

Regional Strawberry Preplant meeting

Strawberry Production Considerations: Pre-plant and Post-Transplant

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HAMPTON ROADS AGRICULTURAL RESEARCH AND EXTENSION CENTER

VIRGINIA COOPERATIVE EXTENSION

Farm Planning

- ✓ Put sufficient time and thought into planning process.
- ✓ Know your farm operations well.

Questions to ask yourself:

- Do I have the labor to manage strawberry production from start to finish?
- Do I have a market where I can sell berries?
- In the past three years, have I been able to sell majority of berries produced?
- Are there berries that go unpicked at my site each year ?
- What has been the average profit I made in the past three years with berry production?
- What are pest issues that I faced in the past three years?

Planning for Commercial Strawberry Production

Site selection

Row orientation: North-South

Wildlife

Windbreaks

Soils

- Sandy loam to sandy clay-loam.
Clay or rocky soils difficult to bed.
- pH 6.0 to 6.2.
- Slope of 5 to 7% ideal.
- Avoid sites previously under cultivation with tomato, potato, or eggplant.

Soil amendment and nutrient management:

- Soil test to determine how much limestone needs added.
- Apply 60 lbs N, 60 lbs P_2O_5 and 120 lbs K_2O /acre at preplant if no soil test conducted.

Fumigation

- Annual plasticulture gaining popularity
 - Raised beds
 - Plastic mulch
 - Preplant fumigants

- What is fumigation?

Fumigation is a method to suffocate or poison pests by filling an area with gaseous pesticides.

In the raised beds, fumigation is achieved by:

- Covering the beds with plastic layer .
- Injecting fumigant through the sub-surface (drip) irrigation system or with shanks on a bedder.
- Keeping the fumigant trapped in the soil air space to kill pests.



Multi-function bedder: shapes the bed, fumigates bed, lays plastic tarp. When beds are done, plastic should be firm, and in contact with the soil. Beds should be raised at least 6 inches and free of soil clods.

Factors that Influence Soil Fumigation:

Soil Moisture

- **50-75% Moisture in Sandy Loams:** when Darkened soil forms a ball with defined finger marks, very light soil/water staining on fingers, not sticky.

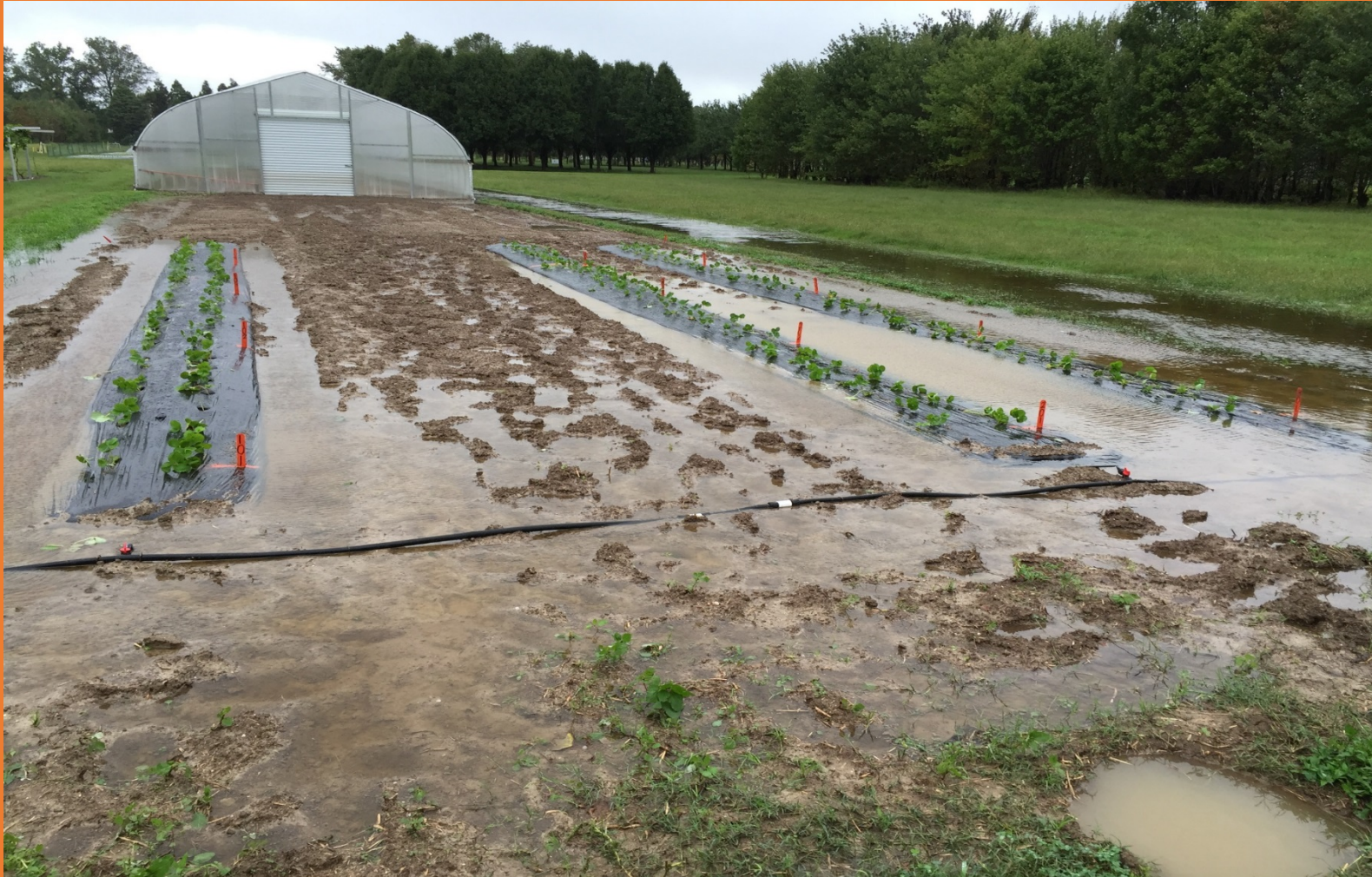
Factors that Influence Soil Fumigation:

