Blueberry, cane berries, and winegrape pruning and training workshop
Northern Virginia, 20-21 March 2018

Southern Region Small Fruit Consortium

When: 20-21 March 2018

What: Hands-on small fruit and grapevine pruning and training workshop for extension agents in southeast US states comprising the Southern Region Small Fruit Consortium (http://www.smallfruits.org). Classroom updates on small fruit and wine grape pest management/IPM will precede the field activities. Plant material at Hartland includes both young and older highbush blueberry plantings, mature blackberries and raspberry plantings of multiple varieties (primocane and floricane bearing cultivars). Naked Mountain vineyards include young and mature vinifera where both cane-pruning and cordon training/spur-pruning can be demonstrated.

Where: Field activities conducted at Hartland Orchard (http://www.hartlandorchard.com/) and Naked Mountain Winery (http://www.nakedmountainwinery.com/). The two sites are in Fauquier County, Virginia, about two miles apart; both share a Markham, VA mailing address and both are easily accessible from I-66. Hartland Orchards is 45 miles west of Washington's Dulles Airport (IAD), and 12 miles east of the Holiday Inn at Front Royal VA.

Who (instructional team):
Tony Wolf, Virginia Tech, grapes/viticulture
Tremain Hatch, Virginia Tech, grapes/viticulture
Allen Straw, Virginia Tech, small fruits (blueberry pruning)
Pierson Geyer, AgriBerry (www.AgriBerry.com) (caneberry pruning)
Brian Green, hosting, Hartland Orchards
Doug Pfeiffer, Virginia Tech fruit entomology
Mizuho Nita, Virginia Tech grape pathology
Phil Brannen, fruit pathologist, University of Georgia

Agenda: 20-21 March 2018

20 March: Agents arrive afternoon at Holiday Inn, Front Royal before 3:00 pm (https://www.ihg.com/holidayinn/hotels/us/en/front-royal/ftryl/hoteldetail
3:00 pm: IPM updates for blueberries, cane berries and grapes (Madison/Monroe conference room)
Presenters: Drs. Doug Pfeiffer (VT); Mizuho Nita (VT); and Phil Brannen (U of Georgia)
6:00 pm: Dinner, Houlihan's Restaurant (attached to hotel)
7:00 pm: Social mixer, Madison/Monroe conference room

21 March: Breakfast at hotel (included with room) and then transportation to Hartland Orchards for blueberry and cane berry pruning and training discussion and hands-on work. We do NOT have a rain-date or contingency plan for foul weather; bring wet weather gear. Morning (8:30 to 12:30) will be spent at Hartland Orchards followed by catered lunch. Group will move by van to Naked Mountain Winery after lunch for grape pruning and training. We anticipate finishing by 4:30 pm followed by a wine tasting at Naked Mountain Winery for those interested, or travel home or back to hotel. The following times are approximate.

Blueberry, cane berries, and winegrape pruning and training workshop

21 March:

8:00: Depart hotel and travel to Hartland Orchards

8:30: Introductions and overview of blueberry training goals, demonstration
Allen Straw

9:00: Hands-on blueberry pruning, teams of 4-5 agents
Peculiars: All northern highbush blue berries; 4-5-yr-old planting of 'Surecrop', 'Bluecrop' and 'Reka'; more mature planting of 'Bluecrop'

10:30: Cane berry pruning goals, demonstration
Pierson Geyer, Agriberry

11:00: Hands-on blackberry and raspberry pruning, teams of 4-5 agents
Peculiars: Primocane raspberry cultivars ('Caroline' and 'Heritage'), are mowed to prune (job's done!); floricane raspberries include 'Mac Black' and 'Jewel' (black), and several red cultivars, all of which are trellised. The main blackberries are 'Natchez' and 'Ouachita' but others (all floricane) from the Arkansas program also.

12:30: Break for lunch (catered on site by Apple House, Linden, VA) [under cover at Hartland]

1:15: Review or further pruning (and/or additional pest management topic)

2:00: Depart for Naked Mountain Vineyard

2:15: Introductions and overview of winegrape pruning and training
Tony Wolf and Tremain Hatch

2:45: Hands-on grapevine pruning, teams of 4-5 agents
Peculiars: (all bunch wine grapes); 15-yer-old 'Riesling' – combination of head-trained and cane-pruned as well as cordon-trained and spur-pruned; 20-yr-old Cab Sauvignon trained on modified lyre; 6-yr-old 'Chardonnay', head-trained and cane-pruned.

4:30:* Optional wine tasting while at Naked Mountain Winery, Randy Morgan

5:15: Depart for Front Royal, hotel; dinner at Houlihan's or other restaurants in area, on-your-own

*Options at this point (4:30 pm) are:

- Wine tasting at Naked Mountain, followed by transport back to Holiday Inn, Front Royal
- Van transportation directly to Dulles Airport (about 1 hour, depending on traffic)
- Departure home for those who drove. Your starting point is Markham, Virginia.

