3.9 lb	**Golf courses and sod farms only**. Treat when mole crickets or their damage first appear. For best results, water before treating to drive the adults and nymphs to the surface, especially if soil is dry, but do not water after treating. If possible, treat in the late afternoon or early evening. More than one treatment at higher rates may be required during the growing season to knock down existing populations. Do not graze or provide livestock treated grass.
beta-cyfluthrin (Tempo Ultra GC)	0.27 fl. oz (8.0 mL)	12.0 fl. oz	Residential and nonresidential sites, **but not for use on golf courses, sod farms, and sod grown for seed**. For best results, water before treating to drive the adults and nymphs to the surface, especially if soil is dry.
bifenthrin (Talstar EZ) (Talstar GC) (Talstar PL)	 2.3-4.6 lb 2.3-4.6 lb 2.3-4.6 lb	 100.0-200.0 lb 100.0-200.0 lb 100.0-200.0 lb	Residential and nonresidential sites. For best results, water before treating to drive the adults and nymphs to the surface, especially if soil is dry. Treat in late afternoon or early evening, and then water in ≤0.5 inch immediately after treating.
clothianidin (Arena 0.25G) (Arena 50WDG)	 0.4 lb 0.294 fl. oz	 160.0 lb 12.8 fl. oz	Arena 0.25G and 50WDP: Residential and nonresidential sites. Arena 0.25G: For suppression of mole crickets. Highest rate suggested. Arena 50WDG: For suppression of mole crickets. Use high rate. For best results water before treating to drive the adults and nymphs to the surface, especially if the soil is dry. Apply enough water to move AI to where target insects are active.
clothianidin (0.025%) and bifenthrin (0.125%) (Aloft GC G) clothianidin (24.70%) and bifenthrin (12.30%) (Aloft GC SC)	 1.8-3.6 lb 0.27-0.44 oz	 80.0-160.0 lb 11.65-19.0 oz	Aloft GC G and GC SC: **RESTRICTED USE.** Contact and systemic insect pest control for turf on residential and nonresidential sites, including lawns, commercial public, parks, recreational areas, athletic fields, golf courses, and sod farms. For the granular formulation, apply enough water (≥0.5 inch), to release AI from the carrier.
dinotefuran (Zylam 20SG)	1.0 oz	2.7 lb	Zylam 20SG: Residential and nonresidential sites, including sod farms. Optimum control can be achieved when applications are made prior to or at egg hatch of the target pests followed by sufficient irrigation or rainfall to move AI through the turf thatch layer. The AI in Zylam is highly systemic and has a high water solubility. It is highly mobile and resistant to biodegradation. These physical traits make the AI a good candidate for leaching into the ground water, particularly where the water table is shallow and roots are permeable. Caution must be taken when using this product. Do not graze treated areas or use clippings from treated areas for feed or forage. Keep children and pets off areas until spray has dried. Do not apply to areas that are water logged or saturated or frozen.

Table 7.11 - Insecticides for Mole Crickets

Insecticide	Amount product per 1,000 sq ft	Amount product per acre	Remarks
imidacloprid (0.2%) and bifenthrin (0.16%) (Allectus G) (Allectus GC) imidacloprid (5%) and bifenthrin (2%) (Allectus GC SC)	 2.9 lb 2.9 lb (for Allectus G and GC, a single annual application may be made using 4.6-5.7 lb) 1.32-1.65 fl. oz (for Allectus GC SC, a single annual application may be made using 2.64-3.3 oz)	 125.0 lb 125.0 lb (for Allectus G and GC, a single annual application may be made using 200.0-250.0 lb) 3.6-4.5 pt (for Allectus GC SC, a single annual application may be made using 7.2-9.0 pt)	Allectus G: Residential and nonresidential sites, **but not for use on golf courses or sod farms**. Allectus GC SC: **RESTRICTED USE.** Golf courses and sod farms only. For best results for all Allectus formulations, water before treating to drive the adults and nymphs to the surface, especially if soil is dry. Treat in late afternoon or early evening, and then water in ≤ 0.5 inch immediately after treating.
indoxacarb (Advion Mole Cricket Bait)	1.15-4.6 lb	50.0-200.0 lb	Residential and nonresidential sites, **but not for use on sod farms and sod grown for seed**. Do not allow livestock or domestic animals to consume the bait or graze in treated areas. Water soil before treating to bring mole crickets to surface, and treat infested areas in late afternoon. Rainfall or irrigation within 2-3 days after treating may reduce bait effectiveness.
lambda-cyhalothrin (Scimitar GC)	0.24 fl. oz (7.0 mL) (nymphs and young adults) (use 4-10 gal water) 0.47 fl. oz (14 mL) (adults) (use 4-10 gal water)	10.0 fl. oz (nymphs and young adults) 20.0 fl. oz (adults)	**RESTRICTED USE.** Residential and nonresidential sites. For best results, water before treating to drive nymphs and adults to the surface, especially if soil is dry. Also, use a nonionic wetting agent, penetrant, or similar adjuvant. Use highest water application rates possible when treating. Immediately after treating, apply 0.25 to 0.5 inch of water.
thiamethoxam (Meridian 25WG)	1.5-1.95 oz/5,000 sq ft	12.7-17.0 oz	Residential and nonresidential sites. For suppression of mole crickets.
trichlorfon (Dylox 6.2G) (Dylox 420SL)	3.0 lb 6.9 fl. oz	130.0 lb 300.0 fl. oz	Dylox 6.2G, and 420SL: Residential, park, and golf course sites. For best results, thatch layer must be <0.5 inch at time of treatment. Apply Dylox 420SL immediately after mixing with water. AI breaks down within 9-15 minutes in high pH water (i.e. pH ≥9). Do not use treated area or clippings from treated areas for feed or forage.

Turf: Weeds

Shawn D. Askew, Professor, Virginia Tech

■ Weedy Grasses

There are several preemergence crabgrass killers available which will do an excellent job of controlling crabgrass and other annual grasses. Goosegrass is more difficult to control than most of the other annual grasses. Higher rates are suggested for goosegrass control and repeating herbicide application in May or June is suggested for best results.

Preemergence crabgrass killers kill seedlings as they germinate. Thus, it is necessary that they are applied in advance of crabgrass germination. Crabgrass usually germinates after April 15 in the mountains and March 15 in the Piedmont areas.

Midseason to late postemergent applications for annual grasses are considered to be less desirable than preemergent or early postemergent control. Late postemergent treatments will usually result in turfgrass discoloration and browning of crabgrass foliage, and later bare areas in a lawn. However, early postemergent treatments will provide excellent crabgrass control and allow turfgrass to begin to cover during the summer and fall. Goosegrass is very difficult to control with postemergent herbicides. It is possible to control crabgrass and allow a more difficult problem with goosegrass to develop without competition for the space left by the dying crabgrass. Arsenical herbicides may still be used on a restricted basis in golf and sod turf but are banned from residential and athletic turf. Fenoxaprop, mesotrione, quinclorac, topramezone, and metribuzin are used to control annual grasses in certain turfgrasses during late spring and summer.

Most perennial grasses are controlled by physical removal or by non-selective chemicals. Bermudagrass (aka wiregrass) can be controlled with multiple treatments of mesotrione, topramezone, fenoxaprop, or fluazifop each mixed with triclopyr and applied at 3-week intervals. Dallisgrass may be selectively controlled in warm-season turf with arsenical herbicides in golf or sod turf or with various sulfonylurea products applied repeatedly in the fall. Dallisgrass and other Paspalum sp. may be suppressed in cool-season golf or sod turf, with pinoxaden, or with various turf with topramezone or mesotrione.

Table 7.12 - Annual Grass Control[1]
In Bluegrass, Tall Fescue, Perennial Ryegrass, and Common Bermudagrass

Herbicide	Crabgrass	Goosegrass	Annual Bluegrass	Foxtail	Sandbur	Annual treatments[2]
Preemergent						
Benefin	S	I	I	S	I	2
Bensulide	S	R	S	S	—	1-2
Bensulide + Oxadiazon	S	S	S	S	I	2
DCPA	S	I	I	S	I	2
Dithiopyr	S	I	I	S	—	1
Ethofumesate	—	—	S	—	—	2-3
Oryzalin	S	I	S-I	S	S-I	2
Oxadiazon	S	S	I	S	I	1
Pendimethalin	S	I	I	S	I	2
Prodiamine	S	I	I	S	—	1
Pinoxaden	S-I	R	R	S	S-I	1
Siduron	S	R	R	S	—	2
Benefin + Oryzalin	S	S-I	S-I	S	S-I	1
Benefin + Trifluralin	S	I	S-I	S	S-I	2
Postemergent						
Dithiopyr	S	I	I-R	S	—	1
DSMA, MSMA	S	I-R	R	S	S-I	2-6
Dithiopyr + MSMA[3]	S	I	I-R	S	S-I	1
Dithiopyr + fenoxaprop	S	S-I	I-R	S	—	1
Fenoxaprop	S	I	I-R	S	—	2
Flazasulfuron[4]	I-R	I-R	S-I	I-R	I-R	2
Foramsulfuron[4]	I-R	S-I	S	I-R	I-R	2
Mesotrione	S	S-I	I-R	S	—	2-4
Metsulfuron	I-R	R	S-I	I-R	I-R	2
Quinclorac	S	I-R	R	S	—	1-2
Trifloxysulfuron[4]	I-R	I-R	S	I-R	I-R	2
Topramezone	S	S	R	S	—	1-3

[1]The relative effectiveness of commonly used herbicides for selected weeds is using S = weed susceptible; I = intermediate, good control at times with high rates, sometimes poor, may require more than one treatment; R = resistant weeds in most instances.
[2]Lower label rates may require additional applications.
[3]Not for use in residential or athletic turf.
[4]For use on warm-season grasses only.

Table 7.13 - Preemergent

Application	Weed Problems	Chemical Rate/ 1000 sq ft	Remarks
New seeding bluegrass, tall fescue, perennial ryegrass, creeping bentgrass	Annual grasses: barnyardgrass, crabgrass, foxtails	siduron (Tupersan 3.7oz of 50% WP) mesotrione (Tenacity 0.12 oz of 4FL)	Apply at time of seeding. Kills annual weedy grasses, but not annual bluegrass. For use on bluegrass, tall fescue, or perennial ryegrass. Do not use on bermudagrass. Apply at time of seeding. Kills annual weedy grasses including goosegrass and suppresses annual bluegrass. Also kills many broadleaves. For best results, repeat application at first mowing (usually 6 weeks after seeding). For use on bluegrass, tall fescue, and centipedegrass. Consult label regarding perennial ryegrass and fine fescue as some seeding restrictions may apply.
New seeding tall fescue, perennial ryegrass, bluegrass, bentgrass	Annual grasses: crabgrass, foxtails, barnyardgrass	quinclorac (Drive 0.28 oz of 75% DF)	Apply at time of seeding for fescue and ryegrass. Must use 7 days before or 28 days after bentgrass and bluegrass seeding. Controls annual grasses and some broadleaf weeds, but not goosegrass or annual bluegrass.
Preemergent bermudagrass (during establishment from sprigs)	Annual grasses: crabgrass, goosegrass, foxtails	oxadiazon (Ronstar G 3.4 lb of 2% gran or Ronstar 2.2 oz of 50WP)	Apply at the time of sprigging and do not disturb soil surface after application. Provides preemergence control of the annual grasses and allows good establishment of bermudagrass sprigs. For use by commercial and landscape personnel only. Ronstar is not for home lawns.
Preemergent bermudagrass, zoysiagrass (during establishment from seed)	Annual grasses: crabgrass, foxtails, barnyardgrass	quinclorac (Drive 0.19 oz of 75% DF)	Apply at time of seeding. Controls annual grasses and some broadleaf weeds, but not goosegrass or annual bluegrass.
Established turf bluegrass, tall fescue, perennial ryegrass, bermudagrass	Annual grasses: barnyardgrass, crabgrass, foxtails	benefin (Balan 3.0 lb of 2.5% gran or 1.8 oz of 60DF)	Apply uniformly in late winter or early spring before crabgrass emergence. May be reapplied after 2 months for continued crabgrass control. Reseeding should not be attempted for 6 weeks after application.
		bensulide (Betasan 7.5- 9.4 oz of 4EC or 1.9- 2.3 lb of 12.5% gran or 3.3 lb of 7% gran)	Same. Do not reseed within 4 months of application. If for some reason turfgrass must be reseeded, charcoal will inactivate this herbicide. Application may be repeated after 3 to 4 months for continued crabgrass control.
		DCPA (Dacthal 1/3 lb of 75% WP or 5.0 lb of 5% gran or 5.1 oz of 6FL)	Apply in the early spring before crabgrass emergence. Flowering of forsythia can be used as a guide for proper timing of application. In areas where late-germinating crabgrass is experienced, a second application of half the regular rate is necessary after 8 weeks. In addition to crabgrass control, the DCPA treatments will provide some preemergence control of sandbur and postemergence control of corn speedwell.
		dithiopyr (Dimension 1.5 oz of 1EC)	Apply prior to or at crabgrass emergence. On fall seeded turfgrasses, delay application to early Postemergence for improved tolerance.
		oxadiazon (Ronstar 3.4 lbs of 2% gran or Ronstar 2.2 oz of 50WP)	Apply in the early spring before crabgrass emergence. Oxadiazon is used on bluegrass, bermudagrass, tall fescue, and perennial ryegrass. Ronstar is not for use on home lawns.
		pendimethalin (Pendulum 2G 1.75 to 2.25 lbs or Pendulum Aqua cap 1.6 oz of 3.8 ME)	Apply in the early spring before crabgrass emergence. Professional applicators may also use PreM 60WDG. Must be reapplied after 6-8 weeks for continued crabgrass control.
		prodiamine (Barricade 0.40 oz of 65WG)	Apply in spring before crabgrass germination. Irrigation or rain is desirable within a week to 10 days after application. Wait 6 mo to overseed by broadcasting over the surface. This waiting period may be reduced to 4 mo by drilling seed directly into the soil.
		benefin + trifluralin (Team 2G 3.5 lb of 1.3 + 0.7 gran)	Apply in spring before crabgrass germination and repeat application to maintain late season control.
		bensulide + oxadiazon (Goosegrass/Crabgrass Control 2.6 lb of 5.25 + 1.31 gran)	Apply in spring before crabgrass germination.

Table 7.13 - Preemergent (continued)

Application	Weed Problems	Chemical Rate/ 1000 sq ft	Remarks
Established turf bluegrass, tall fescue, perennial ryegrass, bermudagrass	Goosegrass	oxadiazon (Ronstar 3.4 lb of 2% gran or Ronstar 2.2 oz of 50WP)	Apply uniformly in early spring before goosegrass germination. This treatment will also give crabgrass control. Oxadiazon provides a high level of goosegrass control from early spring application. Ronstar is not for use on home lawns.
		pendimethalin (Pendulum Aqua cap 1.1 oz of 3.8 ME)	Apply in early spring and repeat after 6 weeks to improve late season goosegrass and crabgrass control.
		prodiamine (Barricade 0.40 oz of 65WG)	Apply in spring before goosegrass germination. Irrigation or rain is desirable within a week to 10 days after application. Wait 6 mo to overseed by broadcasting over the surface. This waiting period may be reduced to 4 mo by drilling seed directly into the soil. Repeat application according to label directions for goosegrass control.
		oxadiazon + bensulide (Goosegrass/Crabgrass Control 2.6 lb of 1.31 + 5.25 gran)	Apply in early spring before goosegrass germination. This treatment also controls crabgrass when applied as a preemergence. This product may be allowed on golf greens for goosegrass control; however injury must be acceptable.
Established bermudagrass	Goosegrass, crabgrass	benefin + oryzalin (XL Herbicide 3.0 lb of 1% + 1% gran and repeat after 8 weeks)	Apply in spring before annual grass germination. Reseeding turfgrass areas should be delayed at least 6 weeks after application.
		oxadiazon (Ronstar 1.8 to 2.2 oz of 50WP or 3.4 lb of 2% gran)	Apply in early spring to dormant bermudagrass and irrigate to wash into soil surface. It is suggested for fairways, parks, golf courses and lawns. Ronstar is not for use on home lawns, putting greens or tees.
Established turf, bluegrass, tall fescue, bermudagrass, perennial ryegrass	Annual bluegrass	bensulide (Betasan 0.6 pt of 4EC or 2.25 lb of 12.5% gran or 4.1 lb of 7% gran)	Apply in late August before annual bluegrass germination. Do not overseed or reseed for 4 or more months. Application of activated charcoal will inactivate bensulide and allow reseeding of desirable grass. Spring treatments for crabgrass control do not provide sufficient residual activity for any appreciable annual bluegrass control in the Fall.
		bensulide (Betasan 9.6 fl oz of 4EC) dithiopyr (Dimension 1.84 fl oz of 1EC) prodiamine (Barricade 0.5-1.0 fl oz of 4EC)	Apply in late August before annual bluegrass germination. Do not overseed or reseed for 4 months or as specified on label. Application of activated charcoal will inactivate herbicide and allow for reseeding of desirable grasses.
		ethofumesate (Prograss 1.5-2.0 oz of 1.5EC and repeat after 30 to 60 days)	Preemergence and early postemergence annual bluegrass control is obtained with this treatment. Apply to dormant bermudagrass and bluegrass in the fall and repeat the treatment at 30 to 60 days. First application may be made at 15 to 30 days after overseeding bermudagrass with perennial ryegrass. Do not apply after January 1 on bluegrass and bermudagrass turf. Initial treatments before bermudagrass goes dormant or treatments made after February 1 are likely to cause bermudagrass injury. These treatments may be made for annual bluegrass control during establishment and on established perennial ryegrass. With perennial ryegrass, application can be made in spring if annual bluegrass is emerging.
Established bermudagrass	Annual bluegrass	simazine (Princep DF 0.4 oz of 90DF or 0.75 oz of 4L)	Apply before annual bluegrass germinates. Do not overseed or seed for 4 months before or 6 months after treatment. May be used only in coastal plain area of Virginia. For control of a few broadleaf weeds, read label. Hybrid bermudagrasses are slightly more sensitive to simazine.

Table 7.14 - Postemergent

Application	Weed Problems	Chemical Rate/ 1000 sq ft	Remarks
Established turf, bluegrass, bermudagrass, tall fescue, perennial ryegrass	Annual grasses: crabgrass, foxtails, goosegrass	DSMA (Many formulations available. Must follow directions on label of container.) OR MSMA	Various formulations are available. Start in June when annual grass is in the 1 to 3 leaf stage and less than 1 inch tall. At least 3 applications at 7-day intervals are necessary for goosegrass control. Timing of application is critical. Apply when soil moisture is adequate for rapid growth of crabgrass and turf. Some discoloration of turfgrass is to be expected. Follow label instructions for use of individual formulations. Use lower rate when mid-day temperatures are 80°F or higher. Not for use in lawns or athletic fields.
Established turf, bluegrass, tall fescue, perennial ryegrass, fine fescue	Annual grasses: crabgrass, foxtail, goosegrass	fenoxaprop (Acclaim 1EC at 0.345 to 0.73 oz)	Turfgrasses should be more than one year old. The low rate is used early in year (about June 15) when crabgrass is in seedling stage (not tillered). As tillering becomes evident (1 to 3/ plant), the high rate is used for adequate control. The turfgrasses also become more tolerant in July as growth pattern begins to slow. Tank mixing with broadleaf herbicides tends to reduce effectiveness on crabgrass.
		dithiopyr (Dimension at 1.5 oz of 1EC)	Apply at emergence and up until tillering of crabgrass. Excellent control of crabgrass but only suppression of goosegrass is expected.
		mesotrione (0.09-0.18 oz of 4SC)	Apply at emergence through tillering. Tillering plants require two applications at 3-week intervals. Plants exceeding 10 tillers often require 3 applications at 3-week intervals, especially if the lower rate must be used. Also controls goosegrass, nimblewill, creeping bentgrass, foxtail, barnyardgrass, and several other grass and broadleaf species. Suppresses bermudagrass. Do not use more than 0.5 lb ai/A in a single season.
		quinclorac (Drive 0.37 oz of 75DF)	Apply at emergence through tillering. Two applications may be needed on tillering crabgrass but do not exceed 2 lb ai/A during a season. Also controls several broadleaf weeds, especially clover. Does not control goosegrass. Read and follow label instructions. Avoid drift to desirable ornamental plants.
		topramezone (Pylex 0.023 oz of 2.8SC)	Apply at emergence through tillering. Two applications may be needed on mature crabgrass of over 10 tillers or when lower rates are used. Add methylated seed oil adjuvant at 0.5% by volume. Controls goosegrass at any growth stage. Also controls foxtails and some other grasses and broadleaf weeds but does not control sedges.
		fenoxaprop or DSMA, MSMA + Preemergence	Use label rates of pendimethalin, dithiopyr, bensulide, DCPA, or siduron.
Established bermudagrass only	Goosegrass	metribuzin (0.125-0.25 oz of Sencor 75TH)	Metribuzin should be tank-mixed with DSMA or MSMA where labels do not prohibit this treatment, at the user's discretion. Apply to actively growing bermudagrass and goosegrass in 40 gallons of water/A (1 gal/1000 sq ft). Repeat in 2 to 3 weeks - 2 applications maximum/year. Do not use on golf greens. Expect some discoloration of the bermudagrass. Do not use on bluegrass, fescues, or perennial ryegrasses.
Established bermudagrass, zoysiagrass	Goosegrass	foramsulfuron (Revolver 0.6 fl oz of 0.19 EC)	Apply 2 to 3 times. May mix or apply in sequence with MSMA or metribuzin.
Established dormant bermudagrass	Annual bluegrass, other winter annual weeds	glyphosate (Roundup 0.28 oz of 4.0 lb/gal LC); add 0.5% nonionic surfactant	Apply with 1/2 gal of water/1000 sq ft to actively growing annual bluegrass and other winter annual weeds in late winter on dormant bermudagrass (must be applied before any bermudagrass greenup.)
Established bermudagrass, zoysiagrass only	Annual bluegrass, roughstalk bluegrass, perennial ryegrass	foramsulfuron (Revolver 0.4 fl oz of 0.19EC) trifloxysulfuron (Monument 0.007-0.011 oz of 75WG) rimsulfuron (Tranxit 0.046 oz of 25DF)	Apply any time after 50 percent bermudagrass greenup or during dormancy, but not within 1 month of greenup. Products may move in watershed or track onto surrounding cool-season grasses. Do not apply to saturated soils and irrigate 4 to 12 hours after treatment with 0.1 inch water.