Soil Temperature



- The higher the soil temperature, the further the fumigant often moves – through soil, but also potentially into the air above the ground.
- Acceptable soil temperatures at the point of injection usually between 40° and 90° F.

Bed dimensions



Shallow beds (≤ 4 inch high)

- Can cause temporary flooding.
- Promote crown and root rot.
- Increase incidences of leaf spots and mildew.
- Exposure to standing water at harvest season can result in mushy fruits.

Plant spacing

- 12 Inches = 17,500 plants/A
- 14 Inches = 15,000 plants/A
- 15 Inches = 14,000 plants/A



Figure 9: Finished Strawberry Bed

Planting depth



Planting depths- Left: Too shallow; Center: Correct; Right: Too deep



Cover crop.

Annual ryegrass at 50 lbs/A

Irrigation

Establishment phase:

Drip emitter spacing: 12 to 8 inches.

Drip system “on” few hours per week during the establishment period.

Overhead Irrigation spacing: 40 by 40 ft.

Overhead sprinkler irrigation two to three days after transplanting.

- Plant type- plugs vs. fresh dug vs. cut offs.
- Rain events

Winter season: Winter rains generally sufficient. Water loss from the plant is minimal.

Winter protection: Overhead sprinkler irrigation. Estimate around 150,000 gal. of water per acre for three consecutive frost/freeze nights at 1.8 acre-inches/night.

Pump capacity: 90 gpm. Electric pump is preferable.

Managing Strawberry Diseases: Pre-Plant, Transplant, & Early Season Considerations.

- 2 common sources:
 - Soil - “Black Root Rot”
 - Strawberry transplants

Strawberry Diseases

“Black Root Rot”

- Soil Fungi
 - Rhizoctonia*
 - Pythiums*
 - Fusariums*
 - Others?
- Nematodes?
 - Pratylenchus*
 - Meloidogyne*

Soil Sampling Instructions for Nematode Assays

- *Best* at or just after end of harvest
 - or prior to fumigating
- ≥ 6 inches deep (from beds if possible)
- ≥ 20 cores/4 acre field (more = better)
- Mix cores in clean bucket
- Add ≥ 1 pt soil to bag; label completely!
- Submit through county extension office

VA Tech Nematode Assay Report

Nematode Analysis Report

Date Received: _____ Date Processed: _____ Sample Condition: _____

Sample Lab No.: D253 Counted By: _____ Date: _____

Nematodes Present in 500cc of soil:

40 *Pratylenchus* (Lesion)
Meloidogyne (Root-Knot)
Heterodera (SCN Juveniles)
(Cysts)
Globodera (TCN Juveniles)
(Cysts)

Trichodorus (Stubby Root)
Xiphinema (Dagger)
Tylenchorhynchus (Stunt)
560 *Helicotylenchus* (Spiral)
Hoplolaimus (Lance)

Mesocriconema (Ring)
Belonolaimus (Sting)
Paratylenchus (Pin)
Hemicycliophora (Sheath)
Others

Recommendation:

- ☐ A Nematode problem not detected:
☒ B Possible nematode problem
☐ C Nematodes are a problem; control options are advisable:

Reset Form

Specific Remarks:

2018 Strawberry Fumigants

- Telone (1,3-D) in short supply
 - Dow says temporary
- Shaking up what fumigants are available
 - Dow dropped Telone C-17 in 2018
- Triest: shifting from PC60 to PC80
 - PC80: more chloropicrin (80% vs 60%)
 - PC80: Less 1,3-D nema-killer (20% vs 40%)

Strawberry Fumigant Efficacy Nematodes

Relative Efficacy: Currently Registered Fumigants or Fumigant Combinations for Managing Soilborne Nematodes, Diseases, and Weeds in Plasticulture Strawberries¹

Product	Rate/Treated Acre		Nematodes	Diseases	Nutsedge	Annual Weeds
	Volume (gal)	Weight (lb)				
Telone II (1,3-D)	15-27	153-275	E	P	None	None
Telone EC³	9-24 ⁴	91-242 ⁴	E	P	None	None
Telone C-35 (1,3-D + chloropicrin)	39-50	437-560	E	E	P	F
InLine (1,3-D + chloropicrin)	29-57.6 (See label)	325-645 (See label)	E	E	P	G
Pic-Clor 60 (1,3-D + chloropicrin)	48.6	588	E	E	P	G
Pic-Clor 60 EC³	42.6	503	E	E	P	G
Pic-Clor 80 (1,3-D + chloropicrin)	48.6	588	VG?	E	P?	G?
Chloropicrin	48.6	150-350	P	E	None	None
Tri-Pic 100 EC ³	8-24	100-300	P	E	None	None
Chloropicrin + Metam Sodium ⁵	19.5-31.5+37.5-75	275-544+379-758	F	E	F	VG
Metam Sodium ⁵	37.5-75	379-758	F	G	P	VG
Metam Potassium ⁵	30-62	318-657	F	G	P	VG
Paladin (dimethyl disulfide) ⁶	35.0-51.3	310-455	VG	VG	VG	G ⁵
Paladin EC ^{3,6}	37.0-54.2	326-479	VG	VG	VG	G ⁵
Dominus (allyl isothiocyanates) ⁷	25-40 ⁴	212-340 ⁴	F	G	P	G

LEGEND: E=excellent; VG=very good; G=good; F=fair; P=poor.

C.S. Johnson, 2018

If you know you have nematodes & can't or don't want to fumigate:

7

Pre-planting and Early Post-planting: Nematode Management						
Pest/Problem	Management Options	Amount of Formulation per Acre	Effectiveness (+) or Importance (*)	REI	PHI	Comments
Nematodes	Nimitz or Fluensulfone 480EC	3.5 - 7 pt per treated acre	See comments	0 hr	0 days	Nimitz is a "traditional contact nematicide". It has not been extensively tested on strawberry in the Southeast and Mid-Atlantic states, but research on other crops in these areas and on strawberry elsewhere suggests moderate to good activity – not quite as effective as soil fumigant standards - against most major plant-parasitic nematode species. 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.
	Majestene (heat-killed <i>Burkholderia</i> spp. strain A396)	4 – 8 qt (8 – 16 pt or 1-2 gal)	See comments	4 hr	0 days	Majestene is a biological nematicide approved for organic strawberry production. It has not been extensively field-tested on strawberry in the Southeast and Mid-Atlantic states, but research to date suggests useful activity against root-knot, lesion, sting, stunt, ring, and reniform nematodes. Can be applied as a pre-plant incorporated, in-furrow or banded spray as long as spray volume is sufficient to thoroughly soak the root zone. However, Majestene can also be drip-applied prior to planting, at planting or shortly thereafter, and again later in the season. Higher rates are likely more effective, and repeated applications also increase the extent and duration of nematode control. If nematode populations are high, another product may also be necessary for control.