22 March: We will have at least one van driving to Dulles Airport on the morning of 22 March; the departure time from Holiday Inn hotel will be communicated once itineraries are known.

Note: Agents are asked to bring hand pruning shears if possible. These are not permitted on carry-on airline baggage. Please indicate on your travel information if you intend to bring shears in checked baggage or by car. Thank you.

Questions:

Dr. Wayne Mitchem, NCSU, mitchem@ncsu.edu (704) 472-4369
Dr. Tony Wolf, Virginia Tech, vitis@vt.edu (540) 232-6034

What's new in berry pest management?

Douglas G. Pfeiffer
Dept. of Entomology
Virginia Tech, Blacksburg

Blueberry, Caneberry and Winegrape Workshop
Southern Region Small Fruit Consortium
Front Royal VA

Berry Pest Management

•The Traditional Players …

Berry Pest Management

•The Traditional Players …

Fruit feeders

- **Cranberry Fruitworm, *Acrobasis vaccinii* Riley**

- **Cherry Fruitworm, *Grapholita packardii* Zeller**

Blueberry Maggot, *Rhagoletis mendax* Curran

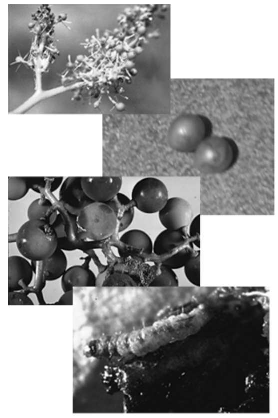
NCSU, USDA

Grape Berry Moth, *Paralobesia viteana*

Rufus Isaacs, MSU

- Formely *Endopiza*
- Key pest in eastern U.S. vineyards
- 3-5 generations annually
- NY threshold 2% injured clusters
- mid summer 2000 in VA:
  - 19, 27, 58, 79, 83, 95% injured clusters **(Avg. 60.2%)**

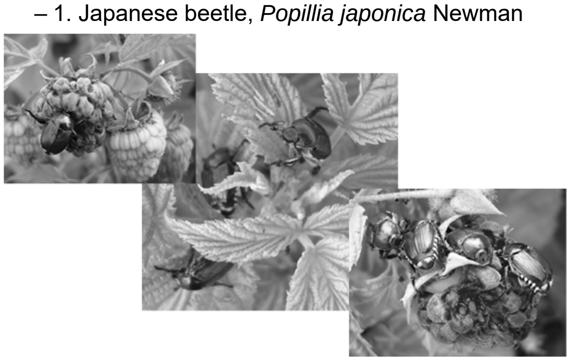
GBM injury



- Exterior feeders initially
- Enter and tunnel beneath berry surface
- Red spot on surface of berry
- Larva in rotted berry

Pests Causing Direct Injury to Caneberries

– 1. Japanese beetle, *Popillia japonica* Newman



Berry Pest Management

•The Traditional Players …

Fruit feeders

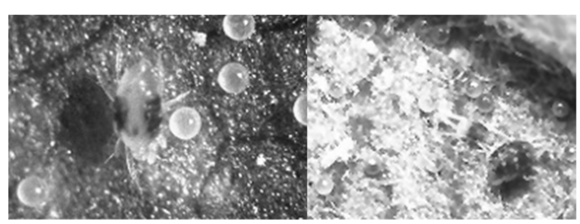
Foliar feeders

Pests Causing Indirect Injury to Grape

– 1. Japanese beetle, *Popillia japonica* (Newman)

Pests Causing Indirect Injury to Grape

European red mite, *Panonychus ulmi* (Koch), twospotted spider mite, *Tetranychus urticae* Koch



Berry Pest Management

•The Traditional Players …

Fruit feeders

Foliar feeders

Borers

Pests Causing Indirect Injury to Grape

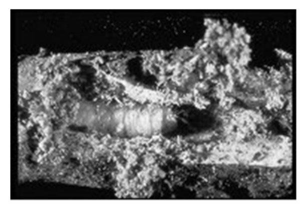
– 3. **Grape root borer, *Vitacea polistiformis* (Harris) (Sesiidae)**

Mating Disruption for GRB?

Pests Causing Indirect Injury to Caneberries

– **Raspberry crown borer *Pennisetia marginata* (Harris) (Sesiidae)**
– Rednecked cane borer *Agrilus ruficollis* (F.) (Buprestidae)
– Raspberry cane borer *Oberea bimaculata* (Olivier) (Cerambycidae)

Wash. St. Univ.



Col. St. Univ.