Table 7.14 - Postemergent (continued)

Application	Weed Problems	Chemical Rate/ 1000 sq ft	Remarks
Established turf	Dallisgrass (Paspalum dilatatum)	MSMA (Follow directions on container label) Pinoxaden (Manuscript 19.2 oz of 0.42 EC)	Apply June through September when mid-day temperatures do not exceed 90°F. June to early July is best timing and has a better enviromental condition for control. Two or three applications at 7- to 10-day intervals will be required for control. Not for use in lawns or athletic fields. Apply in fall when Paspalum weeds are actively growing. For spot treatments, apply 9.6 fl oz per 10,000 sq ft. Do not apply more than 19.2 fl oz/A per year.
Established turf bluegrass, tall fescue, perennial ryegrass, bermudagrass	Yellow and purple nutsedge as well as other sedges.	halosulfuron (Sedgehammer 0.023 oz of 75WDG) sulfentrazone (Dismiss 0.35 oz of 4L)	Apply when actively growing. Avoid applications when turf and nutsedge are under stress. A nonionic surfactant should be added at a rate of 0.25-0.50% V/V. Halosulfuron is not labeled for use on golf greens. Apply when sedges are actively growing. Ensure uniform coverage. Works quickly compared to other sedge herbicides. Weeds begin to brown within 3 days. Excessive rates or certain tank mixtures, especially fertilizers, may lead to temporary turf discoloration.
	Yellow nutsedge	bentazon (Basagran T/O 1.0 oz of a 4 lb/gal LC) MSMA (MSMA6 1.0 oz of 6 lb/gal LC)	Apply when actively growing. At least 2 applications at 10-day intervals will be required for control. A third application may be made if needed (no more than three/year). A crop oil should be added at 0.25% V/V. Not effective for purple nutsedge control. Bentazon is not labeled for use on golf greens. Perennial ryegrass has shown considerable injury in some cases.
Established turf bermudagrass	Purple nutsedge, wild onion, wild garlic	imazaquin (Image 0.5-1.0 oz of 1.5 lb/gal)	Apply when actively growing. Imazaquin may be tank-mixed with MSMA for control of yellow nutsedge. A nonionic surfactant should be added at 0.25% V/V.
Renovation of established turf	Tall fescue, quackgrass, bermudagrass, orchardgrass, nimblewill	glyphosate (Roundup 2.5 oz 4.0 lb/gal LC)	Allow 2 to 4 weeks without mowing before chemical treatment. See label for desirable plant size to treat. Allow 7 days before clipping the dead sod and vertical mowing to 1/4 inch deep into soil. Seed the desired turfgrass and irrigate as needed. Early fall applications coincide with seeding dates, but application can also be made at other times when undesirable grass is actively growing.
Established turf bluegrass, tall fescue, perennial ryegrass	Bermudagrass, quackgrass, orchardgrass, nimblewill	mesotrione (Tenacity 0.12 to 0.18 oz of 4SC)	Mix with triclopyr (Turflon Ester 0.5-0.75 oz of 4EC) for best results. Apply twice in spring after weeds are green and twice in early fall before frost. Repeat treatments at a 3-week interval. Do not apply triclopyr to bluegrass during mid summer. Mesotrione treatments may continue during midsummer at 3-week intervals if weeds persist. Rates may be lowered as the number of treatments is increased. Frequent applications at low rates control weeds far better than few applications at high rates.
		topramezone (Pylex 0.023 oz of 2.8SC)	Mix with triclopyr (Turflon Ester 0.5-0.75 oz of 4EC) for best results. Also, include 0.5% methylated seed oil adjuvant. Apply three times in fall at 3-week intervals not to exceed 4 fl oz Pylex per acre per year.

■ Moss Control

Moss gradually invades lawns in areas where the turfgrasses are growing poorly. The infested site may be described as wet, shady, highly acidic, and under low fertility. A program to control moss involves correcting the turfgrass growing conditions as much as possible. Remove as much moss as possible by raking, vertical mowing and aerifying to prepare a seed bed to reseed thin turfgrass areas. Select a species/cultivar adapted to the area conditions. Maintain optimum growing conditions for the turfgrass as fertility, pH, moisture (not excessive) and mowing height/frequency. The turfgrass density is very important to prevent further moss encroachment. Sometimes a shade tree may be removed to allow enough light for good turfgrass growth.

Chemical formulations for moss control usually contain iron, copper, or potassium salts of fatty acids as active ingrediants. Ferrous sulfates and chelated iron products applied as liquid sprays are generally rapid and effective on moss. Dry formulations of ferrous sulfate monohydrate are available such as Moss Control Granules for Lawns containing 5% iron (follow label directions). Carfentrazone (Quicksilver T&O) is an herbicide for broadleaf control that can be used in lawns or putting greens for moss control. Apply 6.7 ounces Quicksilver T&O per acre or 0.15 ounce per 1,000 square feet twice at 3-week intervals. Moss discoloration is a sign of successful treatment and takes longer under cool conditions. Moss control is temporary and treatment may be required annually. Managers should improve conditions for turfgrass growth while minimizing the favorable environment for the moss. Read and follow label directions carefully.

■ Broadleaf Weeds

The herbicide response table that follows compares the susceptibility of common lawn weeds to weed killers. Annual weeds live only one year and should be treated in the seedling stage. Winter annuals germinate in the fall and should be controlled at that time. Spring germinating annuals, likewise, need to be treated in the spring. Biennial plants live 2 years and perennials live for 3 years or more. In

general, broadleaf weeds respond best to weed killers when they are most actively growing and in the seedling stage. This is usually in the spring or fall. When equally effective, we prefer the fall application because of less likelihood of damage to ornamental and garden plants. Application of high rates of weed killer during hot dry conditions may brown desirable grasses. Effectiveness of postemergence broadleaf herbicides is better when rainfall or irrigation does not occur for 24 hours after application.

Most lawns that need treatment contain a variety of weeds which can best be controlled by a combination of ingredients. Many formulations are sold that contain more than one ingredient. It is necessary that label direction on the container be followed to get the proper application rate. When combinations are used, the results are additive and the individual rates are reduced, slightly. A combination of 2,4-D and dicamba (1.0 lb + 0.25 lb) or 2,4-D and mecoprop (1.0 lb + 1.0 lb) is very effective on a wide range of broadleaf weeds. We would consider this to be the best treatment for an average lawn with a variety of weeds. Knotweed, dock, and red sorrel are susceptible to dicamba. Dicamba is soil-mobile and should not be used in the root area of shallow-rooted trees or shrubs. The specific herbicide(s) should be selected according to the kinds of weeds present in the turf and the appropriate herbicides may be tank-mixed or purchased as a pre-mixed formulation.

Combinations of 2,4-D + mecoprop + dicamba and other three-way mixtures are on the market. Follow label directions on the containers for proper application rates and directions. The low rate of dicamba in these three-way mixtures reduces the possibility of dicamba injury.

Triclopyr may be purchased as a formulation mixture with 2,4-D (Turflon D, Chaser) or clopyralid (Confront) or may be used as a tank-mixture with these herbicides. Some formulation mixtures are suggested for use by professional personnel in charge of weed control applications. Read the label for rates to use for specific weeds and turfgrass tolerances. Triclopyr should not be used on bermudagrass unless some injury can be tolerated and then lower label rates are suggested.

Newly seeded turf areas should not be treated with broadleaf weed killers until enough growth has occurred to allow two mowings. The broadleaf weed killers recommended for lawns are not particularly toxic to humans, pets, birds, or wildlife. They would create a problem only if ingested in large quantities. They are biodegraded by soil micro-organisms and their persistence in the soil would range from 2 to 4 weeks for 2,4-D, and possibly 6 months for dicamba.

The chemicals noted can be used safely at recommended rates on bluegrass, fescue, or common bermudagrass. The bentgrasses are susceptible to injury from 2,4-D; however, there are formulations containing low rates of 2,4-D in combination with other materials that may be safely used. Avoid application on bentgrasses when temperatures exceed 85°F.

The availability of many formulations of the various broadleaf herbicides which vary in amount of active ingredient makes it difficult to establish a general rate to apply to 1000 sq ft or to add to 1 gal of water. Directions on the container label should be used as a guide to determine the proper amount of formulation to use. With a 4.0 lbs/gal formulation, 1.0 qt contains 1.0 lb of active ingredient and a rate given in lb/A is equal to qt/A. To convert to small areas, 1.0 qt/A = 1-1/2 tbsp/1000 sq ft.

Table 7.15 - Conversion for Small Area Application

	Formulation available					
Rate Desired	**1 lb/gal.**	**2 lb/gal.**	**4 lb/gal.**	**1 lb/gal.**	**2 lb/gal.**	**4 lb/gal.**
	Quarts/Acre[1]			**Tablespoons/1000 sp ft**		
1/3 lb/A	1-1/2	3/4	3/8	2-1/4	1-1/8	9/16
1/2 lb/A	2	1	1/2	3	1-1/2	3/4
1 lb/A	4	2	1[1]	6	3	1-1/2[1]
1-1/2 lb/A	6	3	1-1/2	9	4-1/2	2-1/4
2 lb/A	8	4	2	12	6	3

[1]One quart/A is equal to 1-1/2 tablespoons/1000 sq ft.
Two tablespoons are equal to 1.0 fluid ounce or 29.6 cc.

Table 7.16 - Preemergent Broadleaf Weed Control

Application	Weed Problem	Chemical	Remarks
Preemergent (Established turf)	Annual broadleaf weeds	DCPA (Dacthal 1/3 lb of 75% WP or 5.1 oz of 6FL or 5.0 lb of 5% gran)	DCPA will provide some preemergent control of prostrate and spotted spurge, common chickweed, carpetweed, purslane, and sandbur. Creeping speedwell may be controlled with high rates as a postemergence application in May or June.
		isoxaben (Gallery 3/8-1/2 oz of 75DF)	Apply uniformly in early spring prior to germination of target weeds such as: white clover, spotted spurge, yellow woodsorrel, or prostrate knotweed. Fall germinating weeds may require applications in late summer (common chickweed, henbit, dandelion, corn speedwell, shepherdspurse, broadleaf and buckhorn plantains). Is safe in and around various trees, shrubs, and groundcovers in May or June.

Table 7.17 - Broadleaf Weed Control in Bluegrass, Tall Fescue, Perennial Ryegrass, and Common Bermudagrass
The relative effectiveness of commonly used herbicides for selected weeds is listed in this table. See (1) for key.

Weeds which are intermediate in response should be given repeat treatment rather than increasing the rate of a single application. It may sometimes be desirable to treat at times other than those listed. When this is necessary, make sure that good growing conditions prevail and contact with desirable plants is prevented. Combination products may be more effective than individual chemicals on a particular weed. The herbicides listed may be purchased as a pre-mixed formulation or separately and tank-mixed as labels allow. **Use caution when applying triclopyr or clopyralid to bermudagrass-see label restrictions.**

Weed	Response to Herbicides (lb/A)1									Preferred Time to Treat
	Classification	2, 4-D 1.5-2.0	Dicamba 0.33-0.5	2,4-D + Mecoprop 1+1	2, 4-D + Mecoprop + Dicamba	2, 4-D + Dicamba 1.0+0.33	2, 4-D + Dichlorprop + Mecoprop	2, 4-D+ Triclopyr 1.0+0.5	Triclopyr + Clopyralid 0.56+0.19	
Bedstraw	A	I-R	S	I	I-R	S	—	—	—	April & May
Bindweed	P	S	S	S-I	S	S	S	S	—	May & June
Bittercress	WA or B	S	S	S	S	S	S	S	—	Oct & Nov
Blackmedic	A, B, & P	R	S	I	S	S	S	S	S	April & May
Buttercup	WA, B, & P	S-I	I	S	S	S	S	I	S	Oct & Nov
Buttonweed, Virginia	P	R	R	R	I-R	I	I	I	I	May & repeat
Carpetweed	SA	S	S	S	S	S	S	S	—	May & June
Catsear, Dandelion	P	S-I	S	S	S	S	S	S	S	Oct & Nov
Chickweed, Common	WA	R	S	S	S	S	S	S	S	Oct & Nov
Mouseear	P	I-R	S	S-I	S	S	S	S	S-I	Oct & Nov
Chicory	P	S	S	S	S	S	S	S	—	Oct & Nov
Cinquefoil, Common	A	S	S	S	S	S	S	S	—	May & June
Clover, Crimson	SA	S	S	S	S	S	S	S	S	May & June
Hop	SA	I	S	S	S	S	S	S	S	April & May
White	P	I	S	S	S	S	S	S	S	Oct & Nov
Daisy, Oxeye	P	I	I	I	I	I	I	I	—	Oct & Nov or May
Dandelion	P	S	S	S	S	S	S	S	S-I	Oct & Nov
Dock	P	I	S	I	I	S	I	I	I	Feb - April
Dogfennel	P	R	S	I-R	I-R	S	I	I	S-I	Oct & Nov or April
Garlic, Wild	P	I	I	I	I	S-I	I	—	—	Oct - Nov. & Feb - March
Geranium, Carolina	WA	S	S	S	S	S	S	S	—	April - May
Ground Ivy	P	I-R	S-I	I	I	S-I	I	S- I	S-I	April - May
Hawkweed	P	S-I	S-I	S-I	S-I	S	S-I	S-I	I	Aug & Sept
Healall	P	S	S-I	S-I	S-I	S	S	—	—	Oct & Nov
Henbit	WA	I	S	I	S-I	S	S	S	S	Oct & Nov
Honeysuckle	P	S-I	S	S-I	S	S	S	S	—	May & June
Horsenettle	P	I-R	I	I-R	I-R	I	I	I	—	May & June
Horseweed	WA, SA	I	S	S-I	S-I	S	—	—	S	Oct or May
Knapweed, Spotted	B	I	S	I	I	S	I	S	—	Oct & Nov
Knawel (German Moss)	WA	R	S	I	I	S	S	S-I	—	Oct & Nov
Knotweed	SA	R	S	I	I	S	I	—	—	March - April
Lambsquarters	SA	S	S	S	S	S	S	S	S	April & May
Lespedeza	SA	I-R	S	S-I	S	S	S	S	I	April & May
Mallow, Common	SA	I-R	S-I	I	I	S-I	S-I	—	S-I	April & May

Table 7.17 - Broadleaf Weed Control in Bluegrass, Tall Fescue, Perennial Ryegrass, and Common Bermudagrass (continued)
The relative effectiveness of commonly used herbicides for selected weeds is listed in this table. See (1) for key.

Weeds which are intermediate in response should be given repeat treatment rather than increasing the rate of a single application. It may sometimes be desirable to treat at times other than those listed. When this is necessary, make sure that good growing conditions prevail and contact with desirable plants is prevented. Combination products may be more effective than individual chemicals on a particular weed. The herbicides listed may be purchased as a pre-mixed formulation or separately and tank-mixed as labels allow. **Use caution when applying triclopyr or clopyralid to bermudagrass-see label restrictions.**

Weed	Response to Herbicides (lb/A)1									Preferred Time to Treat
	Classification	2, 4-D 1.5-2.0	Dicamba 0.33-0.5	2,4-D + Mecoprop 1+1	2, 4-D + Mecoprop + Dicamba	2, 4-D + Dicamba 1.0+0.33	2, 4-D + Dichlorprop + Mecoprop	2, 4-D+ Triclopyr 1.0+0.5	Triclopyr + Clopyralid 0.56+0.19	
Mugwort	P	I-R	S-I	I-R	I-R	S-I	I	—	—	March
Mustards	WA & B	S	S	I	S-I	S	S	—	—	Oct & Nov
Onion, Wild	P	I	I	I	I	S-I	I	—	—	Oct - Nov & Feb - March
Ornamental Plants	P	S-I	S	S-I	S-I	S	S	S	—	Most likely to injure April to June
Oxalis	A,P	I-R	R	I-R	I-R	I	S	I	I -R	April - May
Pennycress	A	S	S	S	S	S	—	—	—	Oct & Nov
Pepperweed	WA or B	S	S	S	S	S	S	—	S- I	Oct & Nov
Pigweed	SA	S	S	S	S	S	S	S	—	April & May
Plantains	P	S	I-R	S	S	S	S	S	S- I	Oct & Nov
Poison Ivy	P	I	S-I	I	I	S-I	I	S-I	I	June
Pony Foot	P	S	S-I	S-I	S-I	S	—	—	—	Oct & Nov
Poorjoe (Diodia)	A	S-I	—	S-I	S-I	S	—	—	—	May & June
Prostrate Spurge	SA	I	S	I	S-I	S	S-I	S-I	I	April - May
Purslane	SA	I	S	I	I	S	I	S-I	—	May & June
Red Sorrel Shepherds'	P	R	S	I	I	S	I	S-I	S-I	Oct & Nov
Purse	WA	S	S	S	S	S	S	S	S- I	Oct & Nov
Smartweed	SA	I-R	S	I-R	I	S	I	I	I	April & May
Sowthistle	WA	S	S	S	S	S	S	S	—	Oct & Nov
Speedwell, Corn	SA or WA	R	R	R	R	I-R	I	I	I	April
Spotted Spurge	SA	I-R	S-I	S-I	S-I	S-I	S-I	S-I	I	May & June
Star-of-bethlehem	P	R	I-R	R	R	I-R	R	—	—	April
Teasel (Common)	B	S	S	S	S	S	S	S	-	April & May
Thistle, Bull	B	S-I	S	S-I	S-I	S	S-I	S-I	—	Oct & Nov
Canada	P	I	I	I-R	I	I	I	I	S-I	Oct & Nov
Curl	B or P	S	S	S	S	S	S	S	—	April
Musk	B	S	S	S	S	S	S	S	I	April
Vegetables	A	S	S	S	S	S	S	S	S	Most likely to injure April to June
Violet	P	I-R	I	I-R	I-R	I	I	I	I	April
Wild Carrot	B	S	S	S	S	S	S	S	I	Oct & Nov
Wild Strawberry	P	R	S-I	R	I-R	S-I	I	I	—	Oct & Nov
Yarrow	P	I	S	I	I	S	I	I	—	Oct & Nov
Yellow Rocket	B or P	S-I	S-I	S-I	S-I	S	S	S	—	Oct & Nov
Yellow Woodsorrel	A	R	R	I-R	I	I	S	I	1-R	April & May

[1]S = weed susceptible; I = intermediate, good control at times with high rates, sometimes poor, may require more than one treatment; R = resistant weeds in most instances; A = annual; SA = summer annual; WA = winter annual; B = biennial; and P = perennial.

Table 7.18 - Golf Course Putting Greens (Bentgrass or Bermudagrass)		
Weed Problem	**Chemical Rate/1000 sq ft**	**Remarks**
Preemergent control of annual grasses	bensulide 7.0-9.4 oz (4.0 lb/gal formulation) or (6.0-8.0 lb of 3.6% gran) or (1.9-2.4 lb of 12.5% gran or 2.4-4.1 lb of 7% gran)	Apply uniformly in the late winter or early spring before crabgrass emergence. August or September application is used for annual bluegrass control. The higher rate is needed for annual bluegrass. For crabgrass, the lower rate is effective and may be repeated after 4 months for better continuous crabgrass control. Goosegrass control is generally poor with bensulide.
	bensulide + oxadiazon (Goosegrass/Crabgrass Control® 2.6 lb of a 5.25% + 1.31% gran)	For use on bermudagrass and bentgrass putting greens, apply with a properly calibrated drop spreader. Use only where goosegrass is heavy on the green during a prior year and the herbicidal side effects are tolerable. Irrigate the green immediately after application. Do not treat greens with less than desirable turf cover and root system.
Postemergent control of annual grasses	DSMA (Follow directions on container label).	Follow label directions. Discoloration of grass should be expected. Use only when mid-day temperatures are below 90°F. Goosegrass control will require 2 to 3 applications at 4- to 7-day intervals and is seldom 100% effective. Goosegrass will also require the higher rates. Other label formulations may be equally effective. Follow label directions for rates.
Postemergent control of broadleaf weeds	dicamba 1.0-2.0 tsp (4.0 lb/gal formulation)	Margin to tolerance is narrow. Excessive rates will kill grass. A teaspoon is 1/6 fluid ounce. Do not try to spot-treat on green or excessive rates will occur. Start spraying on apron and move across the green. Best to put on 1/2 rate in one direction and retreat with remaining 1/2 at right angles.
	mecoprop (MCPP) 1.5-2.0 oz of 2.0 lb/gal formulation	Seaside, Arlington, and Congressional bents may be injured.
	2,4-D + MCPP + dicamba 1.0 oz of Trex-San Bent OR 1.0 oz of Trimec Broadleaf Herbicide (Bent Formula)	A commercial mixture with a reduced rate of 2, 4-D which gives a good spectrum of weed control and increased margin of safety over dicamba alone. Do not over-apply. Slight yellowing may occur temporarily. Do not irrigate within 24 hours after application.
Postemergent control of moss	carfentrazone (QuickSilver 0.15 oz of 1.9EC)	Apply at 2-week intervals for at least 3 treatments. Moss will return unless suitable changes in greens management such as increased mowing heights, proper fertility, etc. are met.