VA Tech Nematode Assay Report

Nematode Analysis Report

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Sample Lab No.: Counted By: Date:

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☐ <i>Meloidogyne</i> (Root-Knot)	☐ <i>Xiphinema</i> (Dagger)	☐ <i>Belonolaimus</i> (Sting)
☐ <i>Heterodera</i> (SCN Juveniles)	☐ <i>Tylenchorhynchus</i> (Stunt)	☐ <i>Paratylenchus</i> (Pin)
☐ (Cysts)	☐ <i>Helicotylenchus</i> (Spiral)	☐ <i>Hemicycliophora</i> (Sheath)
☐ <i>Globodera</i> (TCN Juveniles)	☐ <i>Hoplolaimus</i> (Lance)	☐ Others
☐ (Cysts)		

Recommendation:

- ☒ A Nematode problem not detected:
- ☐ B Possible nematode problem
- ☐ C Nematodes are a problem; control options are advisable:

Reset Form

Specific Remarks:

Strawberry Fumigant Efficacy

Diseases Soil-Borne

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Telone EC ³	9-24 ⁴	91-242 ⁴	E	P	None	None
Telone C-35 (1,3-D + chloropicrin)	39-50	437-560	E	E	P	F
InLine (1,3-D + chloropicrin)	29-57.6 (<i>See label</i>)	325-645 (<i>See label</i>)	E	E	P	G
Pic-Clor 60 (1,3-D + chloropicrin)	48.6	588	E	E	P	G
Pic-Clor 60 EC ³	42.6	503	E	E	P	G
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Chloropicrin	48.6	150-350	P	E	None	None
Tri-Pic 100 EC³	8-24	100-300	P	E	None	None
Chloropicrin + Metam Sodium ⁵	19.5-31.5+37.5-75	275-544+379-758	F	E	F	VG
Metam Sodium ⁵	37.5-75	379-758	F	G	P	VG
Metam Potassium ⁵	30-62	318-657	F	G	P	VG
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Paladin EC ^{3,6}	37.0-54.2	326-479	VG	VG	VG	G ⁵
Dominus (allyl isothiocyanates) ⁷	25-40 ⁴	212-340 ⁴	F	G	P	G

LEGEND: E=excellent; VG=very good; G=good; F=fair; P=poor.

Strawberry Fumigant Efficacy

Nutsedge

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Strawberry Fumigant Efficacy

Annual Weeds

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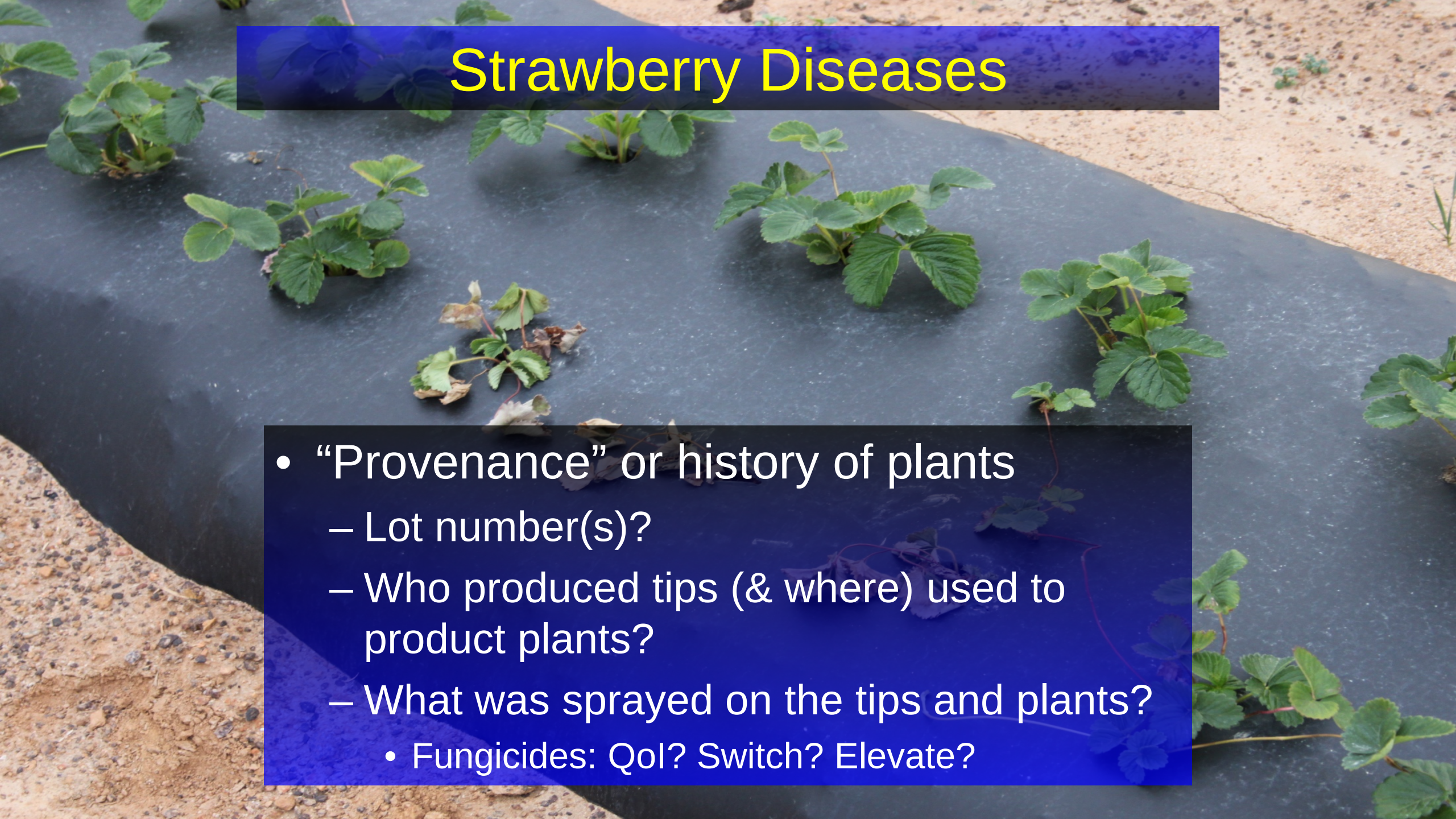
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Strawberry Diseases