- **Pests Causing Indirect Injury to Caneberries**
  – Raspberry crown borer *Pennisetia marginata* (Harris) (Sesiidae)
  – Rednecked cane borer *Agrilus ruficollis* (F.) (Buprestidae)
  – Raspberry cane borer *Oberea bimaculata* (Olivier) (Cerambycidae)

Rednecked Cane Borer

•Cultural control: Remove galled canes in dormant season or early spring.

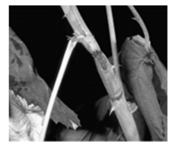
•This is most effective if nearby wild hosts are eliminated, and also more effective in open settings (wild brambles in nearby woods provide a source of wild beetles).

Pests Causing Indirect Injury to Caneberries

- Raspberry crown borer *Pennisetia marginata* (Harris) (Sesiidae)
- Rednecked cane borer *Agrilus ruficollis* (F.) (Buprestidae)
- Raspberry cane borer *Oberea bimaculata* (Olivier) (Cerambycidae)

Raspberry Cane Borer

- **Adults appear in June, and are present until late August. After ovipositing, the female girdles 6 mm above and 6 mm below the egg puncture.**
- **Shoot tips wilt in early summer.**



Berry Pest Management

- The Traditional Players
- **New pests ….**

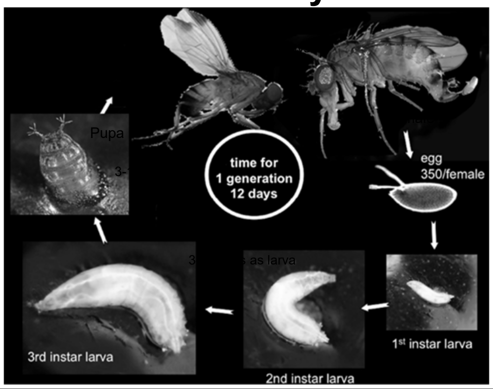
    Spotted-wing drosophila

    Spotted lanternfly

SWD Host List – Grape?

- Initial impressions in western states that grape not highly vulnerable
- Mainly seen where grapes are already split
- What is the situation in eastern wine grape regions?

SWD Life Cycle



Infesting Both Red and White Varieties

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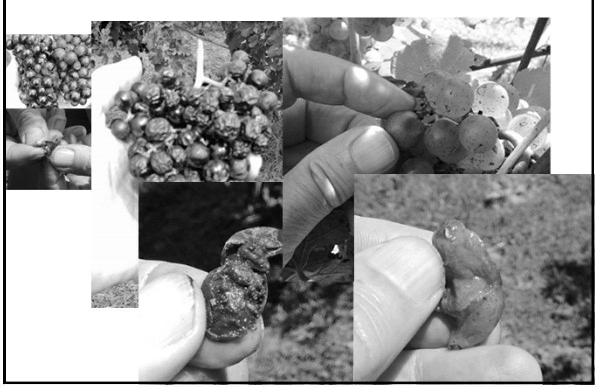
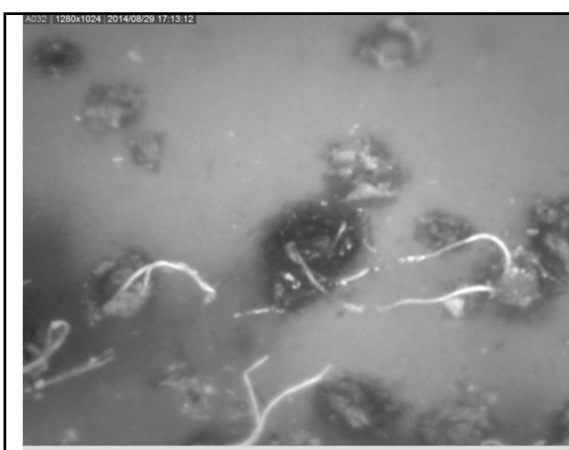




Varietal Differences in SWD Success

- Original perception was that susceptibility began at veraison
  - **Now we know that risk really starts at about 15° Brix**
  - Original perception thin-skinned reds most at risk
    - **Whites also vulnerable – in fact Viognier seems one of the most at risk**
- Importance of early injury?
  - **Small green berries can support SWD development if manually injured prior to exposure**

Battles at several levels

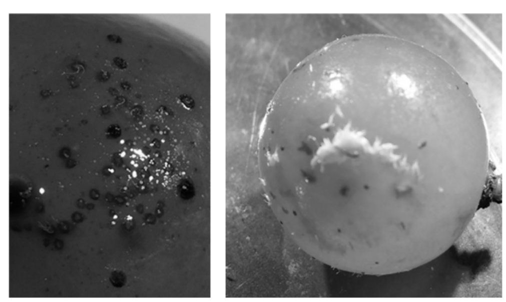
- SWD versus growers
- SWD versus winemakers
- SWD versus berries
- **SWD versus AFF**
- SWD versus parasitoids
- SWD versus insecticides

Zaprionus indianus Gupta, African fig fly

Incidence in wine grapes

- Weak ovipositor
- Sometimes high incidence in grape berries
  - In some Virginia clusters, 90% of emerging drosphilids were AFF
  - Sweep net samples in Pennsylvania vineyards
- How do they get into grapes?