■ Golf Course Fairways

Fairway weed control can be accomplished with the same weed killers listed in the first part of the turf section. The same rates and remarks will apply. See Growth Regulation section in this publication for suppression of annual bluegrass in fairway bluegrasses and perennial ryegrasses.

■ Golf Course Sand Traps

Weeds in sand traps present considerable problems in golf course management. EPTC (Eptam 5G) is used in sand traps. All weed growth must be removed before application. Eptam must be raked into the sand to a 2- to 3-inch depth immediately after application. It will not injure greens when blasted or tracked on the turf by players. Follow directions on the container label for correct rate and method of application.

■ Nonselective Control of Perennial Grasses

(Bermudagrass, Fescue, Nimblewill, Orchardgrass, Quackgrass)

Undesirable patches or clumps of perennial grasses can be treated with glyphosate (Roundup, Kleenup). Lightly wet the foliage of the undesirable grass in the spring or summer when it is actively growing. Follow label directions for rates of application and proper timing. Glyphosate has no soil residual and reseeding can occur as soon as the foliage has turned brown (7-10 days).

■ Weed Control in Driveways, Fence Lines, and Parking Areas

There are many good soil sterilants on the market that will give long-term control of weeds. These are discussed in the non-selective section of this guide. These materials are very powerful weed killers and not designed for homegrounds situations. Many trees and shrubs have been killed when application of soil sterilants was made within their root feeding areas. See glyphosate for nonselective weed control above.

Table 7.19 - Woody Plant Control Around Homes, Cabins, Buildings, Fence Lines, Trails, and Vacant Lots		
Problem and Application Technique	**Chemical and Application Rate**	**Remarks**
Foliage Spray		
Honeysuckle	2, 4-D amine 1.5 oz of 3.8 lb/ gal/1.0 gal water	Wet thoroughly all foliage and stems to runoff. Apply during active growth periods after full leaf stage in spring. Turfgrasses will survive some drippage.
Honeysuckle, blackberry, poison ivy, Virginia creeper, wild rose, willow, many other shrubs and trees.	triclopyr (Brush-B-Gon 5.7%, mix 4.0 oz with 1.0 gal water)	Same as above.
Blackberry, poison ivy, Virginia creeper, and other woody plants. Also bermudagrass, quackgrass, nimblewill, other grasses.	glyphosate (Roundup 41%, mix 1.0-6.0 oz with 1.0 gal water)	Several formulations are available. Use according to label directions (Kleenup, Roundup, Blot-out, and others).

Turf: Growth Regulators

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Growth regulators are utilized to reduce the amount of mowing and trimming needed for maintaining turfgrass. The suggested growth regulator, applied before seedhead formation, will also inhibit the development of seedheads of cool-season turfgrasses for one season. Bermudagrass seedheads are inhibited for about 4 weeks.

Growth regulators are suggested for use on areas such as highways and other rights-of-way, industrial parks, schools, cemeteries, airports, and golf course roughs. They are particularly useful along fence lines, sloping areas, guard rails, and other areas difficult to mow and trim. A few growth regulators are available for well-maintained and extensively managed turfgrasses. These growth regulators are used for turfgrass growth suppression and/or annual bluegrass suppression.

Spring growth regulator application should be delayed until turfgrass reaches a desirable density. In many cases where mowing can be utilized, the regulator may be best applied after the first time the grass is clipped. This clipping will achieve a more neatly trimmed appearance for a longer period. Caution: the turfgrass stand does not become more dense after treatment; therefore, the turfgrass may remain at the density you see at the time of treatment. If thatch is showing through when the regulator is applied, it may continue to show for 6 to 8 weeks. Generally, after the period of turfgrass growth suppression, the foliage may even take on a darker green appearance.

The turfgrass should have a good appearance and be actively growing at the time of treatment with growth regulator. Any debris or clippings should be removed. For seedhead control, apply at least 2 weeks prior to seedhead emergence. Apply when rain is not expected for 24 hours.

Table 7.20 - Use of Growth Regulators

Application	Turfgrass Shoot Regulation	Chemical Rate/1000 sq ft	Remarks
Established rough turf (Highway rights-of-way, airports, cemetaries, parks and other cool season rough turfgrasses)	Tall Fescue and Bluegrass	imazethapyr + imazapyr (Event at 0.18 to 0.22 oz) OR imazethapyr + imazapyr (Event at 0.09 oz)	The introductory comments above provide useful information on where and when to apply PGRs. They are best utilized on medium- to low-managed turf but where frequent mowing has been necessary. Not used on residential turf around homes and apartments. The PGRs are most useful during the spring to reduce growth for 6 to 8 weeks. This period usually accounts for 60% of the year's total growth of fescue.
Established rough turf (Warm season turfgrass)	Bermudagrass (Common)	flurprimidol (Cutless 50w rate varies with cultivar, see label)	Same as above. Time of application is usually later in spring after green-up and before peak period of vegetative growth.
Established well-maintained turf	Bluegrass and Perennial Ryegrass in fairways and well maintained turfgrass areas	flurprimidol (Cutless at 0.18 oz of 50 WP)	Apply in spring before major flush of growth but after greenup requiring mowing once or twice. This will also suppress annual bluegrass growth but allows seedhead development or flowering of the annual bluegrass.
Established well-maintained turf	Bluegrass and Perennial Ryegrass in fairways and well maintained turfgrass areas	trinexapac (Primo at 0.75 oz of 1 lb/gal)	Apply in spring after greenup requiring mowing but before major flush of turfgrass growth. Reduce rate by 50% or more if mowing height is less than 0.5 inches (see label). Sequential applications are suggested at monthly intervals. Apply after turfgrass has been mowed. Do not apply in hot, dry weather or when turfgrass is under stress. Application rate varies with turfgrass species. Read label for further specifics. Annual bluegrass will be suppressed to a much greater extent than perennial bluegrass. Overseed this area if needed. Trinexapac is also suggested for edging along sidewalks, curbs, driveways, flower beds, fences, and parking areas. Make application at monthly intervals during active growth periods. Follow label directions.
		paclobutrazol (Fertilizer with TGR poa annua control at 2.9 lb of 0.42% or TGR turf Enhancer at 0.33 oz of 50WP)	Apply in spring after greenup occurs and mowing is required. Annual bluegrass is suppressed. Do not apply where area contains as much as 70% annual bluegrass.

Pests of Forestry and Christmas Trees: Forest Insects

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Every tree species serves as host to numerous insects that feed on roots, stems, branches, leaves, and fruits. Most of these insect species are of limited consequence. Some species occasionally reach outbreak population levels that can cause damage and impact tree and forest health. There are also well known species that are considered primary pests and frequently cause significant impact on tree and forest health. Non-native invasive insects have also become part of Virginia's forests, and in some cases these pests are the worst, since there is often little host-tree resistance or natural enemies to help keep their populations in check. Pest populations tend to be cyclic, especially for native pests. A critical part of pest management is to survey and identify when pest populations are on the rise in an area. Knowing this helps with planning and decision-making.

The Red Imported Fire Ant (RIFA) has become established in many counties in south-central Virginia and impacts loggers who cut and move timber. For the management of Red Imported Fire Ants and for information on the quarantine, see section labled "Red Imported Fire Ant Management for Foresters and Loggers" at the end of the of part 8-1.

For native pests, sound forest management practices can be used to limit site conditions responsible for allowing the pest populations to build up. Such practices are a basis for effective integrated pest management. Proper site selection, stand density, stand and tree vigor, and proper sanitation are among the most important. Under poor management and inadequate protection practices, salvage operations may be the only recourse. Pesticide applications may be utilized for prevention of potential insect population buildup and suppression of outbreaks that threaten the vigor as well as survival of trees. However, use of pesticides is not recommended without knowledge of pest status. Use pesticides only if pests are present or are predicted to be present from a standard or systematic sample survey. They should be used in settings where compatible with management and of limited risk to the environment.

Technical assistance is available from the Virginia Department of Forestry and the U.S. Forest Service - Forest Health Protection, as well as the Virginia Cooperative Extension Service. State and federal forestry agencies may provide control services on a cost-sharing basis as well as survey and detection programs in cooperation with public and private forest land owners. Control programs for new, introduced, or as yet not established pests such as the spongy moth are conducted by the Bureau of Plant Protection and Pesticide Regulation of the Virginia Department of Agriculture and Consumer Services with the Cooperation of the Animal and Plant Health Inspection Service, the USDA, the US Forest Service, the Virginia Department of Forestry, and Virginia Cooperative Extension.

Table 8.1 - Insects and Insecticides
Special Note: Some of the following chemicals may be restricted to conifers only or tree nurseries only; read the label and use only as directed.

Insect Host	Recommended Control	Remarks
Adelgids Balsam woolly adelgid	Carbaryl Chlorpyrifos Dormant oil Esfenvalerate Imidacloprid Permethrin	Scout regularly for adelgid or trees losing apical dominance; remove infested trees if practical. Spray bark and foliage to runoff in June or when found May-October. If infested plants are few and scattered, rogue and burn, and spray trees in a 20 foot diameter circle around rogued trees. When removing infested trees, wrap trees in tarp so no adelgids fall off as the tree is removed. For additional information on this pest, refer to: http://bit.ly/1Rx5aMS
Adelgids Hemlock woolly adelgid (eastern and Carolina hemlock)	Dormant oil Imidacloprid Dinotefuran (Safari)	For soil applications of systemic pesticides, amount applied is based on diameter of trunk at breast height. Dinotefuran and imidacloprid soil applications, trunk injections, or basal spray should be applied in spring (March – April) or late fall (Oct. – Nov.). Do not use on trees with less than 50% foliage. For dormant oil use 1% rate during the spring months and 2% during the fall or winter. For foliar applications, spray foliage and twigs to run off in early spring. For additional information on this pest, refer to: http://bit.ly/1kHQosy
Aphids (various hardwoods)	Carbaryl Esfenvalerate Imidacloprid Malathion Permethrin	Thorough coverage of foliage for leaf-feeding aphids or twigs and branches for bark-feeding aphids. Treat when aphids are first seen. May occur throughout the season. Treat when high populations of aphids are seen. For additional information on this pest, refer to: http://bit.ly/1Xtt6EA
Aphids (various conifers)	Carbaryl Esfenvalerate Imidacloprid Malathion Permethrin	Aphids rarely harm forest trees; heavily infested seedlings can be sprayed. Thorough coverage of new shoots, twigs and branches. Treat when first seen. May occur throughout season.

Table 8.1 - Insects and Insecticides (continued)
Special Note: Some of the following chemicals may be restricted to conifers only or tree nurseries only; read the label and use only as directed.

Insect Host	Recommended Control	Remarks
Bark Beetles Ips engraver beetles, Southern pine beetle, Turpentine beetle (pines), Walnut Twig Beetle (black walnut)	Bifenthrin Permethrin Imidacloprid	Bark beetle impact can be prevented or reduced by growing trees at lower densities, thinning during rotation, and in general keeping the basal area at about 80 square feet. In forest stands, salvage timber with a buffer strip of uninfested trees at the active head(s) of the infestation as soon as possible. This is called "cut and remove." Turpentine beetle infestations can be treated without felling by spraying the lower boles of infested and adjacent uninfested trees. In these situations, repeated sprayings may be necessary due to short residual time on the bark. Walnut Twig Beetle: If the tree is already infested, limited control with bark sprays of permethrin can be obtained. If wishing to protect an uninfested tree, soil drenches of imidacloprid can be used but walnuts cannot be harvested, the following year walnuts are OK to eat. For additional information on this pest, refer to: http://bit.ly/1PPPCVY
Roundheaded Borers	Permethrin	This chemical is registered for preconstruction lumber and logs against wood destroying insects. For wood borers in standing trees, heavily infested trees should be salvaged for fuel wood or felled and bucked to encourage predation of borer larvae by ants; if left standing, such trees serve as breeding grounds for borers that will infest and degrade additional trees. Spraying is impractical. Do not move infested wood out of area. For additional information on this pest, refer to: http://bit.ly/1NvZUYV
Fall Cankerworms (many hardwoods but prefers oaks)	*Bacillus thuringiensis (BT)* Carbaryl Diflubenzuron Tebufenozide	Apply treatment when egg hatch is complete and larvae are young, usually in early to mid- May. For all but Bt, do not allow spray or run off to get into bodies of water or streams. See label for aerial application dosage rates. Sticky banding of the trunk in the fall for adult fall cankerworm can be used to prevent wingless females from climbing the trees and mating with males. They also can be used to monitor activity.
Defoliators Caterpillars, beetles, etc.	*Bacillus thuringiensis (BT)* Carbaryl Diflubenzuron Tebufenozide	There are many other insects that occasionally defoliate Virginia forests. The impact of defoliation depends primarily on host condition, time of year, and degree of foliage loss. Tree growth and vigor are reduced most by heavy defoliation early in the year. Trees that are in good health at the time of defoliation will survive. Trees already under stress at that time of defoliation will lose vigor and sometimes die from the effects of secondary agents and adverse environmental conditions.
Emerald Ash Borer (Ash and Fringe Tree)	**Systemic insecticides** Azadirachtin Dinotefuran Emamectin benzoate Imidacloprid **Contact insecticides** Bifenthrin Carbaryl Cyfluthrin Permethrin	After cutting trees, do not move wood out of area. Destroy, chip, or leave wood on site. For additional information on this pest, refer to: http://bit.ly/1Mmvvza
Fall Webworm (many hardwoods)	*Bacillus thuringiensis (BT)* Carbaryl Diflubenzuron Tebufenozide	Rarely has significant impact on forest trees; high density populations rarely persist for more than two seasons. Stressed trees can be protected against defoliation impact by spraying the first webworm generation in mid- to late June. If necessary, spray the second generation in mid- to late August. For additional information on this pest, refer to: http://bit.ly/1p6aa1C
Spongy Moth (many hardwoods)	Bacillus thuringiensis (BT) Carbaryl Diflubenzuron Tebufenozide	Treat in the spring when most larvae are in second instars and most oak leafs are at least half expanded. For Bt, treat when larvae first emerge. Most treatments are coordinated through local- state-federal cooperative suppression programs. For additional information on this pest, refer to: https://www.vdacs.virginia.gov/plant-industry-services-spongy-moth.shtml.
Mites Spruce spider mite (conifers, especially spruces, hemlock, Fraser fir in nurseries, and plantations. Seldom on pine)	Avid Clofentezine Dormant oil Etoxazole Floramite Spiromesifen	Treat in early spring and fall (usually late April and mid- September) when mites are most active; use oil as a dormant spray (makes foliage oily) For additional information on this pest, refer to: http://bit.ly/1PPQ7iS and http://bit.ly/1k4Wr9Z
Mites Eriophyid mite (Needle Sheath Mite)	Carbaryl Chlorpyrifos Dimethoate Dormant oil	Treat as soon as detected (early spring); oils may alter foliage appearance.

Pine Tip Moth Nantucket pine tip moth (2 and 3 needle pines only)	Carbaryl Confirm Diflubenzuron Esfenvalerate Imidacloprid Imidan Permethrin Tebufenozide	Thoroughly wet all shoots and needles in the spring and repeat 1 to 2 times later in the summer. Pheromone traps are used to time male flight activity. A general rule is to treat 10 days after catching males in traps so that susceptible early instar larvae are at their first peak. The distinct 1st generation that this rule depends on break down with each succeeding generation, of which there are three in Virginia.
Pine Webworm (pine)	*Bacillus thuringiensis (BT)*	Rarely contributes to seedling mortality. Spray only when webworm population density is high and seedling stocking marginal. Treat as soon as detected.
Sawflies Virginia pine sawfly, introduced pine sawfly, red-headed pine sawfly	Carbaryl Esfenvalerate Imidacloprid	Treat Virginia pine sawfly in April; introduced pine sawfly on white pine in June and September; red-headed pine sawfly, June to September. Since pine sawflies tend to avoid current season's foliage, defoliation is rarely total and trees can survive repeated infestations. See label for aerial application directions. For additional information on this pest, refer to: http://bit.ly/1MmwGi2
Scale Insects Pine needle scale, pine tortoise or scale, elongate hemlock scale, etc.	Carbaryl Dormant oil Malathion Permethrin	Treat for pine needle scale mid- to late May and mid- to late July; pine tortoise scale mid- June and July. For all other scale insects treat at crawler date. Scale insects rarely reach high densities or have serious impact on hardwood forests; spread of invading beech scale and associated beech bark disease can be slowed through salvage of infested trees. Spraying is not practical in the forest setting.
Spotted Lanternfly	imidacloprid bifenthrin zeta- cypermethrin carbaryl malathion Dinotefuran	The systemic insecticides dinotefuran and imidacloprid can be used as trunk sprays, trunk injections, or soil drenches, depending on the label. Use contact insecticides such as bifenthrin, zeta- cypermethrin, carbaryl, and malathion as spot sprays on nymphs and adults seen on the trunk, branches, and foliage of plants. Repeat spot sprays as needed. May not be economical or feasible for large forest tracts. Loggers shipping trees out of the Quarantine zone are required to get a Spotted Lanternfly Permit, see: https://www.vdacs.virginia.gov/plant-industry-services.shtml and see: https://ext.vt.edu/agriculture/commercial-horticulture/spotted-lanternfly.html
Tent Caterpillars Forest tent caterpillar (many hardwoods)	*Bacillus thuringiensis (BT)* Carbaryl Diflubenzuron Malathion Tebufenozide	Treat for forest tent caterpillar in early spring when first leaves are fully expanded. Forest tent caterpillars occasionally cause extensive hardwood forest defoliation. They do not make the web tents in the crotch of the tree branches.
Eastern tent caterpillar (wild cherry)		Eastern tent caterpillar can fully defoliate trees in early spring but only have minor impact and should not be treated in the forest setting. For additional information on this pest, refer to: http://bit.ly/1AdP9Gq
Weevils Pine reproduction weevils, Pales weevil, Eastern Pitcheating weevil. (conifers: feed on first year stumps and the base of recently dead trees as larvae. The adults may feed on live twigs.)	Esfenvalerate Imidan Permethrin	In forest plantations, wait one year to replant with seedlings if harvesting took place after June 1. Seedlings are currently treated in nursery beds prior to lifting under SLN registration; foresters and landowners can order seedlings that are already treated. In Christmas tree plantations, stump removal or stump treatment with insecticide (as described below) is recommended. Thoroughly soak stumps and ground surface 1 to 2 ft around stumps or slash prior to mid- March. Apply Imidan as 4% top dip for seedlings prior to planting. Follow label directions. For seedlings: Apply as a full coverage spray to seedlings immediately after planting. For stumps: Thoroughly soak stumps and ground surface around stumps or slash prior to mid- March. Only stumps or wood cut since previous summer need treatment. Dilute Asana in kerosene. For additional information on this pest, refer to: https://www.pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/2902/2902-1102/ENTO-386.pdf
White Pine Weevil (eastern white pine, Scots pine, and Norway spruce: feed in the tops of trees only.)	Permethrin	Treat when plantations show 5% or more weeviled tips. Applications must be made prior to adult egg laying, usually April 1. Treat only 1.5 to 2 ft of the main terminal shoot, not the entire tree or laterals. A full 4 gal knapsack sprayer will treat approximately 200 terminal shoots. For additional information on this pest, refer to: http://bit.ly/1XtwDD1
Precautions: Do not allow any insecticides as sprays, drift, or runoff to contaminate bodies of water, streams, or drainage systems. Carbaryl is highly toxic to honeybees. Follow precautionary instructions on labels and use protective equipment wherever specified. **Equivalents:** 1 lb WP/100 gal = 1 Tablespoon/gal; 1 pt EC/100 gal = 1 teaspoon/gal		

Pests of Forestry and Christmas Trees: Insecticide Recommendations for Fraser Fir Seedbeds and Liner Beds

Eric R. Day, Extension Entomologist, Virginia Tech
Kyle R. Peer, Superintendent, Reynolds Homestead FRRC

Table 8.2 - Soil Insects[1,2]

Insects	Insecticide	Rates	Timing and Comments
Root Aphids	Imidacloprid		Treat when aphids are first discovered and completely water in granular material. Treat only if damage such as yellowing is observed. Most of the time root aphids are not present in damaging numbers.
White Grubs	*Bacillus Popillae* (Milky spore disease) for Japanese beetle only; not effective on other grub species. *Beauvania bassiana* Carbaryl (Sevin 10G) Entomopathogenic Nematodes Halofenozide (Mach 2) Imidacloprid (Merit 0.75 WSP) Lambda-Cyhalothrin (Scimitar) Trichlorfon (Dylox 6.2)	For proper rates, see label.	White grubs include several species of scarab beetle larvae. Treat with insecticides in July.
			Japanese beetle grubs are the only species that will be controlled adequately by milky spore products. Follow label instructions for application. When using these products, be aware that control is not immediate. Milky spore is a slow-acting disease agent; grubs will take up to 30 days to die. However, when the disease is established in the turf, control can be effective for years without further application. After application, the disease perpetuates and spreads by infecting and being transported by grubs. If another grub treatment is applied to an area treated with milky spore, this will slow the spread of the disease and is therefore not desirable. White grubs can also be controlled by entomopathogenic nematodes. Not all nematode species (named on the product label under the "Active Ingredients" section) available commercially will provide adequate control. Products with *Steinernema carpocapsae* should not be used for grub control. Entomopathogenic nematode products should be applied only when the pest is present. Apply nematodes late in the day to avoid exposure to UV light damage. Irrigate the day before and immediately after application. Early spring treatments are usually not effective because soil temperatures should be at least 60˚F.
			Beauvaria bassiana (an entomopathogenic fungus) products also provide control. Follow label instructions and water 1/2 inch immediately after application. Avoid fungicide applications when using these products. Several chemical insecticides are available for grub management. These products should be applied at the labeled rate and watered in with 1/4-1/2 inch of water. Most insecticides provide the best control when used against early instar grubs that are present in early to mid- August. Populations high enough to warrant treatment are 6 to 10 grubs/sq ft. White grubs stop feeding in September or October, so control during fall may not prove successful. Spring treatments usually are not effective. Cultural management: reducing thatch will increase penetration of any treatment applied to the turf.
Cutworms	Permethrin		Treat when cutworms are first discovered, avoid weedy growth as cutworm moths prefer to lay eggs in thick vegetation as well as low-lying places.