The background of the slide is a photograph of several strawberry plants growing in a field. The plants are green with characteristic three-lobed leaves. They are planted in rows, with dark mulch visible between them. A blue semi-transparent rectangular box is overlaid on the top left and center of the image, containing the title and a list of bullet points.

- 2nd common source:
 - In or on strawberry transplants
 - Get plants from a reputable source
 - Threat less from out-door vs in-door production
 - Make sure diagnosis is accurate
 - Cull “hot-spots” & surrounding trays

Strawberry Diseases

The background image shows several strawberry plants growing in a field. The plants are spaced out on a black plastic mulch, with sandy soil visible between the plants. Some plants appear healthy with green leaves, while others show signs of distress, such as yellowing or browning leaves.

- “Provenance” or history of plants
 - Lot number(s)?
 - Who produced tips (& where) used to product plants?
 - What was sprayed on the tips and plants?
 - Fungicides: QoI? Switch? Elevate?

Inspect transplants: *Phytophthora*





Phytophthora & Strawberry

Before Planting:

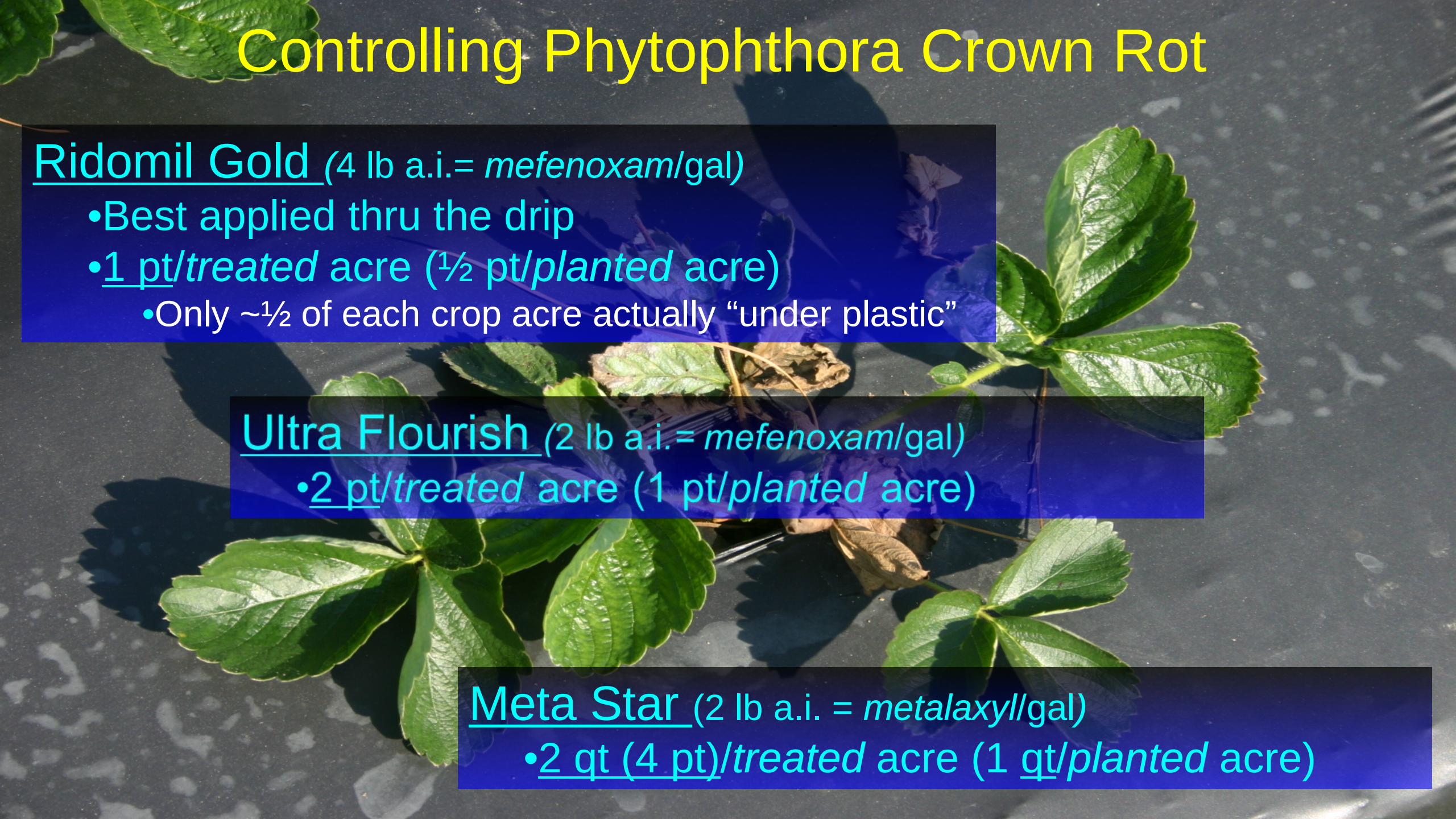
- Keep “Sweet Charlie” plugs/plants separate from other cultivars
- Keep trays/boxes off the ground, on pallets or other structure(s)