AFF ability to colonize SWD infested grapes?

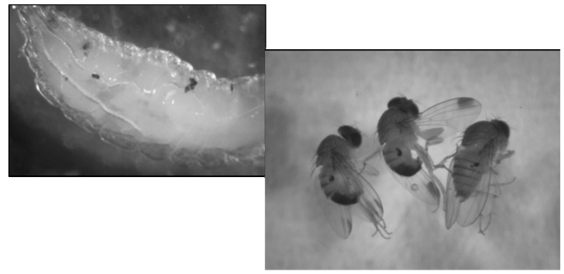


Sentinel Trapping Results

- Larval parasitoid *Leptopilina boulardi* (Figitidae) most abundant parasitoid reared from traps
- Pupal parasitoid *Pachycrepoideus vindemiae* (Pteromalidae) reared in lower numbers

Photos by Paul Marek

Parasitization Bioassay Results



Conclusions

- Conservation biological control with native parasitoids is not likely to be successful against SWD or AFF
- SWD and AFF have better resistance to *Leptopilina* than *D. melanogaster*, and AFF is less attractive to *Leptopilina* as a host
- These results support the case for classical biological control
- Observed edge effect may affect biological control for pest drosophilids

Battles at several levels

- SWD versus growers
- SWD versus winemakers
- SWD versus berries
- SWD versus AFF
- SWD versus parasitoids
- **SWD versus insecticides**

SWD Management
Chemical Control

- Need materials with short PHI
- Need materials of various MOA
- Need to rotate in a spray program!
- Label restrictions for maximum applications

- In high risk crops, need to spray weekly or more often

- Need local research on efficacy

Addition of sucrose to enhance efficacy

- On grape foliage, the **addition of 2.4 g/liter of sugar** with insecticide sprays resulted in an **11 and 6% increase of SWD mortality** at 1 and 2 d exposures to residues, respectively, averaged over seven insecticides with three concentrations
- **spinetoram and cyantraniliprole:** **<u>with 1.2 g/liter sucrose</u>** reduced the larval infestation of blueberries by 95–100%, relative to the untreated control; **<u>without sucrose</u>** infestation was reduced by 46–91%.

Cowles et al. (2015)

SWD Chemical Control

Insecticide	IRAC	Rate/A	Grape PHI	Seasonal Max
Sevin	1a	1-2 qt	7d	5 applics
Malathion	1b	1.88 pt	3d	2 applics
Imidan	1b	1.3-2.12 lb	7-14d	6.5 lb
Brigade	3	8-16 oz	30d	16 oz
Danitol	3	10.6-21 fl oz	21d	2 applics
Mustang Max	3	2-4 fl oz	1d	24 fl oz
Tombstone	3	2.4-3.2 fl oz	3d	12.8 fl oz
PyGanic	3	4.5-18 fl oz	0d	n/a
Delegate	5	3.5 oz	7d	5 applics
Entrust	5	1.25-2.5 oz	7d	5 applics
Grandevo	unknown	2-3 lb	0d	n/a
Surround	unknown	25-50 lb	0d	n/a

SWD Management Cultural Control

•Prune to open up fruit zone

•Harvest fruit promptly to eliminate breeding sites (viticultural considerations?)

•Get fruit as cold as possible as soon as possible

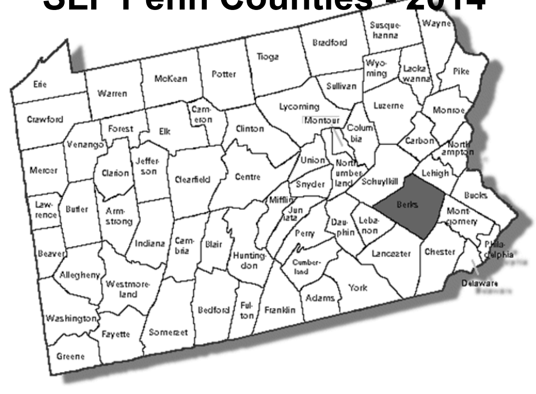
•Destroy nearby overripe or rotten

•Proper management of pomace

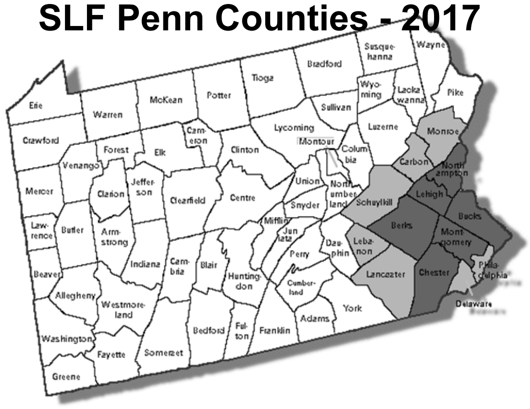
Spotted lanternfly, *Lycorma delicatula*