[1] After transplanting from the liner bed to the field, consult the information listed under Christmas trees.
[2] Generally most soil insects are controlled with fumigants used for weed control prior to planting. The following is remedial control for insects detected after the bed is established.

Table 8.3 - Foliage And Stem Insects

Insects	Insecticide	Rates	Timing and Comments
Balsam Woolly Adelgid	Asana XL Bifenthrin Horticultural Oil Imidacloprid Permethrin		Treat when found in June or May–October with Asana XL or Lorsban. Spray bark and foliage to runoff. Use horticultural oil in winter during dormant periods. Horticultural oil may give the foliage an oily appearance and burn some tips.
Balsam Twig Aphid	Asana XL Bifenthrin Imidacloprid		Treat in about the first week of May or just prior to buds opening in the spring. Severe cases only need be treated as this insect is generally a cosmetic pest.
	Dormant oil		Use 1% rate for Dormant oil. Maintain temperature restrictions.
Spruce Spider Mite	Bifenthrin Insecticidal Soap Mavrik Savey San Mite		Treat in early May or late September or when mites are found.
	Dormant oil		Dormant oil in late March will control mites in most situations.

Pests of Forestry and Christmas Trees: Fungicide Recommendations for Conifer Seedbeds and Liner Beds

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Table 8.4 - Diseases (Refer to product label for application rates, directions, and precautionary information. Follow product label directions on pesticide resistance development and tank-mix and/or rotate products at risk for development to other modes of action, as advised on the product label to minimize chance of pesticide resistance development.)

Disease	Fungicide	Comments
Botrytis blight	Bravo Weather Stik, Daconil Zn, Echo 720 (chlorothalonil)	Begin applications in nursery beds when seedlings are 4 inches tall and when cool, moist conditions favor disease development. Make additional applications at 7- to 14-day intervals as long as conditions favorable for disease persist.
	3336 EG Turf and Ornamental Systemic Fungicide (thiophanate methyl)	
	Spectro 90WDG (chlorothalonil + thiophanate methyl)	
	Tourney (metconazole)	Apply as needed on 14 to 28-day interval.
Needle casts, tip blight	Bravo Weather Stik, Daconil Zn, Echo 720 (chlorothalonil)	Make first application in spring when new shoot growth is 0.5-2.0 inches in length. For nursery beds, apply the highest rate specified on a 3-week schedule until conditions no longer favor disease development.
	Spectro 90WDG Turf and Ornamental Fungicide (chlorothalonil + thiophanate methyl)	Apply at budbreak and repeat at 2-3 week intervals until needles are fully elongated and conditions no longer favor disease development.
Phytophthora root rot	Alude (dipotassium phosphite)	Can apply as foliar spray, soil drench, or bare-root dip.
	Mefenoxam 2 AQ Subdue Maxx Fungicide (mefenoxam)	Can be used as a foliar application and soil surface spray in at least 50 gal water in spring and again in fall.
	Subdue GR Granular Fungicide (Metalaxyl-M)	Granular product.
	Segway O Greenhouse and Nursery Fungicide (cyazofamid)	Can be used as a soil drench or soil surface spray or delivered via irrigation system.

Pests of Forestry and Christmas Trees: Weed Control in Fraser Fir Seedbeds and Liner Beds

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Table 8.5 - Weed Control[1]

Pest	Herbicide and Rate	Comments
Most Weed Species	dazomet (Basamid 218-421 lb/A or 5.0 to 9.6 lb/1000 sq ft)	Preplant soil fumigation. Incorporate after application. Irrigate or cover with plastic after application. Do not use below soil temperature of 43ºF. Waiting period for seeding ranges from 10 to over 30 days.
Annual and Perennial Weeds	glyphosate (Roundup Pro 2.0-5.0 qt/A or 1.3-2.6 fl oz/gal, Roundup ProMax,1.0-3.3 qt/A or 2.0 fl oz/gal, or other labeled formulation)	For site preparation prior to seeding. Apply when weeds are actively growing. Do not allow spray to contact desired foliage.
Many Annual Weeds	oxyfluorfen (Goal 2XL 1.0-4.0 pt/A or GoalTender 0.5-2.9 pt/A)	Apply after seeding but prior to seedling emergence. Preemergence control of weeds from seed. For small areas, apply 0.4-1.4 fl oz Goal 2XL or 0.2-0.7 fl oz GoalTender/1000 sq ft.
	oxyfluorfen (Goal 2XL 1.0-2.0 pt/A or GoalTender 0.5-1.0 pt/A)	Postemergence control of weeds less than 4 inches tall plus residual control. Do not apply sooner than 5 weeks after fir emergence. Fir seedlings must be hardened off prior to spraying. For small areas, apply 0.4-0.7 fl oz Goal 2XL or 0.2-0.37 fl oz GoalTender/1000 sq ft.
Annual and Perennial Grasses	sethoxydim (Segment II 1.3 fl oz/gallon plus 0.5 fl oz/gallon methylated seed oil or crop oil concentrate)	Postemergence control of most grasses. Spray to wet when grasses are actively growing. Will not control wild onion, yellow nutsedge, or any broadleaf weed.

[1]After transplanting from the liner bed to the field, consult the information listed under Christmas trees.

Pests of Forestry and Christmas Trees: Christmas Tree Insects

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Early detection and accurate identification of insect pests is the key to prevention of serious damage and loss in Christmas tree plantations. Growers should be knowledgeable about the more common, injurious insects and mites — their recognition, host plants, damage, seasonal development, and habits. Chapter 10, Insects, in the "Christmas Tree Production Manual" is a helpful reference (Virginia Cooperative Extension Publication 420-075). The "Christmas Tree Pest Manual," Michigan State University publication E-2676, contains full-color illustrations to aid in identification as well as biological and chemical information.

Effective control depends on the timely and thorough application of recommended control measures. Control measures applied improperly or not in accordance with label directions are ineffective and a waste of time, materials, and labor, and may constitute a misuse of pesticides. Use pesticides only if pests are present or are predicted to be present from a standard or systematic sample survey.

Amounts of pesticide to use in preparing sprays or applying treatment are specified in this control guide. Even so, they should be determined from the label on the container of the pesticide at the time of application. Be sure to read ALL of the directions and precautions on the label before and at the time of application of each treatment. Use ONLY the recommended amounts of the formulation. For many insecticides listed, other formulations are available and registered for use: Carbaryl (Sevin) - 50 WP, 80S, 4F, and Sevimol; Dursban-2E and 50WP (Lorsban is the trade name for chlorpyrifos marketed for agricultural crops); Orthene - 9.4% EC and 15.6% EC; diazinon-4E and 50WP; Malathion-50% EC and 25WP; Dipel-3.2% WP, 6L, and 8L; Thuricide-32 LV, HP, and HPC. Formulation often depends on type of application as well as company marketing policy. Dusts are not recommended, since they are readily washed off by rain. WP residues are not as persistent as emulsifiable concentrates; although addition of a sticker often improves residual activity. Insecticides marked ** are restricted-use pesticides.

■ Major Insects and Mites Infesting Christmas Trees

Insects and mites vary in their host preferences and their severity on different hosts. The following list of pests associated with each type of tree is an aid in identifying potentially damaging species. **The pests are listed in order of importance and occurrence generally.** Most insects and the spruce mite tend to be localized on scattered trees rather than uniformly distributed through plantations.

Balsam Fir
balsam woolly adelgid
aphids
balsam twig aphid

Blue (and Sitka) Spruce
spruce mite
white pine weevil
sawflies
aphids
Cooley spruce gall adelgid

Douglas-Fir
spruce mite
white pine weevil
Cooley spruce gall adelgid

Eastern White Pine
white pine weevil
pales weevil
eastern pine weevil
white pine aphid
pine bark adelgid
sawflies
bagworm
pine needle scale
pine webworm
eriophyid mites

Fraser Fir
balsam woolly adelgid
aphids
spruce mite
eriophyid mites
balsam twig aphid
Cryptomeria scale
Elongate Hemlock Scale

Norway Spruce
white pine weevil
eastern spruce gall adelgid
aphids
pine needle scale
sawflies
eriophyid mites
spruce mite

Red Pine
pine tip moth
sawflies
pine root collar weevil
pales weevil
eastern pine weevil
white pine aphid

Scotch Pine
pine tip moth
pine needle scale
pine tortoise scale
pine bark adelgid
sawflies
pales weevil
eastern pine weevil
pine webworm
aphids
spittlebug
woolly pine scale

Virginia Pine
Virginia pine sawfly
pine tip moth
pales weevil
pine webworm

White Fir
aphids

White Spruce
spruce mite
white pine weevil
sawflies
aphids

■ Fraser Fir Scouting Schedule for Insects and Mites

SCOUTING AND CONTROL NOTES

(Specific chemical recommendations are in the following sections.)

Bagworm: *Scouting:* January: Look for overwintering bags. *Cultural Control:* Pick off and destroy bags in the fall and winter. Bags can be destroyed by dropping them in a can of kerosene or burying them at least 6" deep. *Chemical Control:* It is important to treat in mid-June when the larvae are small and susceptible to insecticides. Larger larvae with bags are not easily controlled. See the most recent Virginia Pest Management Guide for insecticides labeled for control of bagworms. *Biological Control:* Spraying with *Bacillus thuringiensis (Bt,* Dipel, Thuricide, etc.) in early to mid-June should give satisfactory control.

Spruce Spider Mite: *Scouting*: Start scouting in mid- April and continue scouting once a month until the first heavy frost. Walk through the plantation in a Z or W pattern. Pick a tree at random once every 50 feet. Check the shoot for mites or mite damage; you may need a 10X hand lens to see the mites. You should be examining at least 15 shoots per acre. Carry a sheet of paper with two columns marked to record the total number of shoots sampled and the total number of shoots with mites. The presence of damage alone is not enough; record it as positive if you find the mites or mite eggs. Based on research in North Carolina that is applicable to Virginia, the economic threshold is based on the size of the tree. On trees less than waist high, treat if the percentage of shoots with mites exceeds 40%. On trees waist high to year before sale, treat if the percentage of shoots with mites exceeds 20%. On trees at the year of sale, treat if the percentage of shoots with mites exceeds 10%. Use these guidelines for determining when to come back and sample again. If no mites or eggs are observed then return in 6-8 weeks. If less than 10% of the shoots have mites or eggs return in 4-5 weeks. If more than 10% of the shoots have mites or eggs return in 2 weeks. If there are more than 10 days of hot, dry weather check the trees sooner. *Cultural Control:* Avoid having bare earth under trees as this will reduce the number of predators on the tree and increase the number of Spruce Spider Mites. *Mechanical Control:* None known. *Chemical Control:* **See Fact Sheet 444-235 for more detail.**

Balsam Twig Aphid: *Scouting*: Start in early April to determine the amount of damage present. Walk through the field in a Z or W pattern. Scouting for Balsam Twig Aphid can be done at the same time as the Spruce Spider Mite scouting. Threshold for Christmas Tree Growers: Treat only if the trees are within 2 years of harvest. If more than 10% of the trees have at least one damaged twig then consider treating. The amount of damage an individual grower/ buyer will tolerate is variable as some buyers consider a small amount of twig damage good because the upturned needles give the tree a silvery appearance. This may take a number of seasons of working with buyers to perfect how much damage you can leave and still not reduce your price. *Mechanical Control:* None known. *Cultural Control:* Maintain the trees in good growing condition and trees should continue to vigorously grow even with populations of Balsam Twig Aphid present. *Chemical Control:* Treat between mid- April and bud break. If you wait until after bud break, it is too late for control this season and you should postpone treatment until next year. **See Fact Sheet 444-228 for more detail.**

Balsam Woolly Adelgid (BWA): *Scouting:* The best time to scout is in July as the adelgids are covered with a white cottony wax and are easily observed. In the winter they are much smaller and lack the woolly covering making them much harder to see. Look also for the trees that are flattening out on the top or have a crooked leader; this is early damage from the BWA. Walk through the field in a Z or W pattern. Threshold for Christmas Tree Growers: Treat the entire block if an infestation is found. *Mechanical Control:* If only one or two infested trees are found, wrap the infested trees in a tarp and cut down and remove. You will still need to spot spray the surrounding trees. *Cultural Control:* Avoid excess use of nitrogen fertilizer. **Chemical Control: See Fact Sheet 444-233 for more detail.**

White Grubs: *General Comment:* White grubs are seldom a problem on plantations where a grass strip is maintained between the trees. Scouting should be performed in areas where new trees are to be planted or where yellowing or slow growth occurs on established trees. *Scouting:* Check especially in areas where trees are yellowing or not growing. Look also in areas with poor grass growth or where polecats or foxes are digging up grubs. In June lift up 1-foot-square sections of sod, five sites per 2 acres. Threshold for Christmas Tree Growers: Treat if you find on average more then 1 grub per hole and you have damage. *Mechanical Control:* None known. *Cultural Control:* Maintain as much grass growing between the trees as possible as the white grubs prefer to feed on grass roots and only move to tree roots when nothing else is available. *Chemical Control:* Treat with Diazinon or Oftanol in the same manner you would treat a lawn. See Table 8.2 - Soil Insect, Pests of Forestry and Christmas Trees: Insecticide Recommendations for Fraser Fir Seedbeds and Liner Beds.

Table 8.6 - Fraser Fir Scouting Schedule for Insects and Mites[1]
Virginia Tech IPM Program - Prepared by Eric R. Day

Pest Problem	Activity	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
Bagworm	Scouting	Scout											
	Treatment						Treat						
Spruce Spider Mite	Scouting				Scout	(Scout)	(Scout)	(Scout)	(Scout)	(Scout)	(Scout)		
	Treatment					Spray				Spray			
Balsam Twig Aphid	Scouting				Scout	Scout							
	Treatment				Treat								
White Grubs	Scouting						Scout						
	Treatment								Treat				
Balsam Woolly Adelgid	Scouting							Scout					
	Treatment							Treat					

[1]Modified in part from Fraser Fir IPM by Dr. Jill Sidebotton, N.C. Cooperative Extension

■ Spruce Scouting Schedule for Insects and Mites

SCOUTING AND CONTROL NOTES

(Specific chemical recommendations are in the following sections.)

Bagworm: *Scouting:* January: Look for overwintering bags. *Cultural Control:* Pick off and destroy bags in the fall and winter. Bags can be destroyed by dropping them in a can of kerosene or burying them at least 6" deep. *Chemical Control:* It is important to treat in mid- June when the larvae are small and susceptible to insecticides. Larger larvae with bags are not easily controlled. *Biological Control:* Spraying with *Bacillus thuringiensis (Bt,* Dipel, Thuricide, etc.) in early to mid-June should give satisfactory control.

White Pine Weevil (WPW): *Scouting:* Look for resinous bleeding on termimal leaders in late March or early April to find when adult females are feeding and laying eggs. Check trees also in June to determine which tops are actively infested with WPW. Check for a final time in fall to determine the percent of trees that are infested. Threshold for Christmas Tree Farms and Forestry Plantations: If fall surveys indicate that more than 5% of the trees were infested with WPW the previous season, plan on treating the whole plantation or block. *Mechanical Control:* Prune out and destroy infested tops in late June. Make sure stems are cut below where weevils are feeding. Tops must be cut before the weevils make exit holes and leave. *Cultural Control:* Remove all old unattended stands of white pine and Norway spruce that may be harboring populations of WPW. *Chemical Control:* Treat the terminal leader with a registered insecticide before the buds open. Do not treat the lateral shoots as they are not the infestation point. Apply the insecticide no later then late March or early April. For valuable specimen trees it may be necessary to treat each year. *Remarks:* Repeated terminal dieback caused by WPW can give trees an asymmetrical crooked appearance that is aesthetically pleasing to many people. Often the nice old gnarly pine tree has been given its appearance by repeated attacks by WPW.

Spruce Spider Mite: *Scouting:* Start scouting in mid-April and continue scouting once a month until the first heavy frost. Walk through the plantation in a Z or W pattern. Pick a tree at random once every 50 feet. Check the shoot for mites or mite damage; you may need a 10X hand lens to see the mites. You should be examining at least 15 shoots per acre. Carry a sheet of paper with two columns marked to record the total number of shoots sampled and the total number of shoots with mites. The presence of damage alone is not enough; record it as positive if you find the mites or mite eggs. Based on research in North Carolina that is applicable to Virginia, the economic threshold is based on the size of the tree. On trees less than waist high, treat if the percentage of shoots with mites exceeds 40%. On trees waist high to year before sale treat if the percentage of shoots with mites exceeds 20%. On trees at the year of sale, treat if the percentage of shoots with mites exceeds 10%. Use these guidelines for determining when to come back and sample again. If no mites or eggs are observed then return in 6-8 weeks. If less than 10% of the shoots have mites or eggs return in 4-5 weeks. If more than 10% of the shoots have mites or eggs return in 2 weeks. If there are more than 10 days of hot, dry weather check the trees sooner. *Cultural Control:* Avoid having bare earth under trees as this will reduce the number of predators on the tree and increase the number of Spruce Spider Mites. *Mechanical Control:* None known. *Chemical Control:* **See Fact Sheet 444-235 for more detail.**

Cooley Spruce Gall Adelgid and Eastern Spruce Gall Adelgid: *Scouting:* Start scouting in April and look for small tufts of cotton like material at the base of buds. Look again in August and September to determine when the galls have opened up. Threshold for Christmas Tree Farms: Treat when 5% of the trees have ten or more galls; spot spraying may work with smaller infestations. *Cultural Control:* Avoid planting Douglas-fir within 500 yards of Norway Spruce. *Mechanical Control:* None known. *Chemical Control:* Treat with dormant oil in February or March. In severe cases treat with an insecticide in August or September just as the galls turn from brown to green and small openings are created for the adelgids to exit. Treatments can also be applied in April but this is trickier as it needs to be done when the small adelgid is feeding at the base of the needle just before the gall is formed. The adelgids will be covered with a small tuft of wax.

Table 8.7 - Spruce Scouting Schedule for Insects and Mites

Virginia Tech IPM Program - Prepared by Eric R. Day

Pest Problem	Activity	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
Bagworm	Scouting	Scout											
	Treatment			Pick			Spray						Pick
Cooley Spruce Gall Adelgid and Eastern Spruce Gall Adelgid	Scouting				Scout				Scout	Scout			
	Treatment		Oil	Oil					Treat	Treat			
White Pine Weevil	Scouting			Scout									
	Treatment			Spray			Prune						
Spruce Spider Mite	Scouting				Scout	(Scout)	(Scout)	(Scout)	(Scout)	(Scout)	(Scout)		
	Treatment					Spray				Spray			

■ Scotch Pine Scouting Schedule for Insects and Mites

SCOUTING AND CONTROL NOTES

(Specific chemical recommendations are in the following sections.)

Bagworm: *Scouting:* January: Look for overwintering bags. *Cultural Control:* Pick off and destroy bags in the fall and winter. Bags can be destroyed by dropping them in a can of kerosene or burying them at least 6" deep. *Chemical Control:* It is important to treat in mid- June when the larvae are small and susceptible to insecticides. Larger larvae with bags are not easily controlled. See the most recent Virginia Pest Management Guide for insecticides labeled for control of bagworms. *Biological Control:* Spraying with *Bacillus thuringiensis* (Bt, Dipel, Thuricide, etc.) in early to mid-June should give satisfactory control.

Pine Tortoise Scale: *Scouting:* Look for darkened patches or branches on the side or top of the tree. Check the twigs and needles for the presence of the scale insects. High populations will cause browned dead shoots. The presence of honeydew (clear sticky droplets) will also indicate scales, but may also be from aphids, so it is important to identify the source. Ants, bees and wasps will feed on the honeydew and their activity may lead you to a scale infestation. Threshold for Christmas Tree Farms and Forestry Plantations: No known threshold but the presence **coupled** with objectionable damage will warrant treatment. Many trees will support low non-damaging populations. The pine needle scale is heavily fed upon by predators and parasites which control it most years. *Mechanical Control:* Remove infested branches or trees and burn. Works best if the infestation is localized. *Cultural Control:* If chronic problems with this scale are not resolved by chemical or mechanical control it is best to switch to non-susceptible hosts such as spruces, firs, hemlock, or white pine. *Chemical Control:* February or March - Treat with dormant oil. June - For severe cases two sprays 10-14 days apart are recommended during crawler emergence early in June. *Remarks:* Check wind break trees for infestation as scales may spread from these trees as new seedlings are set nearby.