P. cactorum (Crown Rot)

C.S. Johnson, 2018

Image courtesy Nathan O'Berry, VCE, Isle of Wight County

Controlling Phytophthora Crown Rot

The background of the slide shows several strawberry plants growing in a field. Some of the plants exhibit symptoms of crown rot, including yellowing and wilting of the leaves, and some have died, leaving bare stems. The plants are growing in dark, possibly plastic-covered, soil.

Ridomil Gold (4 lb a.i. = *mefenoxam*/gal)

- Best applied thru the drip
- 1 pt/treated acre ($\frac{1}{2}$ pt/planted acre)
 - Only $\sim \frac{1}{2}$ of each crop acre actually “under plastic”

Ultra Flourish (2 lb a.i. = *mefenoxam*/gal)

- 2 pt/treated acre (1 pt/planted acre)

Meta Star (2 lb a.i. = *metalaxyl*/gal)

- 2 qt (4 pt)/treated acre (1 qt/planted acre)

Inspect transplants: *Anthracnose*



Anthracnose Crown Rot



Controlling Anthracnose Crown Rot

Pre-Plant Dips

- For bare-root plants only
- Plants need to be clean before dipping
- **Switch/Abound** —Dip whole plants for 2-5 minutes in 5-8 fl oz product/100 gal water.
 - Plant ASAP after dip to avoid phytotoxicity/stunting
 - Dispose of left-over solution properly