USDA

SLF Penn Counties - 2014

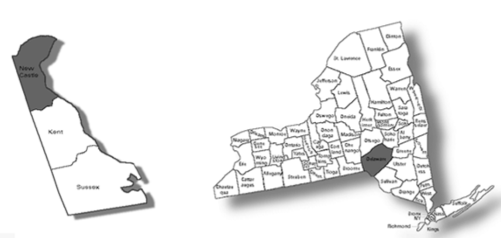


SLF Penn Counties - 2017



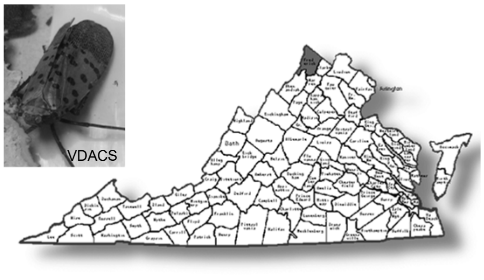
U.S. SLF invasion - 2017

- Also in 2017 – movement into two new states!



U.S. SLF invasion - 2017

- Also in 2017 – Virginia!



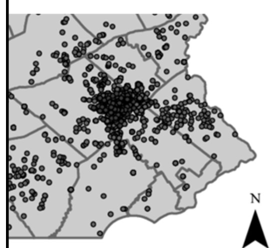
U.S. SLF invasion - 2017

- Also in 2017 – Virginia!

Expansion of SLF Range in the US

- By the end of 2017, SLF occupied 14 PA counties, and had crossed 2 state lines into New Castle Co, DE and Delaware Co, NY

Current U.S. SLF invasion



- PDA eradication efforts:
  - Tree banding
  - Egg scraping
  - TOH removal
  - Trap cropping (TOH)
  - Limited insecticide use

pennsylvania
DEPARTMENT OF AGRICULTURE

PDA

Spotted lanternfly biology

- Tree-of-heaven, *Ailanthus altissima* main host
- >65 other recorded hosts
- Pine, oak, walnut, poplar, grapes, stone fruits, apple.
- Switches to grape and peach if tree-of-heaven is removed.

SLF Host Range

Family	**Species**	**Common name**	**Stage (if reported)**
Aceraceae	Acer palmatum	Japanese maple	Eggs
	Acer rubrum	Red maple	Eggs
	Acer saccharum	Sugar maple	
Actinidiaceae	Actinidia chinensis		Nymph
Anacardiaceae	Rhus chinensis	Chinese sumac	Nymph
	Toxicodendron vernicifluum	Chinese lacquer	Nymph
Araliaceae	Aralia elata	Japanese angelica	Nymph
	Aralia cordata		Nymph
Asclepiadaceae	Metaplexis japonica	Rough potato	Nymph
Betulaceae	Alnus incana	Grey alder	Nymph
	Betula platyphylla	Asian white birch	Eggs
Compositae	Arctium lappa	Greater burdock	Nymph
Fabaceae	Maackia amurensis	Amur maackia	Nymph
	Robinia pseudoacacia	Black locust	
Fagaceae	Quercus aliena	Oriental white oak	Nymph
	Fagus grandifolia	American beech	Eggs
	Quercus montana	Chestnut oak	Eggs
Hydrangeaceae	Philadelphus schrenkii		Nymph
Juglandaceae	**Juglans mandshurica**	**Manchurian walnut**	**Adult/nymph**
	Juglans nigra	Black walnut	Nymph
	Juglans sinensis		Nymph
	Pterocarya stenoptera	Chinese wingnut	Nymph
Magnoliaceae	Magnolia obovata	Japanese bigleaf magnolia	Nymph
	Magnolia kobus	Kobus magnolia	Nymph
	Liriodendron tulipifera	Tuliptree	Eggs

Dara, S. K., L. Berringer, and S. P. Arthurs. 2015. *Lycorma deliculata* (Hemiptera: Fulgoridae): A new invasive pest in the United States. J. Integr. Pest Manag. 6: 1-6.