Nantucket Pine Tip Moth: *Scouting:* March - Look for small copper-colored moths flying from trees when you shake the branches or walk by the tree. At the same time assess the tree for damage from last year. Use a pheromone trap to check for adult activity.*Cultural control:* July - For light infestations, simply shear off the damaged tips containing the insects. Ground beetles, ants and other scavengers should consume the tip moths once on the ground. *Chemical Control:* Late April - Treat with a residual insecticide such as dimethoate; cover all lateral branches and the leader. Additional spray dates: Late-June and Late-August - Treat again with dimethoate if damage is heavy. See Fact Sheet 444-238 for more details.

Pine Needle Scale: *Scouting:* Look for the white scales in the fall and winter and note which rows or blocks need treatment. In early May and early July wrap electrical tape, sticky side up, around twigs with high populations of scale. Treat one week after the first reddish-purple crawler is found. This will usually be about mid-May and mid- to late July. Threshold for Christmas Tree Farms and Forestry Plantations: Treat only if stunted growth, yellowing, or unsightly populations of scales are present. *Cultural Control:* Promote vigorous growth, as scales tend to cause more damage in poorly growing trees. *Chemical Control:* Apply a 2% dormant oil in late March when temperatures are above 45˚F. The dormant oil may remove the waxy bloom on the needles and give the trees a dull appearance but this is temporary and will be hidden by the summer's flush of growth. It would be advisable to avoid dormant oils on the year of harvest. Dormant oil is also sold as superior oil or horticultural oil. Malathion or diazinon can be applied one week after the first crawler is found on the tape or in mid-May and late July. Carbaryl (Sevin®) or dimethoate can be used just as the eggs start to hatch, which is indicated as the date the first crawler is found on the tape. It is thought that applications timed for the summer generation are the most effective. *Remarks:* Crawlers are blown about by wind and carried inadvertently by birds. Adult scales do not have wings and this is the only way pine needle scales are moved about.

Sawflies: Scouting and Thresholds for All Sawflies: Check the upper sections of pine tree for colonies of sawflies on the tips of lateral branches or on the leader. Spot treat where you find them or treat the whole block if more than 5% of the trees are infested. *Mechanical Control:* Cut off and destroy infested branches. Dip sawflies in kerosene or bury 6" deep. *Cultural Control:* Avoid susceptible hosts; replant with spruce or white pine, which are less frequently attacked by sawflies. *Chemical Control:* Spot spray as you find colonies feeding. One method is to carry a small sprayer on the mower and stop and spray as you find the sawflies. Be sure to avoid having the tractor exhaust discharging on a nearby tree as you spray as it may burn a spot. If a whole block needs treatment, a mist blower or back-pack sprayer will work well.

Pine Spittle Bug: Scouting and Thresholds for Pine Spittlebug: In May through early July look for spittle masses on shoots and trunk and for dead and yellow twigs. From mid- June look for oval-shaped adults which will not have a spittle mass. Check trees of all ages in May and June. A small number of spittle masses indicate low population and little threat. If there are a large number of masses check the plantation again in the fall for dead shoots. If dead shoots are present in the fall plan to treat the next season. *Cultural Control:* Maintain trees in the best possible growing condition. Avoid planting the wrong tree in the wrong spot. Consult guides or enlist help from your local county forester on which trees are best suited for your farm or site. Vigorously growing trees rarely suffer damage from spittlebugs. Plant trees that are resistant to Diplodia tip blight. Two- and three-needle pines, such as Austrian pine, tend to have more problems with Diplodia. *Chemical Control:* Control spittlebugs by spraying for the adults about mid- July. To determine the best timing check spittle masses once a week starting in late June. When 95% are empty, usually in mid- July, treat with a registered insecticide. Treat the entire plantation. *Remarks:* Consult the fact sheet if you suspect you have the Saratoga spittlebug, although most growers will have the pine spittle bug.

Table 8.8 - Scotch Pine Scouting Schedule for Insects and Mites

Virginia Tech IPM Program - Prepared by Eric R. Day

Pest Problem	Activity	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
Bagworm	Scouting	Scout											
	Treatment		Pick				Spray					Pick	
Pine Tortoise Scale	Scouting		Scout										
	Treatment		Oil	Oil			Spray						
Nantucket Pine Tip Moth	Scouting			Scout									
	Treatment				Spray		(Spray)	Shear	(Spray)				
Pine Needle Scale	Scouting					Tape		Tape			Scout	Scout	Scout
	Treatment			Oil		Spray		Spray					
Sawflies	Scouting					Scout	Scout	Scout					
	Treatment					Treat	Treat	Treat					
Pine Spittle Bugs	Scouting					Scout	Scout						
	Treatment							Spray					

■ White Pine Scouting Schedule for Insects and Mites

SCOUTING AND CONTROL NOTES

(Specific chemical recommendations are in the following sections.)

Bagworm: *Scouting:* January: Look for overwintering bags. *Cultural Control:* Pick off and destroy bags in the fall and winter. Bags can be destroyed by dropping them in a can of kerosene or burying them at least 6" deep. *Chemical Control:* It is important to treat in mid-June when the larvae are small and susceptible to insecticides. Larger larvae with bags are not easily controlled. See the most recent Virginia Pest Management Guide for insecticides labeled for control of bagworms. *Biological Control:* Spraying with *Bacillus thuringiensis (Bt,* Dipel, Thuricide, etc.) in early to mid- June should give satisfactory control.

Pales Weevil: *Scouting:* In January count the number of stumps and determine if digging the stumps or spraying the stumps is the method of control. The other time to scout is in late summer and early fall on trees that are ready to be harvested. Check for resin covered wounds on small twigs and dead "flagged" twigs. These are places where weevils are feeding. *Mechanical Control:* Dig and remove new stumps where the tree was cut down less then one year ago, "first year stumps". *Cultural Control:* Let Christmas tree land lay fallow for one or two years before replanting and don't interplant new trees near stumps. *Chemical Control:* Purchase treated seedlings only; this will protect seedlings from pales weevil damage and more importantly will protect young trees from being infected with procerum root disease by the weevils. If you are interplanting seedlings next to stumps treat the stumps in February or March with Asana. These two pesticides can be mixed with diesel fuel or kerosene to increase their penetration into the bark. **See Fact Sheet 444-229 for more information.**

White Pine Weevil (WPW): *Scouting:* Look for resinous bleeding in late March or early April to find when adult females are feeding and laying eggs. Check trees also in June to determine which tops are actively infested with WPW. This can be indicated by a curled leader. Check for a final time in fall to determine the percent of trees that are infested. *Threshold for Christmas Tree Farms and Forestry Plantations*: If fall surveys indicate that more than 5% of the trees were infested with WPW the previous season, plan on treating the whole plantation or block. *Mechanical Control:* Prune out and destroy infested tops in late June. Make sure stems are cut below where weevils are feeding. Tops must be cut before the weevils make exit holes and leave. *Cultural Control:* Remove all old unattended stands of white pine and Norway spruce that may by harboring populations of WPW. *Chemical Control:* Treat the terminal leader with a registered insecticide before the buds open. Do not treat the lateral shoots as they are not the infestation point. Apply the insecticide no later then late March or early April. For valuable specimen trees it may be necessary to treat each year. Consult the latest Virginia Pest Management Guide for current labeled insecticides. *Remarks:* Repeated terminal dieback caused by WPW can give trees an asymmetrical crooked appearance that is aesthetically pleasing to many people. Often the nice old gnarly pine tree has been given its appearance by repeated attacks by WPW.

Pine Bark Adelgid: *Scouting:* Check for the white cottony wax on the trunk and twigs. Look for abnormal abundant bud formation that gives the top of the tree a bushy broom like appearance. A profusion of twigs on the top of the tree is sometimes called witch's brooming. Threshold for Christmas Tree Farms and Forestry Plantations: This is rarely a pest and it is uncommon to have damage. If adelgids are present and more then 5% of tops are witch's broomed consider treating with an insecticide or oil. *Cultural Control:* Avoid applying excess nitrogen as this has been shown to increase populations of sucking insects on pines. Switch to a different species of tree other than white pine. *Mechanical Control:* None known. *Chemical Control:* Apply dormant oil at a 2% rate in March; this may temporarily slightly discolor the foliage but this will be covered by the summer flush of growth. Applications of a registered insecticide in May can be made instead for good control. *Remarks:* Try to educate your buyers that this is a mostly harmless pest that is found everywhere including yard trees.

Needle Sheath Mite: *Scouting:* Check trees in March by checking 10 needle bundles on 10 trees randomly selected in each block. Pull open the needles and look with a 10X hand lens at the base for small pale mites. In addition to the mites you will probably see yellowing and stippling, particularly on the south side of the tree. It takes practice to

observe the mites and if you are not sure of what you are finding a subsample of 10 needle bundles may be submitted to the Insect Identification Laboratory through your county extension agent. Threshold for Christmas Tree Farms and Forestry Plantations: If damage and mites are present it is advised to treat. *Cultural Control:* Switch to a different species of tree other than white pine. *Mechanical Control:* None known. *Chemical Control:* Treat with carbaryl (Sevin®) or dormant oil in March or April.

Pine Needle Scale: *Scouting:* Look for the white scales in the fall and winter and note which rows or blocks need treatment. In early May and early July wrap electrical tape, sticky side up, around twigs with high populations of scale. Treat one week after the first reddish-purple crawler is found. This will usually be about mid-May and mid- to late July. Threshold for Christmas Tree Farms and Forestry Plantations: Treat only if stunted growth, yellowing, or unsightly populations of scales are present. *Cultural Control:* Promote vigorous growth, as scales tend to cause more damage in poorly growing trees. *Chemical Control:* Apply a 2% dormant oil in late March when temperatures are above 45°F. The dormant oil may remove the waxy bloom on the needles and give the trees a dull appearance but this is temporary and will be hidden by the summer's flush of growth. It would be advisable to avoid dormant oils on the year of harvest. Dormant oil is also sold as superior oil or horticultural oil. After the first crawler is found on the tape or in mid- May and late July, an insecticide can be applied. It is thought that applications timed for the summer generation are the most effective. *Remarks:* Crawlers are blown about by wind and carried inadvertently by birds. Adult scales do not have wings and these are found on the tape.

Pine Spittle Bug: *Scouting* and Thresholds for Pine Spittlebug: In May through early July look for spittle masses on shoots and trunk and for dead and yellow twigs. From mid- June look for oval shaped adults which will not have a spittle mass. Check trees of all ages in May and June. A small number of spittle masses indicate low population and little threat. If there are a large number of masses check the plantation again in the fall for dead shoots. If dead shoots are present in the fall, plan to treat the next season. *Cultural Control:* Maintain trees in the best possible growing condition. Avoid planting the wrong tree in the wrong spot. Consult guides or enlist help from your local county forester on which trees are best suited for your farm or site. Vigorous growing trees rarely suffer damage from spittlebugs. Plant trees that are resistant to Diplodia tip blight. Two- and three-needle pines, such as Austrian pine, tend to have more problems with Diplodia. *Chemical Control:* Control spittlebugs by spraying for the adults about mid- July. To determine the best timing, check spittle masses once a week starting in late June. When 95% are empty (adults are exposed outside the spittlemass), usually in mid- July, treat with a registered insecticide. Treat the entire plantation. *Remarks:* Submit a sample to the insect ID lab if you suspect you have the Saratoga spittlebug, although most growers will have the pine spittle bug.

White Pine Aphid: *Scouting* and Thresholds for Christmas trees: Check for sooty mold and yellowing in October to determine which areas of the planting have this aphid as it tends to occur in clumps and field edges. This aphid is more common on the upper sections of the tree. Fall scouting is important for finding populations on trees about to be harvested to insure that aphids will not emerge on trees that are brought indoors. In May and June again scout for the aphids and mark trees for spot spraying or spray entire blocks if more then 5% of the trees are infected. *Cultural Control:* Avoid applying excess nitrogen as this has been shown to increase populations of sucking insects on pines. *Mechanical Control:* None known. *Chemical Control:* Treat with insecticidal soap or a registered insecticide in May or whenever you find the aphids. *Remarks:* This is the aphid that customers complain about when they find small black insects crawling on the tree and decorations.

Table 8.9 - White Pine Scouting Schedule for Insects and Mites

Virginia Tech IPM Program - Prepared by Eric R. Day

Pest Problem	Activity	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
Bagworm	Scouting	Scout											
	Treatment		Pick				Spray					Pick	
Pales Weevil	Scouting	Scout							Scout	Scout			
	Treatment		Spray										
White Pine Weevil	Scouting			Scout			Scout				Scout		
	Treatment			Spray			Prune						
Pine Bark Adelgid	Scouting			Scout									
	Treatment			Oil		Spray	Spray						
Needle Sheath Mite	Scouting			Scout									
	Treatment			Oil or spray									
Pine Needle Scale	Scouting					Tape		Tape			Scout	Scout	Scout
	Treatment			Oil		Spray		Spray					
Pine Spittle Bugs	Scouting					Scout	Scout						
	Treatment							Spray					
White Pine Aphid	Scouting					Scout	Scout			Scout			
	Treatment					Spray	Spray						

Table 8.10 - Recommended Control

Insect	Name	Remarks
Adelgids balsam woolly adelgid	Bifenthrin Dinotefuran Esfenvalerate (Asana) Imidacloprid Mineral oil Potassium laurate	Treat in June or when found May-October. Spray bark and foliage to runoff. If infested trees are few and scattered, rogue and burn, and spray trees in a 20 ft diameter circle around rogued tree. When removing infested tree wrap in a tarp so no adelgids fall off as the tree is removed from the field.
Adelgids pine bark adelgid	Carbaryl (Sevin) Chlorpyrifos (Dursban) Dimethoate Endosulfan Mineral oil Dormant oil	Treat in May for crawlers. Strong spray streams help to penetrate cottony masses. Spray bark to runoff including twigs and small branches. Insecticidal soap is also registered for adelgids.
		Oil may remove “bloom” from needles; apply as dormant spray before buds swell.
Adelgids spruce gall adelgid	Carbaryl (Sevin) Chlorpyrifos (Dursban)	Treat after galls have turned brown and opened in late August and September. Timing is more critical in spring: Treat before cottony egg masses appear at bases of buds or before new growth forms needles and bud scales have dropped, which is usually in April.
	Dormant oil	Oil may remove “bloom” from needles; do not use on blue spruce. Apply as dormant spray before buds swell.
Aphids White pine aphid, spotted pine aphid, balsam twig aphid, spruce aphid	Bifenthrin Carbaryl (Sevin) Chlorpyrifos (Dursban) Dinotefuran Esfenvalerate (Asana) Gamma-cyhalothrin Imidacloprid Lambda-Cyhalothrin Mineral oil Dormant oil Potassium laurate Pymetrozine Spirotetramat Thiamethoxam	Aphids are often on scattered individual trees, not all trees. Ants active on trees indicate those infested. Treat when aphids are first seen and before colonies enlarge. May appear at any time in the growing season. Provado should be applied at 4.0-8.0 oz/A. Treat for balsam twig aphid just before bud break or about late April.
Bagworms	Asana, Esfenvalerate, S- Fenvalerate Azadirachtin Bacillus thuringiensis subsp. Kurstaki Beta-cyfluthrin Bifenthrin (Brigade) Carbaryl (Sevin) Chlorantraniliprole Chlorpyrifos (Dursban) Clarified hydrophobic neem oil Cyfluthrin Deltamethrin (K-Othrin) Diazol Diflubenzuron, (Dimilin) Flubendiamide Fluvalinate Gamma-Cyhalothrin Indoxacarb Lambda-Cyhalothrin Larvin, Thiodicarb Malathion Methoxyfenozide Permethrin Pyrethrin Spinosad Spinosyn A Tebufenozide Zeta-Cypermethrin	Treat when bagworms are small in mid-June. The larger the worms, the harder they are to kill. Sevin may cause spruce mite buildup on spruces and firs. Dimilin cannot be used near water bodies. If only a few trees are infested, remove and destroy bags, July-May.

Table 8.10 - Recommended Control (continued)

Insect	Name	Remarks
Mites spruce spider mite (spruces, firs, cedar)	Acequinocyl Avermectin B1 Azadirachtin Bifenazate Bifenthrin (Brigade, Onyx Pro) Chloropyridazin (Sanmite) Clofentezine Emamectin benzoate Etoxazole Fenbutatin-oxide Gamma-cyhalothrin Hexythiazox Lambda-Cyhalothrin Malathion Dormant oil Potassium laurate Spinosad Spinosyn A Spirodiclofen Spiromesifen	Treat in early May and/or mid- to late September before major buildup occurs, or when present otherwise. Multiple generations are most prolific with cool spring and fall weather. Treat with hexythiazox before mites are present. Some of miticides are sold as mixtures with other products
Mites Eriophyid mites (white pine, spruce, fir)	Avermectin B1 Bifenthrin Carbaryl (Sevin) Fenpyroximate Lime sulfur Milbemectin (A mixture of ≥70% Milbemcin A4, & ≤30% Milbemycin A3) Mineral oil Dormant oil Pyrethrins Spirodiclofen Spiromesifen Sulfur	Treat in March or April, or when mites are found. They are active in cold weather, spring and fall. Oil sprays may remove needle ”bloom.”
Mites Rosette bud mites (fraser fir)	Avermectin B1 Fenpyroximate Lime sulfur Mineral oil Sulfur Mixtures of Avermectin B1 & Bifenazate	Treat between the last week of May and the third week of June. Treat 3-5 foot trees when more than 10% have damaged buds.
Pine Tip Moth Nantucket pine tip moth (all 2 and 3 needled pines)	Azinphos-Methyl, Gusathion Bifenthrin (Brigade) Carbaryl (Sevin) Chlorpyrifos (Dursban) Decemthion (Phosmet) Esfenvalerate (Asana) Imidacloprid Permethrin Piperonyl butoxide & Pyrethrins Pyrethrins Spinosyn A	Thoroughly wet all needles and shoots with full coverage spray. Treat in early to late April and repeat 1-2 times at 8-week intervals. Recommend using systemics for the 2nd or 3rd generations, since timing of larval presence is less precise at that time. Systemic: kills larvae in needles and new shoots before they cause serious damage. Full coverage spray of shoots and needles. Contact: kills young and larvae before mining needles and entering shoots. Treat when adults are active, repeat as indicated on the label, before larvae enter shoots.
Pine Webworm	Azadirachtin	Treat for pine webworm (yellow-brown larvae) in July and August; pine false webworm (green sawfly larvae) in May and June. Apply full-coverage spray before nests become enlarged.

Table 8.10 - Recommended Control (continued)

Insect	Name	Remarks
Sawflies redheaded pine sawfly	Azadirachtin Chlorpyrifos (Dursban) Esfenvalerate (Asana) Imidacloprid Malathion Phosmet Spinosyn A	Treat when larvae first appear, before extensive feeding occurs, May to September. Introduced pine sawfly has two generations, June and August. Redheaded pine sawflies may produce colonies at any time in the summer. BT is site labeled for ornamental pine trees.
Sawflies introduced (European) pine sawfly	Acetamiprid Azadirachtin Chlorpyrifos (Dursban) Deltamethrin (K-othrin) Diazinon Esfenvalerate (Asana) Lambda-Cyhalothrin Malathion Phosmet Spinosad Thiamethoxam	
Scale Insects cryptomeria scale pine needle scale, pine tortoise scale, woolly pine scale elongate hemlock scale	Acetamiprid Azadirachtin Buprofezin Chlorpyrifos (Dursban) Diazinon Dinotefuran Gamma-cyhalothrin Lambda-Cyhalothrin Lime sulfur Malathion dormant oil Permethrin Spirotetramat	Cryptomeria scale should be treated with bifenthrin in May. Elongate Hemlock Scale: treat with one of the following in June: Safari (dinotefuran) Talus (buprofezin) a mixture of Dimethoate with a synthetic pyrethroid (esfenvalerate or bifenthrin) Dormant oil may be applied in the winter but growers should only expect 75% control Treat for crawlers of pine needle scale in mid- to late May and/or mid- to late July; pine tortoise scale mid- to late June; and woolly pine scale late June to early July. Use as dormant spray before buds swell. Not fully effective for pine needle scale. Oil spray may remove needle “bloom.”
Spotted Lanternfly	Dinotefuran	Spotted lanternfly is not a pest of Christmas trees but may lay eggs on trees if the farm is in the infested zone. Check trees before shipping for Spotted Lanternflies Growers shipping trees out of the Quarantine zone may be required to get a Spotted Lanternfly Permit, see: https://www.vdacs.virginia.gov/plant-industry-services.shtml and see: https://ext.vt.edu/agriculture/commercial-horticulture/spotted-lanternfly.html

Table 8.10 - Recommended Control (continued)

Insect	Name	Remarks
Spittle Bugs	Acetamiprid Asana, Esfenvalerate Azadirachtin Beauveria bassiana Beta-cyfluthrin Bifenthrin (Brigade) Bromchlophos, Dibrom Carbaryl (Sevin) Chlorantraniliprole Chlorpyrifos (Dursban) Clothianidin Cyfluthrin Deltamethrin (K-othrin) Endosulfan Fenpropanate, Danitol Gamma-cyhalothrin Gusathion, Carfene Imidacloprid Lambda-Cyhalothrin Malathion Permethrin Spirotetramat Tall oil fatty acids, potassium salts Thiamethoxam	Treat in mid- July when 95% of spit masses are empty. A strong stream of water will often remove spittle bugs from the tree.
Weevils Pine reproduction weevils, Pales weevil, Eastern Pitcheating weevil. (coifers: feed on first year stumps and the base of recently dead trees as larvae. The adults may feed on live twigs.)	Bifenthin (for root weevils) Esfenvalerate Imidan Permethrin	In forest plantations, wait one year to replant with seedlings if harvesting took place after June 1. Seedlings are currently treated in nursery beds prior to lifting under SLN registration; foresters and landowners can order seedlings that are already treated. In Christmas tree plantations, stump removal or stump treatment with insecticide (as described below) is recommended. Thoroughly soak stumps and ground surface 1 to 2 ft around stumps or slash prior to mid- march. Apply Imidan as 4% top dip for seedlings prior to planting. Follow label directions. For seedlings: Apply as a full coverage spray to seedlings Immediately after planting. For stumps: Thoroughly soak stumps and ground surface around stumps or slash prior to mid- March. Only stumps or wood cut since previous summer need treatment. Dilute Asana in kerosene.
Weevils Pales weevil	Esfenvalerate (Asana) Permethrin	Apply as a full coverage spray to seedlings immediately after planting. Dilute Asana in water. Thoroughly soak stumps and ground surface 1-2 feet around stumps or slash prior to mid-March. Only stumps or wood cut since previous summer needs treatment. Dilute Asana in kerosene. Dilute permethrin in water.
Weevils White pine weevil	Asana Avermectin B1 Bifenthrin (Brigade) Diflubenzuron (Dimilin) Dinotefuran Emamectin benzoate Imidacloprid	Spray only the main upright leader down to the first branched whorl, prior to April 1-10. Remove and destroy infested shoots before mid- June; do not leave them on the ground.