Controlling Anthracnose Crown Rot

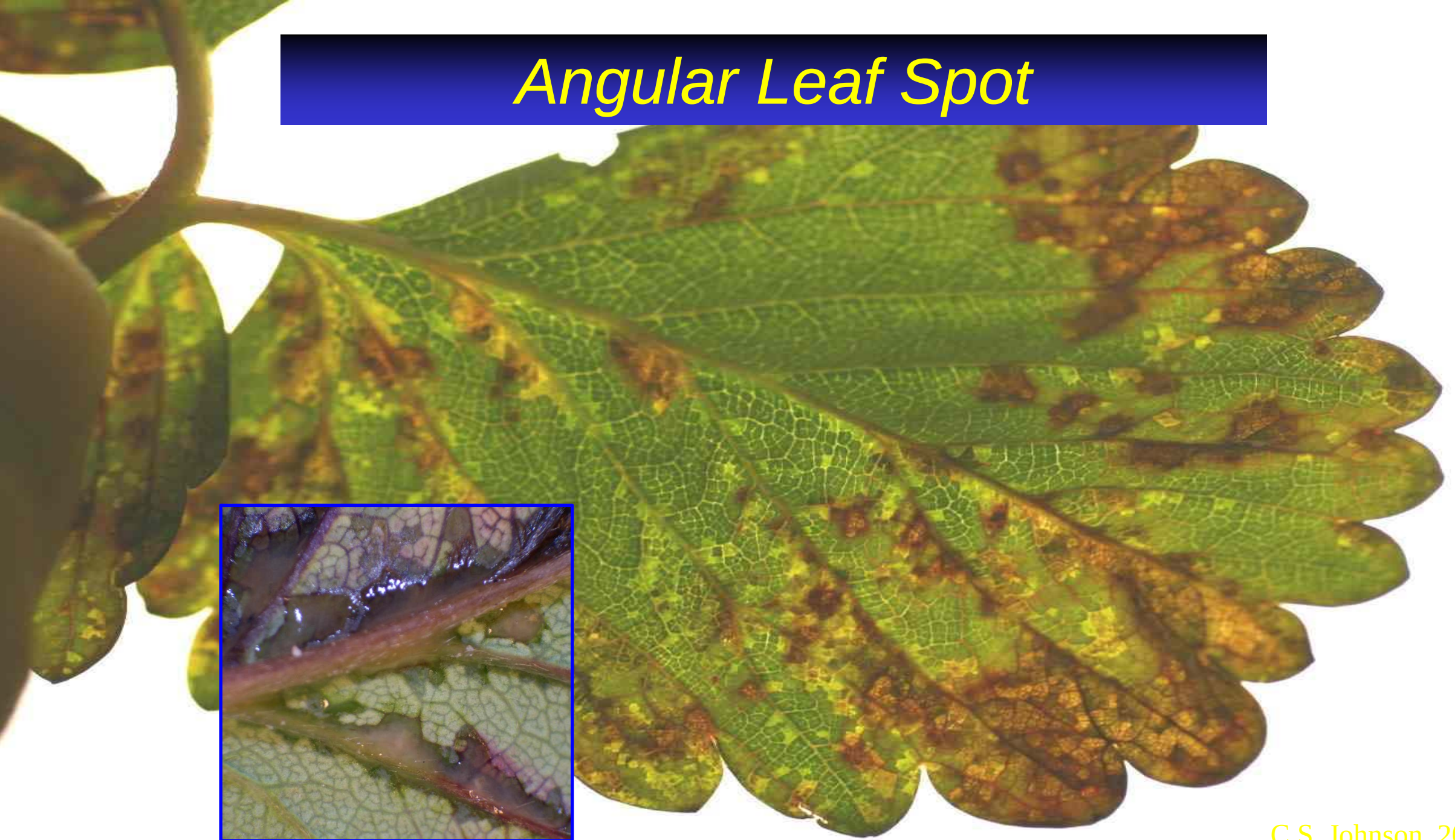
Field Sprays After Planting



In Fall: Captan every 10-14 days in fall (2-3 sprays)

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Angular Leaf Spot



Powdery Mildew



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2017-18 growing season
On-farm variety/advanced
germplasm trials

	Brookdale Farms City of Virginia Beach	Yoder's Farm Rustburg	
Replications	3	3	Virginia Tech • Virginia State University
Preplant fertilizer	10-10-20 at 600 lbs/acre total	4.25 tonnes of composted poultry litter/acre	
Plant count/rep.	12	12	
Fumigation	Pic 100 at 150 lbs/A	Paladin/Pic 21 at 170 lbs/A	
Tarp	VIF 1.25 mil. black	TIF 1.25 mil black	
Beds	60 inch on center; 30-inch top	30-inch top; 6 inch high; 72 inch center	
Planting date	9/27/2017	Chandler: 9/22 (plugs from PEI); Camarosa: 9/17 (plugs from Nova Scotia); NCS -038 and NCS-156: 10/04 (plugs from NCSU)	
Winter protection	Row cover when needed. Row covers also used for floral enhancement of Camarosa and Ruby June: mid-Nov to early Dec.	Row covers come off during warm spells over winter.	
Site history	In prior years, strawberry planted	In prior years, strawberry planted	
USDA Zone	8a	7a	

Varieties evaluated in 2017-18 growing season:

Variety	Year of Release	Affiliation
1. Camarosa	1992	U. California
2. Chandler	1983	U. California
3. NCS 10-038	Unreleased	North Carolina State U.
4. NCS 10-156	Unreleased	North Carolina State U.
5. Ruby June	2014	Lassen Canyon Nursery

Objective. To evaluate a new promising cultivar 'Ruby June' and NC advanced germplasm at grower locations in Virginia.