SLF Host Range

Family	Species	Common namea	Stage (if reported)
Meliaceae	**Cedrela fissilis**	**Argentine Cedar**	**Adult/nymph**
	Toona sinensis	**Chinese Mahogany**	**Adult/eggs/nymph**
Moraceae	Morus alba	White mulberry	Nymph
	Morus bombycis		Nymph
Oleaceae	Syringa vulgaris	Common lilac	Eggs
Platanaceae	Platanus occidentalis	American sycamore	Eggs
	Platanus orientalis	Oriental plane	
Rosaceae	Malus	Apple	
	Prunus mume	Japanese apricot	
	Prunus persica	Peach	
	Prunus salicina	Japanese plum	
	Prunus serotina	Black cherry	Eggs
	P. serrulata cv spontanea	Japanese flowering cherry	Eggs
	Prunus X Yedoensis	Hybrid cherry	Eggs
	Rosa hybrid	Rose	Nymph
	Rosa multiflora	Multiflora rose	Nymph
	Rosa rugose	Rugosa rose	Nymph
	Rubus crataegifolius		Nymph
	Sorbus commixta		Nymph
	Sorbaria sorbifolia	False spiraea	Nymph

Dara, S. K., L. Berringer, and S. P. Arthurs. 2015. *Lycorma deliculata* (Hemiptera: Fulgoridae): A new invasive pest in the United States. J. Integr. Pest Manag. 6: 1-6.

SLF Host Range

Family	Species	Common namea	Stage (if reported)
Rutaceae	Tetradium daniellii	Bee-bee tree	Eggs/nymph
	Phellodendron amurense	**Amur corktree**	**Adult/nymph**
Salicaceae	Populus spp.	Cottonwoods/poplars	
	P. alba	White poplar	Eggs
	Populus koreana	**Korean Poplar**	**Adult**
	Populus tomentiglandulosa		
	Salix matsudana	Corkscrew willow	
	Salix udensis		
	Salix spp.		**Adults/nymph/eggs**
Simaroubaceae	**Picrasma quassioides**		**Adult/nymph**
	Ailanthus altissima	**Tree of heaven**	**Adult/eggs/nymph**
Sterculiaceae	Firmiana simplex	Chinese parasoltree	Nymph
Styracaceae	Styrax obassia Nymph		
	Styrax japonica		**Adult/nymph**
Ulmaceae	Zelkova serrata	Japanese zelkova	Eggs
Umbelliferae	Angelica dahurica	Chinese Angelica	Nymph
Vitaceae	**Parthenocissus quinquefolia**	**Virginia creeper**	**Adult/nymph**
	Vitis amurensis	**Amur grape**	**Adult/nymph**
	Vitis vinifera	**Wine grape**	**Adult/nymph**
	Vitis spp.	**Wild grape**	

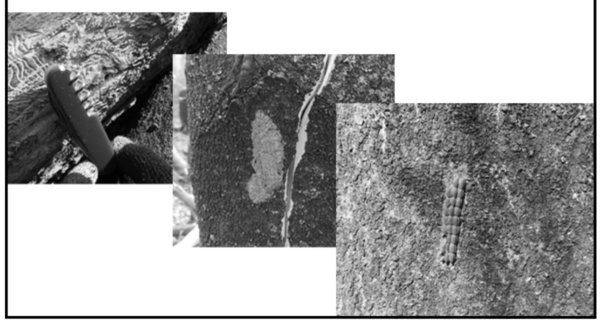
Dara, S. K., L. Berringer, and S. P. Arthurs. 2015. *Lycorma deliculata* (Hemiptera: Fulgoridae): A new invasive pest in the United States. J. Integr. Pest Manag. 6: 1-6.

Spotted lanternfly, *Lycorma delicatula*

- Short range dispersal – flight, hopping, walking
- Long range dispersal – human movement of infested commodities, or egg masses

Spotted lanternfly, *Lycorma delicatula*

- Winter eggs from January 2018

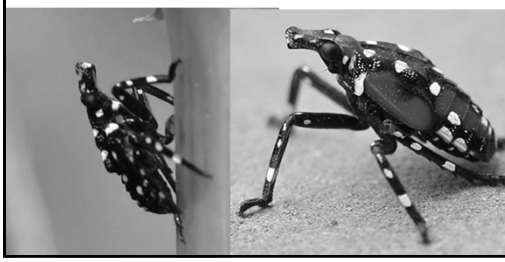


Spotted lanternfly, *Lycorma delicatula*

- Eggs hatch in spring, early summer (May 12 in PA (Spichiger 2015)
- Nymphs feed on a wide variety of plants, on young tissue
- Feeding results in large accumulations of honeydew and sooty mold
- May result in vinegar odor

Spotted lanternfly, *Lycorma delicatula*

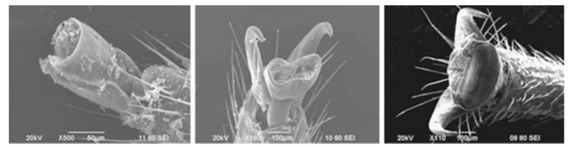
- Nymphs black with white spots in instars 1-3, then red with black spots later in instar 4.