E-emulsifiable; EC-emulsifiable concentrate; WP-wettable powder; F-flowable; S-sprayable; SP sprayable powder; gal-gallon; pt-pint; lb-pound; tsp-teaspoon; tbsp-tablespoon;

[1]**RESTRICTED-USE** insecticide.

Precautions: Do not allow any insecticides as sprays, drift, or runoff to contaminate bodies of water, streams, or drainage systems. Carbaryl is highly toxic to honey bees. Follow precautionary instructions on labels and use protective equipment wherever specified.

Equivalents: 1 lb WP per 100 gal = 1 Tablespoon per gal; 1 pt EC per 100 gal = 1 teaspoon per gal

Pests of Forestry and Christmas Trees: Christmas Tree Weeds

Jeffrey F. Derr, Extension Weed Scientist, Hampton Roads AREC

Weed control is considerably more complicated in crops with a long-duration cropping sequence such as Christmas trees. Perennial weeds are not likely to become a serious problem in annual crops since they can be removed either mechanically or chemically after harvest or before planting. Because perennial weeds such as poison ivy, brambles, shrubs, and small tree sprouts cannot be easily removed without serious risk to young Christmas trees, proper site preparation is critical to the long-range management of a tree plantation. After an effective site preparation program has been completed, preemergence herbicides may be used to prevent the re-establishment of annual grasses and broadleaf weeds. The maintenance of a weed-free strip in the planted row will increase tree survival and subsequent growth.

■ Sod Suppression in Fraser Fir

An alternative to mowing and/or complete vegetation control is sod suppression using low herbicide rates. The intent is to minimize weed competition while maintaining a groundcover to minimize soil erosion. Sod suppression treatments are generally applied in spring when grass has greened up but prior to budbreak of trees. Reapplication may be needed in mid- to late summer. Potential treatments include glyphosate, glyphosate plus oxyfluorfen, sethoxydim plus oxyfluorfen, and sethoxydim plus oxyfluorfen plus clopyralid. See herbicide labels for specific directions.

■ Weed Control in Christmas Trees

Table 8.11 - Herbicides for Weed Control in Christmas Trees

Crop	Weed Problem	Chemical Rate/A	Remarks
Preemergence to weeds	Annual grasses and yellow nutsedge	metolachlor 1.2-2.4 lb Pennant Magnum 1.3-2.6 pt	Apply prior to nutsedge and annual grass emergence and prior to bud break. Combine with simazine for greater broadleaf control. For small areas apply 0.5-0.9 fl oz Pennant Magnum/1,000 sq ft.
	Annual grasses, yellow nutsedge, and certain annual broadleaf weeds	dimethenamid 0.98-1.5 lb ai (Tower 6EC 21.0-32.0 fl oz/A)	Apply to established plantings prior to weed emergence or include a postemergence herbicide to control emerged weeds. Can also be applied to new plantings after the soil has settled from rain or irrigation. Apply as a directed spray either prior to bud break or after new growth has hardened. Combine with a preemergence broadleaf herbicide for broader-spectrum control. Use a shielded spray if trees have been in the ground less than one year. For small areas, apply 0.48-0.73 fl oz/1000 sq ft.
	Most annual grasses and certain annual broadleaf weeds	napropamide 4.0-6.0 lb (Devrinol 50DF 8.0-12.0 lb)	Apply prior to weed germination in fall or early spring. Rainfall or irrigation within 2-3 days after application is needed for maximum weed control. Tank mixing with other herbicides such as simazine improves the spectrum of broadleaf weeds controlled. For small areas apply 2.9-4.4 fl oz Devrinol 50DF/1,000 sq ft.
		oryzalin 2.0-4.0 lb (Surflan 4AS 2.0-4.0 qt, Oryzalin 4AS 2.0-4.0 qt)	Apply to established plants (at least two weeks in containers) as a directed spray before weeds emerge. May be tank mixed with other herbicides such as simazine to control a greater spectrum of broadleaf weeds in field grown Christmas trees. Should be applied in the fall or early spring when rainfall is likely to activate the herbicide. For small areas, apply 1.5-2.9 fl oz Surflan 4AS. Oryzalin is currently unavailable so consider other options.
		pendimethalin 2.0-4.0 lb (Pendulum AquaCap 2.1-4.2 qt)	Apply to established plants as a directed spray prior to weed germination and budbreak. For small areas apply 1.6-3.2 fl oz Pendulum AquaCap per 1000 sq ft.
	Most annual grasses and broadleaf weeds	flumioxazin 0.25-0.375 lb (SureGuard 8.0-12.0 oz)	Preemergence and early postemergence action. Apply as a directed spray to dormant trees prior to weed germination or to small emerged weed seedlings. Combine with a labeled postemergence herbicide for control of larger annual weeds or perennials. Can be applied overtop to dormant conifers. For small areas, apply 0.18-0.275 oz/1,000 sq ft.
		flumioxazin 0.21 lb plus pyroxsulfone 0.27 lb (SureGuard Xtra 20 fl oz)	Make only one application per year. Apply as a directed spray to dormant, established Christmas trees.
		indaziflam 0.036-0.075 lb (Marengo 7.5-15.5 fl oz)	Apply to established Christmas trees as a directed spray, ideally when the trees are dormant. Do not exceed 18.5 fl oz/acre/year. Long residual herbicide for preemergence control of many weeds. Include a postemergence herbicide for control of emerged weeds as indaziflam has limited postemergence activity.

Table 8.11 - Herbicides for Weed Control in Christmas Trees (continued)

Crop	Weed Problem	Chemical Rate/A	Remarks
Preemergence to weeds (continued)	Most annual grasses and broadleaf weeds	oxyfluorfen 1.0-2.0 lb (Goal 2XL 4.0-8.0 pt or Goaltender 2.0-4.0 pt)	Apply as overtop treatment to newly planted or established conifers before bud-break in the spring or after the foliage has hardened off. Preemergence control plus control of small weeds less than 3-4 inches in height. Will injure tender growth if applied after buds break dormancy. For small areas apply 1.5-2.9 fl oz Goal or 7.5-1.5 fl oz GoalTender 2XL/1,000 sq ft.
		pronamide 1.0-2.0 lb (Kerb 50W 2.0-4.0 lb, Kerb SC 2.5-9.5 pt)	Fall application to fir or pine species established one growing season. High rate has given control of quackgrass and other cool-season perennial grasses like fescue, bluegrass and orchardgrass. For small areas, apply 0.7-1.4 oz Kerb 50W or 0.9-3.5 fl oz Kerb SC/1,000 sq ft. RESTRICTED USE.
		simazine 2.0-4.0 lb (Princep 4L 2.0-4.0 qt)	Make application after rainfall has firmed the soil around the roots of Christmas trees and before weeds start to emerge. Simazine may be applied in spring or fall but do not use more than one application of simazine/year or injury may result. Do not use on seedlings less than 2 years of age. For small areas, apply 1.5-2.9 fl oz Princep 4L/1,000 sq ft.
Postemergence to weeds	Certain broadleaf weeds	clopyralid 0.09-0.25 lb (Stinger 1/4-2/3 pt)	Primarily controls legume and composite weeds (clover, vetch, thistles, ragweed, etc.). Use lower rates for small, actively growing weeds. Apply only to trees established at least one year. Can be applied overtop trees.
	Emerged weeds	glyphosate 0.75-3.7 lb ae (Roundup Pro, Roundup ProMax 1.0-3.3 qt, or other labeled formulation; for wiper applications, use 1 part herbicide to 2 parts water; for cut stump treatments, use a 50-100% solution).	For site preparation, apply in strips in the fall prior to planting. Do not disturb treated soil for at least 7 days after treatment. Apply as a directed spray to pine, spruce or fir when trees are not in active growth. Conifers are most tolerant to glyphosate in the fall. Do not allow spray to contact foliage of Christmas trees, especially if earlier applications are made. For small-area application with a hand sprayer, use 2.0 oz/gal of water and lightly wet the foliage. There are other glyphosate formulations available. Check label for application rates.
		glufosinate 0.5-1.5 lb (Finale XL T & O 27-82 fl oz, Cheetah Pro 24-82 fl oz)	Apply as a directed spray, keeping the herbicide off the Christmas tree branches. Contact herbicide with some systemic action. Controls a wide range of annual and perennial weeds. Apply when weeds are small and actively growing. No residual control, add a preemergence herbicide for extended weed control. Ensure complete coverage of weed foliage. For spot application, mix 0.5-3.2 fl oz Finale XL T&0 per gal or 0.5-2.0 fl oz Cheetah Pro per gal.
		paraquat 0.63-1.0 lb (Gramoxone SL 2.5 - 4.0 pt + nonionic surfactant 1.0-2.0 pt/100 gal)	Apply as a directed spray for contact kill of annual weeds. For spot application, mix 0.5-3.2 fl oz Finale XL T&0 per gal or 0.5-2.0 fl oz Cheetah Pro per gal. Do not allow spray to contact desired foliage. May be combined with other herbicides such as simazine for residual control. For small-area application, use 2/3 fl oz plus 0.5 fl oz spreader sticker/gal of water and lightly wet foliage. Thorough coverage is important. RESTRICTED USE.
		topramezone 0.09 lb (Frequency 4 fl oz + a crop oil concentrate or methylated seed oil at 1% v/v)	Apply as a directed spray for control of many broadleaf and certain grassy weeds. Controls glyphosate-resistant weeds such as horseweed, lambsquarters, and ragweed.
	Annual and perennial grasses	clethodim 0.07-0.24 lb (Envoy Plus 9.0-32.0 fl oz + 1.0% crop oil concentrate)	Apply to actively growing grasses. For spot treatment use a 0.44-0.85 fl oz/gal solution plus 1.0% crop oil concentrate. A repeat application may be required for perennial grasses control.
		fluazifop-P-butyl 0.25- 0.375 lb (Fusilade II 16.0-24.0 fl oz + 0.5 pt nonionic surfactant/25.0 gal)	May be applied overtop of selected trees (see label) but should be used as a directed spray after bud break until new growth hardens. (For spot treatment with hand held sprayers, use 0.75 oz of Fusilade II plus 0.5 oz of surfactant/gal of water) Treat perennial grasses at the following stages of growth: bermudagrass 4-8 inch runners; johnsongrass 12-18 inches tall; quackgrass 3-5 leaves, but not more than 10 inches tall. Apply only to actively growing grasses not under moisture stress. A repeat application may be necessary in 7-14 days on some perennial grasses.

Table 8.11 - Herbicides for Weed Control in Christmas Trees (continued)			
Crop	**Weed Problem**	**Chemical Rate/A**	**Remarks**
Postemergence to weeds (continued)	Annual and perennial grasses (continued)	sethoxydim 0.28-0.47 lb (Segment II 1.5-2.5 pt/A) + 2 pt/A crop oil concentrate or 1.5 pt/A methylated seed oil	May be applied overtop young trees or banded to conserve material. Use lower rates on annual grasses less than 6 inches tall and high rate on taller annual grasses and perennial grasses. Apply only to actively growing grass. Do not use under severe moisture stress. For spot treatment, use use 1.3 fl oz Segment II + 0.6 fl oz COC or 0.5 fl oz MSO per gal. A repeat application may be needed to control perennial grasses.

Table 8.12 - Guide for Herbicide Selection – Christmas Trees[1]				
Herbicide	**Fraser Fir**	**Norway Spruce**	**Scotch Pine**	**White Pine**
Devrinol	X	X	X	X
Envoy	X	X	X	X
Frequency	X	X	X	X
Fusilade	X	X	X	X
Goal	X	X	X	X
Gramoxone	X	X	X	X
Kerb	X	X	X	X
Marengo	X	X	X	X
Pendulum	X	X	X	X
Pennant	X	X	X	X
Segment	X	X	X	X
Princep	X	X	X	X
Roundup	X	X	X	X
Stinger	X	—	—	X
SureGuard	X	X	X	X
Surflan	X	X	X	X
Tower	X	X	X	X

[1]An "X" indicates the herbicide is labeled for that particular species. Check the product label for a more complete listing of plants and directions for use.

Table 8.13 - Weed Susceptibilities to Preemergence Herbicides Labeled for Use in Christmas Tree Production[1]										
	Devrinol	**Goal**	**Kerb**	**Pendulum**	**Pennant**	**Princep**	**SureGuard**	**Surflan**	**Tower**	**Marengo**
Annual Grasses										
Crabgrass	E	F	F	E	G	F-G	F-G	E	G	E
Foxtails	E	F	F	E	G	G	F-G	E	G	G
Fall panicum	G	F	P	G	G	F-G	—	G	G	G
Annual Broadleaves										
Lambsquarters	G	G	F	G	P	E	E	G	P	F-G
Morningglory	N	F	P	P	N	G	G	P	N	P
Ragweed	F	G	P	N	N	E	E	P	P	F-G
Smartweed	P	G	F	F	P	E	—	P	P	—
Perennial Grasses and Sedges										
Bermudagrass	N	N	P	N	N	N	N	N	N	N
Johnsongrass	P	N	P	P	N	P	N	P	N	—
Fescue	N	N	E	N	N	P	N	N	N	P
Yellow nutsedge	P	N	N	N	G	N	N	N	F-G	N
Perennial Broadleaves										
Poison ivy	N	N	N	N	N	N	—	N	N	—
Blackberry	N	N	N	N	N	N	—	N	N	—
Honeysuckle	N	N	N	N	N	N	—	N	N	—

[1]E = 90% or greater control, G = 75 to 90% control, F = 50 to 75% control, P = slight control, and N = no control.

Table 8.14 - Weed Susceptibilities to Postemergence Herbicides Labeled for Use in Christmas Tree Production[1]								
	Fusilade	Envoy	Frequency	Gramoxone	Segment	Roundup	Stinger	Finale
Annual Grasses								
Crabgrass	E	E	G	E	E	E	N	G
Foxtails	E	E	G	E	E	E	N	G
Fall panicum	E	E	G	E	E	E	N	G
Annual Broadleaves								
Lambsquarter	N	N	G	E	N	E	N	G
Morningglory	N	N	G	E	N	G	N	G
Ragweed	N	N	G	E	N	E	G	G
Smartweed	N	N	G	E	N	E	F	G
Vetch	N	N	-	F	N	P	G	G
Perennial Grasses and Sedges								
Bermudagrass	G	G	F	P	G	G	N	F
Johnsongrass	G	G	-	P	G	G	N	F
Fescue	P-F	F	P	P	F	G	N	F
Yellow nutsedge	N	N	N	P	N	G	N	F
Perennial Broadleaves								
Canada thistle	N	N	-	P	N	G	G	F
Poison ivy	N	N	-	P	N	G	-	F
Blackberry	N	N	-	P	N	G	-	F
Honeysuckle	N	N	-	P	N	G	-	F

[1]E = 90% or greater control, G = 75 to 90% control, F = 50 to 75% control, P = slight control, and N = no control.

Red Imported Fire Ant Management for Foresters and Loggers

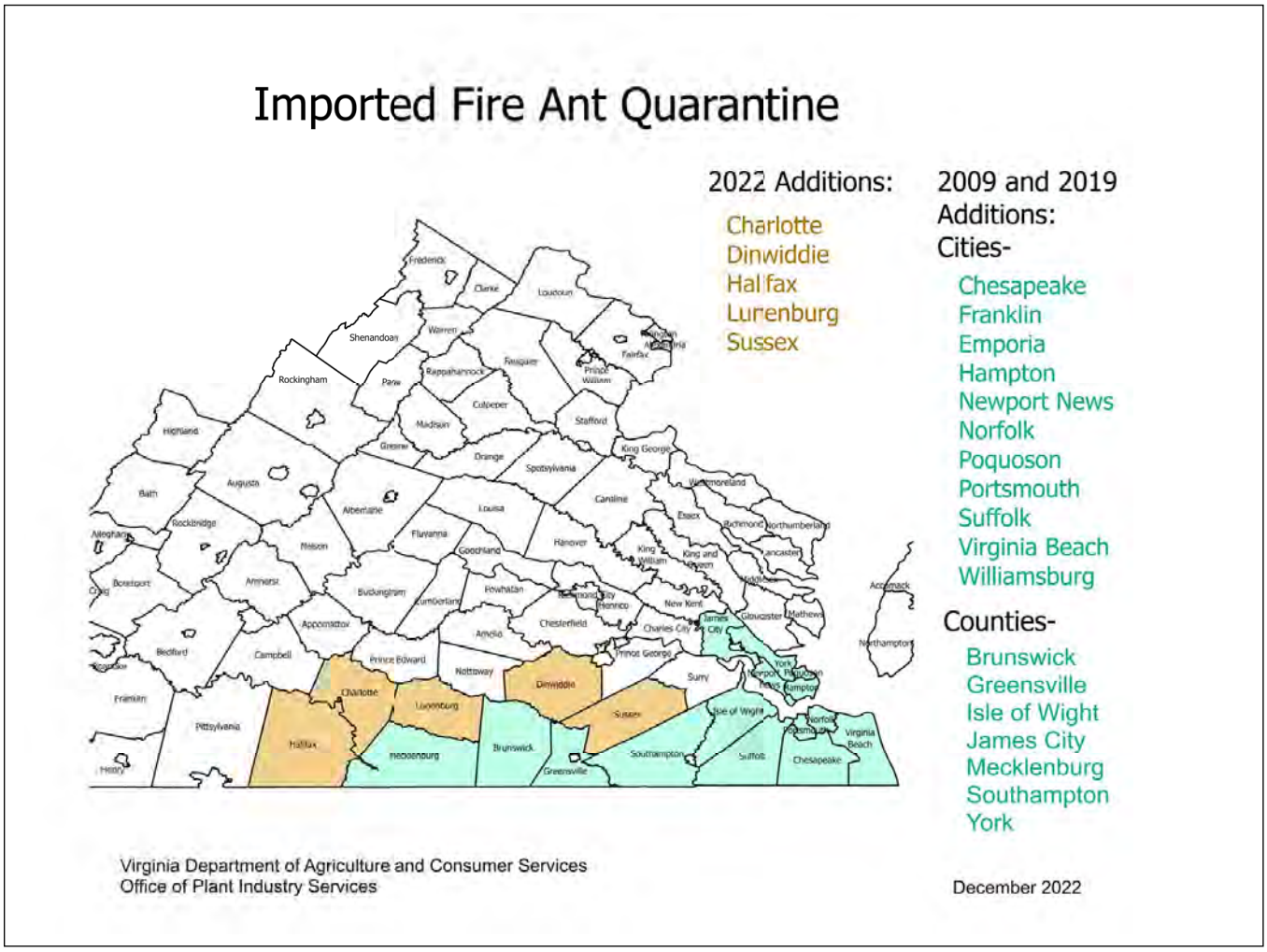
Eric Day, Scott Salom, Lori Chamberlin, Theresa Dellinger, and Katlin DeWitt

This guide is for foresters, woodland owners, and loggers in the Virginia quarantined counties of Brunswick, Greensville, Isle of Wight, James City, Mecklenburg, Southampton, and York and the independent cities of Chesapeake, Emporia, Franklin, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, and Williamsburg.

If you suspect a fire ant infestation within the quarantine area, please use caution and contact your local Virginia Cooperative Extension office for identification. If you suspect a fire ant infestation in Virginia outside of the known locations, submit a sample for confirmation to the Insect Identification Laboratory, via your local Virginia Cooperative Extension office.