Brookdale Farms, Virginia Beach, VA

Highest marketable yield in prepick situation: NCS-156

Highest marketable yield in pick-your-own situation: NCS-156, Ruby June, and Chandler

Least non-market fruits: NCS-156 and Ruby June

Highest total yield: NCS-038 and Chandler

Variety	Marketable yield for prepick growers	Marketable yield; fruits with open slits, slight deformity in shape	Marketable yield for pick your own growers	Non marketable yield	Total yield
	A	B	A + B	C	A+ B+ C
	-----lb/plant-----				
	Harvest period from 4.19.2018 to 6.08.2018				
Chandler	1.9 b	0.2 b	2.1 ab	1.4 b	3.5 ab
Camarosa	1.1 c	0.1 b	1.2 c	1.8 b	3.0 b
Ruby June	1.8 b	0.3 a	2.1 ab	0.9 c	3.0 b
NCS-156	2.4 a	0.1 b	2.5 a	0.8 c	3.3 b
NCS-038	1.6 bc	0.1 b	1.6 bc	2.4 a	4.1 a
Pr>F	0.0019	0.0089	0.0036	0.0001	0.0267

Variety	<i>Fruit size</i>	<i>Total soluble solids</i>	<i>Firmness</i>
	g/fruit	°Brix	kg
Chandler	18.8 cd	6.0 c	0.08 b
Camarosa	21.1 bc	5.6 d	0.12 a
Ruby June	21.7 b	6.5 b	0.09 b
NCS-156	17.3 d	7.7 a	0.10 ab
NCS-038	31.2 a	4.8 e	0.08 b
Pr>F	<0.0001	<0.0001	0.055

Brookdale Farms, Virginia Beach, VA

Largest fruits: NCS-038

Sugar content (TSS): Highest in NCS-156 and least in NCS-038

Firmness: Most firm NCS-156 and Camarosa

	Eye Appeal	Outside Appearance	Flesh Appearance	Firmness	Flavor	Average Overall
NCS 158	4	4	4	4	4	4
Ruby June	4	4	4	4	4	4
Camarosa	3	3	3	4	3	3
NCS 038	4	4	3	4	2	3
Chandler	4	4	4	4	4	4

1-5: 1=Awful, 2 = Not good, 3- Okay, 4 = Good, 5 = Excellent

n = 16 samples in Virginia Beach, VA. Taste test done on May 22, 2018

<i>Variety</i>	<i>Marketable yield</i>	<i>Non marketable yield</i>	<i>Total yield</i>	<i>Fruit size</i>
	<i>A</i>	<i>B</i>	<i>A + B</i>	
	-----lbs/plant-----			-----g/fruit--
	Harvest period: 3 May to June 7, 2018			
Chandler	1.2 a	0.4 ab	1.5 a	18.7 b
Camarosa	1.1 ab	0.5 a	1.6 a	24.8 a
NCS-156	0.7 c	0.1 c	0.8 c	22.9 a
NCS-038	0.9 bc	0.3 b	1.2 b	23.4 a
Pr>F	0.0088	0.0004	0.0011	0.0044

Yoders Farms, Rustburg, VA

Highest marketable yield: Chandler and Camarosa

Highest total yield: Chandler and Camarosa

Fruit Size: Chandler had smaller fruits than others.

<https://ext.vt.edu/small-fruit.html>

FileEditViewHistoryBookmarksToolsHelp

Small Fruit | Virginia Coop... x +

www.ext.vt.edu/topics/agriculture/commercial-horticulture/small-fruit/index.html

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Small Fruit

This page focuses on crop production and marketing aspects pertaining to small fruits (strawberry, blueberry, blackberry, raspberry, and other exotic berries). Information on cultivar recommendations, cultural practices including pruning, training, and trellising, plant and soil sanitation practices, and pest management can be found here.

Resources **Websites** **Publications**

- » [2014 Southeast Regional Strawberry Integrated Management Guide](#)
- » [2014 Southeast Regional Caneberries Integrated Management Guide](#)
- » [Breeding and Production Physiology at UC Davis, Department of Plant Sciences](#)

Featured Publications

- » [2015 Commercial Vegetable Production Recommendations](#)
- » [Pest Management Guide: Horticultural and Forest Crops, 2015](#)

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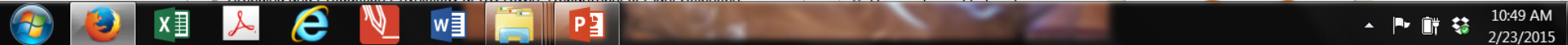
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Publications and Resources


Events and Calendars


Explore more Extension resources:



10:49 AM
2/23/2015

Acknowledgements

Funding

Virginia Strawberry Association

North Carolina State Univ.

Lassen Canyon Nursery

On-Farm Cooperators

- Tom and Ann Baker
- Lowell Yoder
- Allen Straw

Need input from VA growers. Please contact me at jsamtani@vt.edu