USDA

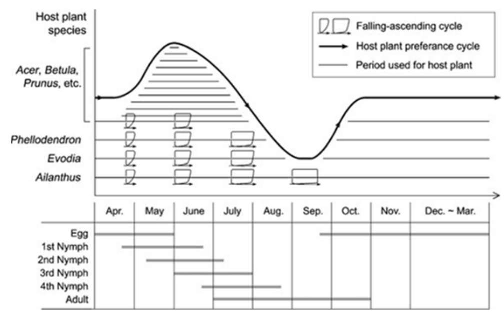
Spotted lanternfly, *Lycorma delicatula*

- Nymphs climb into tree after hatching
- Repeatedly fall to the ground and climb back to foliage
- As they mature, stay in tree longer (arolium development)
- Host range is very broad when young, more restrictive in mature insects



Kim, J. G., E.-H. Lee, Y.-M. Seo, and N.-Y. Kim. 2011. Cyclic behavior of *Lycorma delicatula* (Insecta: Hemiptera: Fulgoridae) on host plants. J. Insect Behav. 24: 423-435.

Spotted lanternfly, *Lycorma delicatula*



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Spotted lanternfly, *Lycorma delicatula*

- Adult feeding aggregations on apple tree and grapevine in PA

Penn State Extension

SLF on Grape

Penn State Entomology

Prospects for Biological Control

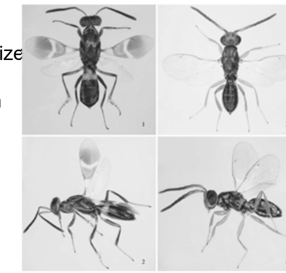
Biocontrol for SLF?

- *Anastatus orientalis*, a solitary endoparasitoid of eggs
- attacks eggs (33-70%, 20-90%)

Choi, M.-Y., Z.-Q. Yang, X.-Y. Wang, Y.-L. Tang, Z.-R. Hou, J. H. Kim, and Y. W. Byeon. 2014. Parasitism rate of egg parasitoid *Anastatus orientalis* (Hymenoptera: Eupelmidae) on *Lycorma delicatula* (Hemiptera: Fulgoridae) in China. Hanguk Ungyong Konchung Hakhoe Chi. 53: 135–139.
Yang, A.-Q., W.-Y. Choi, L.-M. Cao, X.-Y. Wang, and Z.-R. Hou. 2015. A new species of *Anastatus* (Hymenoptera: Eupelmidae) form China, parasitising eggs of *Lycorma delicatula* (Homoptera: Fulgoridae). Zool. Syst. 40: 290-302.

Anastatus orientalis

- Two emergence periods
- The May adults could parasitize the host eggs which were not parasitized in previous Autumn
- the September adults could parasitize the host eggs of the new generation.
- Stabilizing factor



Female Male

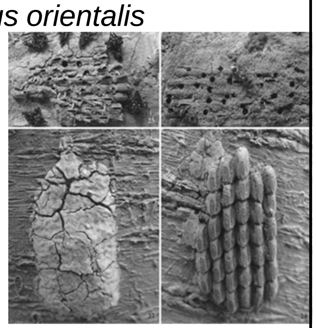
Yang, A.-Q., W.-Y. Choi, L.-M. Cao, X.-Y. Wang, and Z.-R. Hou. 2015. A new species of *Anastatus* (Hymenoptera: Eupelmidae) form China, parasitising eggs of *Lycorma delicatula* (Homoptera: Fulgoridae). Zool. Syst. 40: 290-302.

Anastatus orientalis

- Evidence for parasitization

Parasitoid emergence

SLF emergence



Yang, A.-Q., W.-Y. Choi, L.-M. Cao, X.-Y. Wang, and Z.-R. Hou. 2015. A new species of *Anastatus* (Hymenoptera: Eupelmidae) form China, parasitising eggs of *Lycorma delicatula* (Homoptera: Fulgoridae). Zool. Syst. 40: 290-302.