If you have questions or need a permit because you are moving logs, trucks, or equipment outside of the quarantine area, contact the Virginia Department of Agriculture and Consumer Services (VDACS) Office of Plant Industry Services. Or call 804-786-3515

Fire Ant Quarantine in Virginia



For information on who needs to have a permit and inspection, please visit:
https://www.vdacs.virginia.gov/plant-industry-services-fire-ant-suppressioneand-eradication.shtml

Identification of the Red Imported Fire Ant, (RIFA), *Solenopsis invicta*

Several species of native mound ants that are capable of giving painful stings or bites are found in Virginia. The RIFA is an invasive species that has spread throughout the southeastern United States. It is a small red and black ant that is less than ¼ inch long. It has a thin, two-segmented waist and a two-segmented club on the end of each antenna. Its well known stinger is at the end of the abdomen and is retracted inside the body when not in use. For detailed information on distribution, biology and identification, see: https://www.ento.vt.edu/fireant.html and https://www.pubs.ext.vt.edu/tags.resource.html/pubs_ext_vt_edu:fire-ants. For a fire ant inspection checklist for loggers, see: https://www.pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/ENTO/ento-492/ENTO-492.pdf.

If you see red imported fire ants for the first time or suspect you have a new county record, please submit a sample to your local Virginia Cooperative Extension office. Specimens will need to be in a jar with rubbing alcohol. Use caution when collecting a sample and avoid being stung. An easy method is to use a plastic container and while wearing gloves and long sleeves, quickly scoop up some soil from the top of the mound where the ants are active and quickly mix in rubbing alcohol. Make sure not to step on an adjacent mound when sampling.

RIFA mounds are usually located in sunny locations in non-compacted soils. Look for them along fences, next to farm buildings, near electrical boxes, base of trees and stumps, and containerized trees. Ant mounds will be about 6-8 inches tall and about 12 inches in diameter. Fire ant colonies may also be located under crop debris and litter including trash.

MANAGEMENT IN WOODED AREAS

Fire ants are not normally a problem on established forestry land and do not need to be controlled if no activity is taking place. Fire ants prefer open and sunny locations but are associated with trees when the trunk or base of the tree is exposed to sunlight. Fire ants have been located as well in forest clearings following timber harvests and during site preparation and reforestation operations. Fire ants are rare in shaded woods in part due to high population densities of native ants. For fire ant problems on the interface of housing and woodland areas see the Fire Ant section in the Virginia Pest Management Guide: Home Grounds and Animals.

BEFORE AND DURING HARVEST

Check along newly established logging roads and edges of loading docks for fire ant mounds. Pay particular attention to the base of trees, fence rows, and on relatively undisturbed soils adjacent to those sites. Soil and sand packed by traffic are not likely to have fire ant mounds.

Insect	Recommended Control	Remarks
Fire Ants (All logging situations in the infested counties)	Step 1, Bait treatment Amdro Pro (hydramethylnon) Extinguish (methoprene) Advion (indoxacarb) Step 2, Mound treatment acephate bifenthrin dinotefuran lambda-cyhalothrin spinosad	Timing of treatment: Apply when worker ants are actively looking for food, usually in late afternoon or in the evening. To test, put a small pile of bait next to a mound and see if the ants find it within 30 minutes. Baits: Use fresh bait, preferably from an unopened container. Apply when the ground and grass are dry and no rain is expected for the next 24 to 48 hours. Apply baits with hand-held seed spreaders. Don't apply baits mixed with fertilizer or seed. Baits can be applied anytime during the warm season but fire ants in Virginia have peak activity in late summer. Re-apply baits once or twice a year depending on the situation. Step 2 Treat problem mounds that still have ants with a labeled contact insecticide

SPECIAL INFORMATION FOR DRIVERS MOVING LOGS AND EQUIPMENT FROM SITES IN THE QUARANTINE ZONE.

Logs, plant material, soil, and the vehicles that move material are potential carriers of live fire ants. Conveyances (logging trucks, trailers and equipment) may pick up soil on any part of their structure during the course of operations, and this soil may contain RIFA. It is important to check for clumps of soil trapped on the truck or skidder before it leaves the site.

Regulated articles that may be moved by loggers

Under the terms of the Virginia Fire Ant Quarantine, articles that are capable of transporting the red imported fire ant (regulated articles) are prohibited from moving out of the quarantined area unless certified as free of RIFA. Individuals who plan to move regulated articles out of the quarantined area should Contact VDACS' Office of Plant Industry Services to determine options for certifying regulated articles as free of red imported fire ants.

What is regulated?

Regulated articles include, but are not limited to:

- Any life stage of red imported fire ant
- Soil, except soil shipped in original containers after commercial preparation
- Plants with roots with soil attached and rhizomes with soil attached
- Grass sod
- Used soil-moving equipment unless free of all non-compacted soil
- Used farm equipment, unless free of all non-compacted soil
- Pine straw stored in direct contact with the ground or harvested from infested counties
- Logs and pulpwood with soil attached

Before the truck or equipment arrives at the site

In order to avoid delays, check with VDACS prior to picking up logs from a site in the quarantine area (Brunswick, Greensville, Isle of Wight, James City, Mecklenburg, Southampton, and York and the independent cities of Chesapeake, Emporia, Franklin, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach and Williamsburg). A compliance agreement may be required.

Parking or moving about on the site

- Park on pavement or hard packed soil away from any visible fire ant mounds.
- Check where vehicles are parked overnight, as fire ants may move their nest over a few hours.
- Treat fire ant mounds anywhere vehicles are parked.

Leaving the site

Inspect the truck before beginning your trip even if it has been on site for only a short period of time. The business owner is responsible for getting the cargo inspected and giving you a copy of the permit before you leave the quarantine area. To obtain a permit, the business owner should contact VDACS (Office of Plant Industry Services. Or call 804-786-3515).

Insect	Recommended Control	Remarks
Fire Ants (Trucks, skidders, loaders, and other conveyances that can carry soil)	Sweep or powerwash soil from all vehicles, trailers, and equipment that is moved from a logging operation in an infested county. Set aside an area to clean conveyances.	Trailer landing gear, outriggers, and loaders all have the potential to carry soil infested with fire ants. Conveyances are defined as skidders, loaders, trucks, trailers, and any other equipment that can potentially move soil with fire ants. Truckers should consult the USDA brochure entitled Truckers: Don't Let Imported Fire Ants Hitch a Ride at https://www.aphis.usda.gov/plant_health/plant_pest_info/fireants/downloads/ifa-truckers-brochure.pdf

Post harvest

Fire ants can be common after harvest with nests at the base of remaining trunks. If replanting is planned, control may be necessary to protect the tree planting crews. Monitor site prior to planting and treat as needed using the two-step method. Planting equipment will need to be checked for soil and posible fire ants before being removed from the site. See table above on how and when to treat fire ants.

Low Management Crops and Areas: Aquatic Weeds (Weed Control in Ponds and Lakes)

Robert J. Richardson, Professor and Extension Specialist, North Carolina State University

The use of pesticides in aquatic environments is quite restricted because these areas provide water for irrigation, recreation, and domestic uses. The recommendations in this section use the herbicide's common name. In the state of Virginia, there are over 100 different trade names for glyphosate and 2,4-D. Only those specifically labeled for aquatics may be used. It is important that chemicals used in these areas be applied strictly in accordance with label directions, as the label is the federal law.

Treatment of aquatic weeds should take place in the spring as the weeds begin active growth. It is important to adhere to this application suggestion, even if an infestation is small. Later in the season, weed density and maturity make control more difficult. Sampling the lake bottom in the late spring or early summer in areas heavily infested the year before should show when the growth begins. The treatment of dense weed growth can result in oxygen depletion during the decomposition of the dead plants. Severe oxygen depletion can cause a fish kill. Many times it may be necessary to treat only 1/3 to 1/2 of the impoundment at a time.

Recommendations for aquatic applications are based on rate per surface area, rate per acre foot, or parts per million (ppm). An acre foot is 1 acre of water 1 foot deep. For a pond with a gradual slope, acre feet may be determined approximately by multiplying 1/2 the depth at the deepest point, times the surface area. A pond with 1 surface acre and a gradual slope to a 10-foot depth at the deepest point would contain approximately 5 acre feet of water. It is important to get as accurate an estimate as possible. An acre foot of water weighs 2,700,000 pounds, therefore it will require 2.7 pounds of active ingredient to achieve 1 ppm.

There is a quick reference table at the end of this section with water-use restrictions after herbicide application. These restrictions must be followed. Where more than one herbicide is suggested for a specific aquatic weed, please refer to the herbicide information table to find a suitable product.

Table 9.1 - Effectiveness of Herbicides and Triploid Grass Carp for Control of Weeds Commonly Found in VA Ponds

Weeds	2,4-D	bispyribac	carfentrazone	copper compounds	diquat	diquat +copper	endothall: Aquathol	endothall: Hydrothol	florpyrauxifen-benzyl	flumioxazin	fluridone	glyphosate	imazamox	imazapyr	peroxide compounds	penoxsulam	triclopyr	triploid grass carp
Algae																		
Planktonic	NR	ID	NR	G	P	G	NR	P	NR	ID	NR	NR	NR	NR	G	NR	NR	NR
Filamentous	NR	ID	NR	G	E	E	NR	E	NR	G	NR	NR	NR	NR	ID	NR	NR	P
Chara / Nitella	NR	ID	ID	G	G	E	NR	G	NR	P	NR	NR	NR	NR	ID	NR	NR	E
Floating Plants																		
Azolla (mosquito fern)	NR	G	F	F	E	E	NR	NR	G	ID	E	NR	ID	NR	NR	G	NR	P
Duckweed	P	G	G	P	G	G	NR	NR	NR	E	E	NR	NR	NR	NR	G	P	P
Frogbit	F	ID	ID	NR	E	E	NR	NR	ID	G	NR	P	E	E	NR	ID	G	P
Salvinia, common	NR	G	G	P	E	E	NR	NR	NR	G	E	G	E	ID	NR	ID	NR	P
Salvinia, giant	NR	G	G	P	E	E	F	NR	NR	F	E	G	P	G	NR	E	NR	P
Waterhyacinth	E	G	G	NR	G	G	NR	NR	E	P	F	G	E	G	NR	E	E	P
Watermeal	NR	NR	NR	NR	P	P	NR	NR	NR	G	G	NR	NR	NR	NR	P	NR	P
Water lettuce	NR	G	G	NR	G	G	G	G	NR	E	NR	E	G	E	NR	E	NR	P
Emersed Plants																		
Alligatorweed	P	G	F	NR	NR	NR	NR	NR	G	F	F	G	G	G	NR	G	G	P
American lotus	G	ID	NR	NR	NR	NR	NR	NR	ID	ID	G	E	F	G	NR	ID	G	P
Cattail	F	ID	NR	NR	F	F	NR	NR	NR	P	G	E	G-E	E	NR	ID	F	P
Creeping waterprimrose	E	ID	F	NR	NR	NR	NR	NR	G	ID	F	E	F	E	NR	G	E	P
Floating hearts	P	ID	NR	NR	F	F	E	E	G	ID	F	G	G	G	NR	F	P	P
Fragrant waterlily	G	ID	NR	NR	NR	NR	NR	NR	E	ID	G	E	G	E	NR	ID	G	P
Grass species	NR	ID	NR	NR	F	F	NR	NR	NR	NR	F	E	F	E	NR	ID	NR	P
Parrotfeather	E	G	F	NR	NR	NR	NR	NR	E	F	NR	F	G	E	NR	G	E	NR

Table 9.1. Effectiveness of Herbicides and Triploid Grass Carp for Control of Weeds Commonly Found in VA Ponds (continued)

Weeds	2,4-D	bispyribac	carfentrazone	copper compounds	diquat	diquat +copper	endothall		florpyrauxifen-benzyl	flumioxazin	fluridone	glyphosate	imazamox	imazapyr	peroxide compounds	penoxsulam	triclopyr	triploid grass carp
							Aquathol	Hydrothol										
Emersed Plants (continued)																		
Phragmites (Common reed)	NR	ID	NR	NR	NR	NR	NR	NR	NR	P	NR	G	F-G	E	NR	NR	F	P
Pickeralweed	G	ID	NR	NR	NR	NR	NR	NR	E	ID	NR	F	E	E	NR	ID	G	P
Rush	NR	ID	NR	NR	NR	NR	NR	NR	NR	ID	NR	G	ID	G	NR	ID	F	P
Spatterdock	G	ID	NR	NR	NR	NR	NR	NR	P	ID	G	E	G	E	NR	ID	F	P
Smartweeds	F	ID	NR	NR	F	F	NR	NR	G	ID	F	G	G	G	NR	F	G	P
Waterpennywort	G	G	NR	NR	F	F	NR	NR	ID	G	G	E	E	E	NR	F	G	P
Watershield	E	ID	NR	NR	F	F	NR	NR	G	ID	F	E	G	G	NR	ID	E	P
Submersed Plants																		
Bladderwort	P	ID	ID	NR	F	F	P	P	F	ID	E	NR	F-G	NR	NR	ID	P	E
Cabomba (fanwort)	NR	ID	ID	NR	F	F	F	F	F	G	F	NR	F	NR	NR	ID	NR	F
Coontail	G	ID	ID	NR	E	E	E	E	F	G	E	NR	NR	NR	NR	ID	G	E
Egeria (Brazilian elodea)	NR	ID	ID	F	E	E	P	P	F	ID	E	NR	ID	NR	NR	G	NR	E
Eurasian watermilfoil	E	G	G	NR	G	G	E	NR	E	G	E	NR	F	NR	NR	G	E	P
Hydrilla, monoecious	NR	G	ID	F	G	E	E	E	E	G	E	NR	F	NR	NR	G	NR	E
Naiad, brittle	NR	ID	ID	G	E	E	E	E	ID	G	E	NR	ID	NR	NR	F	NR	E
Naiad, Southern	NR	ID	ID	G	P	G	P	P	ID	G	G	NR	ID	NR	NR	F	NR	E
Parrotfeather	E	G	ID	NR	G	G	E	E	E	G	E	NR	F	NR	NR	G	E	F
Pondweed species	NR	G	ID	NR	E	E	E	E	P-F	G	E	NR	G	NR	NR	G	NR	E
Proliferating spikerush	NR	ID	ID	NR	NR	NR	NR	NR	F	P	F	NR	F	NR	NR	F	NR	E
Variable leaf milfoil	E	ID	G	NR	E	E	E	E	E	E	G	NR	NR	NR	NR	NR	E	P

Key: NR = Not Recommended; P = Poor; G=Good ; ID = Insufficient Data; F = Fair; E = Excellent

Table 9.2 - Herbicide Information. IT IS IMPORTANT TO ALWAYS READ AND FOLLOW THE HERBICIDE LABEL.

Herbicide	Remarks
2,4-D	Rate depends on species and depth of water. Water use restrictions vary by formulation and manufacturer. In general, if water is used for irrigating sensitive crops, 2,4-D should not be used. Turfgrasses are generally tolerant to low concentrations of 2,4-D. Also, many 2,4-D formulations are NOT labelled for aquatic use. Read the label before purchasing and/or use. Avoid drift to susceptible plants.
Aquashade, many dye products are available.	A blue dye that reduces light penetration in water for up to six weeks may be used to reduce filamentous algae growth in ponds, ornamental ponds or fountains, commercial fish ponds, and lakes. There must be little or no flow out of the pond. Additional applications are made to maintain acceptable shade. Aquashade is not effective when weed growth nears the surface.
carfentrazone	Rates vary according to target species. Retreatment of some plants may be required. Methylated seed oil or nonionic surfactant recommended for application on floating plants. Degradation is pH dependent and efficacy will be reduced when water pH > 7.5.
copper complex, copper sulfate, other copper products	For optimum control, spray over surface when algae first become visible. Expect temporary control. Repeat treatments are often necessary. Do not use copper sulfate in trout ponds. Hard water requires more copper sulfate than soft water. The copper complex formulation does not precipitate as fast as copper sulfate and usually provides more effective control results. Dilute copper complex with 9 parts of water and spray the surface. Break up the floating mats of filamentous algae before treatment. Water temperature should be about 60˚F. Apply on a clear day. Corrosive to spray equipment. Water may be used immediately for swimming, fishing, irrigation, and potable water. Do not use copper complex in water containing trout if the carbonate hardness of the water does not exceed 50 ppm, as it may cause fish kill. Excessive rates may also cause fish kill. When treating chara or nitella, treat only to 1/3 of pond at one time. Allow 7 to 14 days between applications.

Table 9.2 - Herbicide Information. IT IS IMPORTANT TO ALWAYS READ AND FOLLOW THE HERBICIDE LABEL. (continued)	
Herbicide	**Remarks**
diquat	Apply uniformly over the surface or inject below water surface. For submersed weeds, apply early in season by pouring directly into water in strips 40 ft apart. Later in season, as weeds reach surface, pour in strips 20 ft apart or inject a dilute solution. Avoid stirring the bottom mud. Diquat binds to clay particles and turbid water will reduce efficacy. Retreatment may be necessary if regrowth occurs from underground vegetative parts. **Diquat may be fatal if swallowed, inhaled, or absorbed through skin.** Copper is sometimes added to improve control with diquat. Be sure to follow the label. When controlling cattail, thoroughly wet the blooms.
endothal, dipotassium salt	Granular materials are preferred for spot treatment or treating marginal areas of a pond. Water temperature should be 65˚F or above. If areas of heavy vegetation are treated, treat in sections 5 to 7 days apart to prevent fish kill by oxygen depletion during vegetation decay. – follow label for safe handling. Rate will be dependent on most difficult weed to control in the pond.
florpyrauxifen-benzyl	May be used for in-water or foliar treatments. Product rates are based on prescription dose units. Allow 14 days or greater between applications. Do not use treated water for irrigation unless specifically allowed by product label. Do not allow contact with sensitive desirable plant species.
flumioxazin	Rates vary according to target species and application method. Degradation is pH dependent and efficacy will be reduced when water pH > 7.5. Mix water should have pH < 7.0. A nonionic surfactant is recommended.
fluridone	Apply uniformly across the waterbody. Do not apply when there is substantial outflow from the pond. Effects on plant will be gradual from 30 to 90 days for complete response. Use rates will vary by target species and water depth. Generally not effective for small spot treatments.
glyphosate	Glyphosate efficacy may be reduced if very hard water containing high concentrations of iron is used to prepare spray solutions. Vegetation must be on or above the surface for treatment to be effective. For floating or emersed weeds, apply to wet foliage above water but do not spray to run off. If applying from a boat, take care not to create waves that may wash the herbicide off floating leaves. Apply in 20.0 gal of water/A as a broadcast spray. Apply to actively growing cattail at the early- to full-bloom stage of growth. Apply when spadderdock, water lily, and water shield are in full bloom. Use only glyphosate formulations labeled for aquatic use. A good surfactant will be required to get spray to wet waxy leaves.
imazamox	Rates vary according to species and application method. A surfactant is recommended for immersed and floating plants; see product label for specifics.
imazapyr	Rates vary according to target species. Retreatment of some plants may be required. The addition of a nonionic surfactant is recommended. When controlling phragmites, apply to green foliage after complete leaf elongation. Complete coverage is necessary. Do not use within the root zone of desirable plants.
triclopyr	Rates vary according to target species. The addition of a nonionic surfactant is recommended. When controlling purple loosestrife, apply to actively growing foliage at flowering. Follow-up spot treatments may be necessary.

Table 9.3 - Water-use Restrictions after Aquatic Herbicide Applications					
Aquatic Herbicide	**Water Use Restriction (days)**				
	Irrigation	**Fishing**	**Swimming**	**Livestock**	**Potable**
carfentrazone	1-14	0	0	0-1	
copper complex	0	0	0	0	0
copper sulfate	0[1]	0	0	0	0
2,4-D	**	**	**	**	**
diquat	1-5	0	0	1	1-3
endothall					
Aquathol K	0	0	0	0	**
Aquathol G	0	0	0	0	**
Hydrothol 191	0	0	0	0	**
florpyrauxifen-benzyl	***	0	0	***	****
flumioxazin	0-5	0	0	0	0
fluridone	0-7	0	0	0	**
glyphosate	0	0	0	0	**
imazamox	**	0	0	0	0
imazapyr	120	0	0	0	**
triclopyr	120	0	0	0*	**

[1]0 = no restriction

* Next growing season for lactating dairy animals. ** Varies, refer to label before use. ***Do not use treated water for irrigation or livestock. Certain irrigation uses may be permitted by label. **** Consult with relevant water authorities prior to application.

Table 9.4 - Herbicide Trade Names (See specific label for use.)	
Common Name	**Aquatic Trade Names**
carfentrazone	Stingray
copper[1]	Komeen, Nautique, Captain, Clearigate, Cutrine Plus, Cutrine Ultra, K-Tea, and many others
2,4-D	various trade names and formulations
diquat	Reward, Weedtrine-D, Eliminator, and many others
endothall inorganic salts	Aquathol K and Aquathol Super K
endothall amine salts	Hydrothol 191 and Hydrothol Granular
flumioxazin, common name - florpyrauxifen-benzyl trade name - Procellacor	Clipper
fluridone	Sonar, Avast!, and Fluridone
glyphosate	various trade names and formulations
imazamox	Clearcast
imazapyr	Habitat and Imazapyr
triclopyr	Renovate 3 and Triclopyr
[1]Copper products may be formulated as copper sulfate pentahydrate, copper complexes, or copper carbonate.	

■ Biological Control

With biological control, natural enemies are released to feed on aquatic weedy vegetation. Fish have been important in aquatic weed control. Triploid (sterile) grass carp have become the fish of choice for several weeds. Naiad, fanwort, hydrilla, coontail, various pondweeds, bladderwort, elodea, and chara are species usually controlled with the triploid sterile grass carp. Plants that are not preferred by the grass carp and, therefore, are not controlled very well include emergent tough or woody stem species such as cattail, waterlily, and rush. Filamentous algae, watermilfoil, Nitella, and watershield are not controlled very well.

Only triploid (sterile) grass carp may be introduced into Virginia waters for aquatic weed control. A permit must be obtained from the Virginia Department of Game and Inland Fisheries. An application may be obtained by a request via telephone (804) 367-8629 or through the Web (https://dwr.virginia.gov/forms-download/PERM/PERM-001.pdf). The application will not be processed without a detailed map(s) of the area. Application must also include the type of weeds and the percent of area covered, size (acres), primary use of the pond, number of fish required, and means for containment of the fish. The application requires a $10 fee and a few weeks for granting approval. These fish may be stocked in relatively small impoundments where they can be readily contained. After receiving a permit, there are locations approved by the Department of Game and Inland Fisheries to purchase guaranteed triploid sterile grass carp.

Triploid (sterile) grass carp should be about 10 to 12 inches at time of stocking and normal stocking rates are 10 to 15 fish per acre of pond. For larger water bodies, stocking rate should be based on acreage of weedy vegetation.

Low Management Crops and Areas: Weed Control in Right-of-Way and Non-Crop Areas

Shawn D. Askew, Professor, Virginia Tech

The treatments given in this section are not for use in crop land unless otherwise indicated under a given crop section. Note: Most of the chemicals listed perform better when wetting agents are added at 0.25% of the total volume. Use nonionic substances such as Induce, Cide Kick, or other suitable wetting agents. Glyphosate, the active ingredient in the well known product Roundup, is now available under a wide range of product names with varying amounts of active ingredient per gallon. When using one of these products, consult the label closely for proper mixing and use instructions.

Avoid spraying in close proximity to desirable plants or streams. Do not allow products to contaminate water used for consumption or irrigation. **Dicamba and picloram are very soil mobile and active. They can move down slopes for considerable distances. Do not apply imazapyr where roots of desirable plants extend into the spray zone.**

Table 9.5 - Brush Control

Problem and Application Technique	Chemical and Application Rate	Remarks
Foliage Spray - Brush		
Ground applications often use volumes ranging from 100-500 gpa. Our research has shown good results with volumes as low as 30- 60 gpa if uniform coverage can be obtained. Note: Drift control agents such as Nalcotrol or Polycontrol at labeled rates greatly reduce risk of off Right-of-Way damage. Use controlled size droplets to reduce risk off of the Right-of-Way damage wherever practical.	fosamine (Krenite S) 8.0-12.0 lb/A (2.0-3.0 gal in 50.0-300.0 gal of water) Apply from mid- June to early fall (prior to leaf coloration) to species listed on label. Susceptible species fail to leaf out the next spring and subsequently die. If rainfall occurs within 24 hours, effectiveness will be reduced. Thorough coverage is imperative for complete control.	
	fosamine (Krenite S) 2,0 gal + imazapyr (Arsenal) 0.5-1.0 pt in 25.0-50.0 gal water	Apply from mid- June to early fall with a Radiarc or other CD sprayer. For use where certain legumes and other Krenite S resistant species occur.
	fosamine (Krenite S) 2.0 gal + glyphosate (Accord XRT) 1.0 gal in 25.0-50.0 gal water	Apply from mid- June to early fall prior to leaf color change.
	picloram + 2,4-D (Tordon 101) 1.0 gal/100 gal of water + surfactant 0.25% v/v	Apply uniformly over top of brush as a coarse spray. Use on all species during June and July.
	glyphosate (Roundup Pro or Accord XRT) 1.0-2.0 gal/100.0 gal of water	Wet foliage thoroughly after full leaf development. Do not store diluted chemical in metal containers or for more than 12 hours before using.
	triclopyr amine (Garlon 3A) 0.5-1.0 gal + 2,4-D amine 2.0 gal/ 100.0 gal water + surfactant 0.25% v/v	Apply 100.0-400.0 gal/A when plants are actively growing. Use higher rates on resistant species or late in growing season applications.
	imazapyr (Arsenal) 0.5-1.0 lb ai/A	Apply in 50.0-200.0 gal water/A.
	Metsulfuron (Escort) 4.0 oz + Fosamine (Krenite S) 1.0-1.5 gal	Apply in 50.0-100.0 gal water. Insure thorough coverage.
	aminocyclopyrachlor+ chlorsulfuron (Perspective) 3.0-11.0 oz/A + 0.25% nonionic surfactant v/v	Use where injury to grasses must be minimal. Apply in 10.0-100.0 gal water/A. May be tank mixed with other products.
	aminocyclopyrachlor + metsulfuron methyl (Streamline) 4.75-11.5 oz/A + 0.25% nonionic surfactant v/v	Apply in 10.0-100.0 gal water/A. May be tank mixed with other products.
	aminocyclopyrachlor + imazapyr + metsulfuron methyl (Viewpoint) 13.0-20.0 oz/A + 0.25% nonionic surfactant v/v	Apply in 10.0-100.0 gal water/A. May be tank mixed with other products.

Table 9.5 - Brush Control (continued)

Problem and Application Technique	Chemical and Application Rate	Remarks
Foliage Spray - Brush		
Low-volume application to foliage aerial or ground. Note: Use wetting agents and drift control agents. Follow label recommendations. Use CDA sprayer such as Radiarc for ground sprays to help reduce drift. Thickeners such as Nalcotrol or Polycontrol help prevent drift.	picloram + 2,4-D (Tordon 101) 1.0- 3.0 qt in 20.0-50.0 gal water/A + surfactant 0.25% v/v	Apply during the growing season.
	triclopyr 2.0-3.0 gal/A (Garlon 3A, or Garlon 4 Ultra) @ + aminopyralid (Milestone) @ 4.0 oz/A + surfactant 0.25% v/v/A	Apply in 20.0-100.0 gal water. Do not apply Garlon 4 when temperatures are expected to exceed 85°F. For aerial application consult label.
	triclopyr (Garlon 3A, Garlon 4, or Garlon 4 Ultra) 0.5-1.0 gal + 1.0-2.0 gal 2,4-D or Tordon 101 (Picloram + 2,4-D) + surfactant 0.25% v/v	Same as above. Do not apply Garlon 4 when daily temperature is expected to exceed 85°F.
	imazapyr (Arsenal) 0.5-1.0 lb ai/A	Apply low-volume spray in 10.0-25.0 gal of water/A
	glyphosate (Accord XRT) 4.0% + imazapyr (Arsenal) 0.5% + water 95.5%	Apply at 8.0-10.0 gal/A.
Dormant Stems, Basal and Stump Treatment		
	triclopyr ester (Garlon 4 Ultra) 20% + basal oil (mineral oil) 80%. Add 1% imazapyr (Stalker) for difficult-to-control species.	Apply anytime except when ground is snow covered. Cover stem up about 18" or over stump and root crown.

■ General Weed Control - Mixture of Annual Grasses and Broadleaf Weeds

Caution. All use recommendations of herbicides as listed under this category must be regarded as non-selective. Therefore, do not use in crop areas except as shown under **Selective Chemical Weed Control Recommendations.** When treating land that will later be used to grow crops, observe all label precautions with respect to critical dosages, waiting intervals before cropping, and residue tolerances in the crops. Avoid spray drift onto crops and ornamentals to prevent injury and illegal residues. Do not apply soil sterilants within the root development area of adjoining crops, ornamentals, or other desirable species; also avoid use in areas where there is danger of chemical runoff.

Table 9.6 - Apply these Herbicides during the Growing Season as a Foliar Spray for General Weed Control

Herbicide	Application Rate ai/acre	Remarks
2,4-D amine + wetting agent (broadleaf weeds only)	2.0-4.0 qt/A + surfactant 0.25% v/v	Spray to wet all foliage; volume of spray/A will depend on height and density of growth. Apply when weeds are 3-4 inches high. Repeat applications when additional weeds appear.
glyphosate (Roundup Pro) (Accord XRT)	2.0-4.0 qt/A	Apply in 20.0-30.0 gal of water/A. Glyphosate is slow acting and may require 5-10 days before visible results occur. If rainfall occurs within 6 hours, effectiveness may be reduced. Do not use with galvanized spray equipment. Use of mechanical agitation or additional wetting agent will cause excessive foaming. Do not allow spray to drift to contact desirable plants. Glyphosate leaves no soil residue.
glyphosate (Roundup Pro) (Accord XRT) + sulfometuron (Oust) + nonionic surfactant	1.0-2.0 qt + 2.0-4.0 oz of product	Gives season long control.
imazapyr (Arsenal)	0.5-1.0 pt product	Do not use near desired vegetation.

Table 9.7 - Specific Perennial Weeds (Except Woody Plants)
(See also SOIL STERILIZATION below for general nonselective control, including perennial weeds.)

Weed	Chemical Rate ai/acre	Remarks
Bermudagrass (wiregrass)	glyphosate 3.0-4.0 lb ai/A (Roundup or Accord XRT 3.0-4.0 qt)	Best control is obtained when treatment is made at late stages of growth but prior to seed head emergence. See remarks for glyphosate under annual grasses and broadleaf weeds above. Repeat as needed.
Canada Thistle	clopyralid (Transline) 1.0-1.25 pt/A + surfactant 0.25%	Best control is obtained when treatment is applied at bloom.
	aminocyclopyrachlor + chlorsulfuron (Perspective) @ 5.0-7.0 oz/A	Apply late spring to early summer in 20.0-40.0 gal water/A
	aminopyralid (Milestone) 5.0-7.0 oz/A + 0.25% v/v nonionic surfactant	Apply late spring to early summer in 20.0-40.0 gal water/A.
Johnsongrass	glyphosate (Roundup Pro or Glypro Plus) 1.0-2.0 qt/A	Best control is obtained when applied in 20.0-25.0 gal water/A during late stages of growth, but prior to seedhead emergence.
	fluazifop (Fusilade 2000) 1.0-1.5 qt/A with either 1.0% crop oil concentrate or 0.25% nonionic surfactant.	Apply when johnsongrass is 8-18 inches tall and before boot stage.
	glyphosate (Roundup Pro or Accord XRT) 1.0 qt + sulfometuron (Oust) 0.125 oz + 10.0-50.0 gal water/A	Apply at time of seedhead formation.
Honeysuckle	2,4-D 2.0-3.0 qt/100 gal water + 0.25% surfactant v/v	Apply in spring or early summer when plants are in full leaf and actively growing. Thoroughly wet all foliage and stems. Do not allow drift to desirable plants. Dicamba may move down slopes for considerable distances.
	glyphosate (Roundup Pro or Accord XRT) 3.0-4.0 qt/100.0 gal water	
	2,4-D 3.0 lb + dicamba 1.5 lb (1.5 gal Banvel 720)/100.0 gal water + 0.25% surfactant v/v	
	2,4-D 2.0 lb + triclopyr 1.0 lb (1.0 gal Crossbow)/ 100 gal water + 0.25% surfactant v/v	
Kudzu	2,4-D + 2, 4-DP + dicamba (Bk-800) 2.0 gal/100.0 gal of water + 0.25% surfactant v/v	Apply at 50.0-100.0 gal solution/A. Dicamba may move down slopes considerable distances.
	glyphosate (Roundup Pro or Accord XRT) 4.0 qts/100.0 gal water	Apply when actively growing.
	triclopyr 2.0-3.0 lb/A (0.67-1.0 gal Garlon 3A or 0.5-0.75 gal Garlon 4) + 0.25% surfactant v/v	Apply when actively growing. Do not apply Garlon 4 when temperatures are expected to exceed 85° F.
	fosamine (Krenite S) 1.5-2.0 gal/100.0 gal water	Apply from mid-summer to early fall.
	metsulfuron (Escort) 4.0 oz/100.0 gal water + 0.25% surfactant v/v	Apply when actively growing.
	dicamba (Vanquish) 2.0 qt/A in 20-30 gal water. Add 0.25% surfactant v/v.	Apply during late dormant season, March-April.
Milkweed (common And dogbane)	dicamba 1.5-2.0 lb (0.38-0.5 gal (Vanquish) + surfactant 0.25% v/v	Apply prior to flowering while plants are actively growing.
	dicamba 1.0 lb + 2,4-D 2.0 lb (1.0 gal Banvel 720)/A + surfactant 0.25% v/v	
	picloram 0.5 lb + 2,4-D 2.0 lb (1.0 gal Tordon 101)/A + surfactant 0.25% v/v	
	2,4-D 2.0 lb + triclopyr 1.0 lb (1.0 gal Crossbow) + 0.25% surfactant v/v	
Mugwort (wild chrysanthemum)	picloram (Tordon) 0.25 lb ai	Do not apply picloram within 100 ft of desirable plants or allow it to contaminate water. Picloram can move down slopes for considerable distances.
Mullen	2,4-D 2.0 lb + surfactant 0.25% v/v	Apply in early summer when in rosette stage. The hairy leaf surface makes this plant difficult to wet; therefore, the use of a surfactant is important.
Musk And Curled Thistles	2,4-D ester 2.0-3.0 lb/50.0-100.0 gal water + surfactant 0.25% v/v	Apply in mid-spring. Midday temperatures should be above 60°F for 2-3 days after application.
	dicamba 1.5 lb (0.38 gal Vanquish) + surfactant 0.25% v/v	Observe above-mentioned precautions when using dicamba.
	dicamba 1.0 lb + 2,4-D 2.0 lb (1.0 gal Banvel 720) + surfactant 0.25% v/v	
	chlorosulfuron (Telar) 0.25-0.5 oz product + surfactant 0.25% v/v	Apply in early spring. Will inhibit grass growth. Not for pastures. Add 0.5% Cide Kick or other wetting agent.

Table 9.7 - Specific Perennial Weeds (Except Woody Plants) (continued)
(See also SOIL STERILIZATION below for general nonselective control, including perennial weeds.)

Weed	Chemical Rate ai/acre	Remarks
Musk And Curled Thistles (continued)	clopyralid (Transline) 1.0-1.25 pts + surfactant 0.25% v/v	Apply from rosette to bud in 25.0-50.0 gal water/A.
	aminopyralid (Milestone) 5.0-7.0 oz + 0.25% v/v nonionic surfactant	Apply late spring to early summer in 20.0-40.0 gal water/A.
Poison Ivy	fosamine 6.0-8.0 lb (1.5-2.0 gal Krenite S)/100.0 gal water dicamba 1.0 lb + 2,4-D 2.0 lb (1.0 gal Banvel 720)/A + surfactant 0.25% v/v	Apply in late summer before leaf coloration. Thorough coverage is imperative. Apply during periods of active growth. **Do not apply within 100 ft of desirable plants or allow dicamba to contaminate water used for irrigation or other domestic purposes.** Dicamba may move down slopes for considerable distances.
	2,4-D 2.0-3.0 lb/100.0 gal water + surfactant 0.25% v/v.	
	triclopyr 4.0 lb (1.0 gal Garlon 4 Ultra)/100.0 gal of water + surfactant 0.25% v/v	Thoroughly wet all foliage and stems. Density of cover will determine volume of spray/A. Spot treat regrowth as required. Thorough coverage and the use of a surfactant is imperative for good control.
	glyphosate 4.0 lb (1.0 gal Roundup Pro or Accord XRT)/100.0 gal water.	
Multiflora Rose	2,4-D 2.0 lb + triclopyr 1.0 lb (Crossbow 1.0 gal)/100.0 gal water + 0.25% surfactant.	Apply when actively growing.
	glyphosate 2.0-3.0 lb (0.50-0.75 gal Roundup Pro or Accord XRT)/100.0 gal water	
	metsulfuron (Escort) 0.75-1.0 oz product in 50.0 gal water/A + 0.25% surfactant	
	triclopyr amine (Garlon 3A) 1.5-3.0 lb (0.5-1.0 gal)/A + 0.25% surfactant	
	fosamine 8.0-12.0 lb (2.0-3.0 gal Krenite S)/100.0 gal water.	Apply from mid- summer to early fall prior to leaf color change. Thorough coverage is imperative.
Cedar	hexazinone 1.0 lb/10.0 gal water (1.0 lb Velpar 90% SP or 0.5 gal Velpar L)	When preparing the liquid mixture, with Velpar 90% SP, the water should be at room temperature to completely dissolve the powder. Spray 3.0 oz of the solution/2-inch basal diameter on the soil near the base of the stem. **For spot control only. Do not treat large areas or every stem in dense stands because erosion may result.** Hexazinone may move down slopes for considerable distances. Do not use near desirable plants.
	Krenite 3.0 gal/100.0 gal water	Apply after July 15. Wet foliage thoroughly.
	2,4-D 4.0-6.0 lb + dicamba 2.0-3.0 lb (2.0-3.0 gal Banvel 720)/100.0 gal water + 2.0 gal Cide Kick	Wet foliage thoroughly. Dicamba may move down slopes considerable distances.

■ Soil Sterilization

Soil sterilant chemicals, by definition, render the soil incapable of supporting plant growth for varying periods. The effect may be temporary, as with fumigants, or for an extended period (semi-permanent). In either case, the action is nonselective at rates specified for use as soil sterilants. Therefore, do not apply within the root development area of adjoining crops or desirable species. Do not use in crops or where there is danger of chemical runoff. Note: Since effectiveness varies considerably with the weed species, degree of infestation, soil and environmental conditions, several herbicidal materials and a range of rates are provided to allow selection of product and dosage based on specific need.

Lower rates (A) apply to annuals, biennials, shallow-rooted perennials, and seedling perennials;

Higher rates (B) apply to established deep-rooted and other hard-to-kill perennials. Read and follow directions on the label for further details.

Table 9.8 - Chemicals and Recommended Use
Soil sterilants are very potent plant killers and should not be used around the home grounds or near desirable plants; as with all pesticides, consult the label before use.

Herbicide	Application Rate ai/acre	Remarks
borate mixtures with sodium chlorate and/ or other chemicals	variable	Follow instructions on the label. Apply as a spray on early growth to first bloom or broadcast as a soil treatment.
bromacil	(A) 3.0-6.0 (B) 10.0-25.0	If dense growth is present, results will be improved if vegetation is removed prior to treatment. Do not apply to frozen ground.
chlorate mixtures with borates or other chemicals	variable	Follow instructions on label. Fire hazard usually less than pure sodium chlorate but caution still is necessary.
diuron or monuron	(A) 5.0-20.0 (B) 20.0-80.0	Diuron gives somewhat longer soil sterility. Monuron is more effective on deep-rooted weeds.
hexazinone (Velpar)	(A) 1.8-4.5 (B) 5.4-10.8	Apply in early spring. Do not apply near desirable vegetation. Consult label for specific rates on different soil types.
imazapyr (Arsenal) (Topsite)	 0.5-1.0 lb 200-300 lb product/A	Do not apply near trees or other desired vegetation.
methyl bromide	1.0-1.5 lb/100 sq ft	Soil fumigant. Apply in concentrated form under vaporproof cover, when soil is moist, not wet, and in good tilth. Remove cover after 24-48 hours. **Warning: methyl bromide is poisonous.**
prometon (Pramitol)	(A) 10.0-15.0 (B) 20.0-60.0	Mix in water or oil. Provides quicker contact kill of top growth with oil. Apply to early growth up to first heading.
tebuthiuron (Spike) (Sprakil S-5)	(A) 4.0-6.0 (B) 6.0-16.0 40-120 lb product/A	Follow label directions. Do not apply near desirable vegetation. Tebuthiuron can move considerable distance down slopes.
diuron + imazapyr (Sahara)	10-15 lb product/A	Mix in 50-100 gal water.
diuron + tebuthiuron (Sprakil 13) (Sprakil 26)	150-400 lb product/A 150-300 lb product/A	Apply granules uniformly over area to be treated.
Bermudagrass Release, Rights-of-Way Only		
glyphosate + sulfomenturon	(Roundup Pro) 1.0 qt + (Oust) 1.0 oz + Cide Kick 1.0 qt	Apply in early spring or October for control of cool-season grasses (Ky 31 fescue, etc.) and weeds.
Summer Grasses in Bermudagrass, Rights-of-Way Only		
sulfomenturon + glyphosate	(Oust) 0.25-0.5 oz + (Roundup Pro) 1.0-2.0 pt + Cide Kick 1.0 qt	Apply in June for control of dallis, broomsedge, johnson, and annual grasses in 50.0 gal of water.
Stabilized Shoulders and Guard Rails		
glyphosate + indaziflam	glyphosate (Roundup Pro) @ 1.0-2.0 qts/A + indaziflam (Esplanade) @ 5.0-7.0 oz/A. Add 1.0-3.0 oz/A of sulfometuron methyl (Oust) for difficult-to control species and longer control time.	Apply in 50.0 gal of water in spring. Repeat if necessary. Keep off of desired vegetation. Do not apply more than 2 ft past guard rail or edge of shoulder to prevent erosion of soil. Will not control bermudagrass.
glyphosate + surflan	(Roundup Pro) 2.0-4.0 qt + Surflan 4.0 lb	
glysophate + pendimethalin	(Roundup Pro) 2.0-4.0 qt + Pendulum 4.0 lb	

Always read the label before applying any pesticide. Use caution when applying herbicides on windy days or when temperature is above 85° F. Many herbicides exhibit soil activity and may cause damage or death to desirable plants if they contact the roots of such plants. This problem is compounded on steep terrain. Always use adequate personal protection clothing or devices as suggested or required by the label.

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