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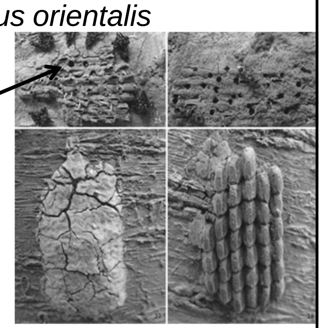

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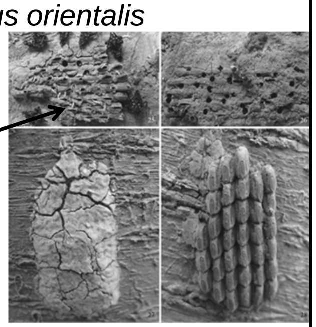
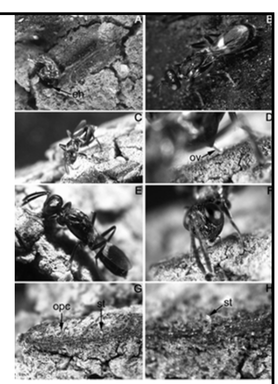


Yang, A.-Q., W.-Y. Choi, L.-M. Cao, X.-Y. Wang, and Z.-R. Hou. 2015. A new species of *Anastatus* (Hymenoptera: Eupelmidae) form China, parasitising eggs of *Lycorma delicatula* (Homoptera: Fulgoridae). Zool. Syst. 40: 290-302.

Biocontrol for SLF?

- *Anastatus* ovipositional behavior
- Host feeding increases mortality



Kim, I.-K., S.-H. Koh, Lee, J.-S., W. I. Choi, and S.-C. Shin. 2011. Discovery of an egg parasitoid of *Lycorma delicatula* (Hemiptera: Fulgoridae) an invasive species in South Korea. J. Asia-Pacif. Entomol. 14: 213–215.

Biocontrol for SLF?

- Bird predation – birds reported to feed on SLF:
  - Jays
  - Magpies
  - Tits (related to our chickadees)
  - Bulbuls (similar to our flycatchers)
  - Doves
- However some birds reported to peck, but not consume, vomit response

Kang, C.-K., S.-I. Lee, and P. G. Jablonski. 2011. Effect of sex and bright coloration on survival and predator-induced wing damage in an aposematic lantern fly with startle display. Ecol. Entomol. 36: 709-716.

Biocontrol for SLF?

- Surveys in 2016 revealed an encyrtid parasitoid
- *Ooencyrtus kuvanae* (Howard)
- Polyphagous, but first non-lepidopteran host

Liu, H., and J. Mottern. 2017. An old remedy for a new problem? Identification of *Ooencyrtus kuvanae* (Hymenoptera: Encyrtidae), an egg parasitoid of *Lycorma delicatula* (Hemiptera: Fulgoridae) in North America. J. Insect Sci. 17: 1-6.

Biocontrol for SLF?

- Some native predatory hemipterans found feeding on SLF in Pennsylvania
- Wheel bug, *Arilus cristatus* (L.)

hiltonpond.org

Biocontrol for SLF?

- Praying mantis feeding on SLF in PA

N. Troyano

Prospects for Chemical Control

Spotted lanternfly, *Lycorma delicatula*

- Chemical control:
  - Pyrethroids: Deltamethrin highly effective
  - Organophosphates: Fenitrothion, chlorpyrifos highly effective
  - Neonicotinoids: Dinotefuran, imidacloprid, thiacloprid highly effective; clothianidin less effective
- Clothianidin controls on TOH

Kim, S.-K., G.-Y. Lee, Y.-H. Shin, and G.-H. Kim. 2010. Chemical control effect against clothing wax cicada, *Lycorma delicatula [sic]* (Hemiptera: Fulgoridae) nymphs and adults. Kor. J. Pestic. Sci. 14: 440-445.
Park, J. D., M. Y. Kim, S. G. Lee, S. C. Shin, K. J. H., and P. I. K. 2009. Biological characteristics of *Lycorma delicatula* and the control effects of some insecticides. Korean J. Appl. Entomol. 48: 53-57.
Shin, Y.-H., S.-R. Moon, C. Yoon, K.-S. Ahn, and F.-H. Kim. 2010. Insecticidal activity of 26 insecticides against eggs and nymphs of *Lycorma delicatula* (Hemiptera: Fulgoridae). Kor. J. Pestic. Sci. 14: 157-163.

Preliminary Tree Fruit & Grape Insecticide Efficacy Ratings For SLF

Neonicotinoids	Provado Leverage Brigadier 1	Actara Voliam Flexi 1	Scorpion Venom 1	Assail 2
OPs Carbamates	Malathion 1	Imidan 1	Carbaryl 1	
Pyrethroids	Baythroid 3	Mustang Max 3	Brigade Sniper 2	

1 = Excellent, 2 = Good, 3 = Fair, 4 = poor

PSU 2018

Preliminary Insecticide Efficacy Ratings For SLF

Homeowner & Organic	Neemix 4.5 (direct contact) 2	M-Pede Safer Soap 1	Entrust ?
Forestry Ornamentals	?	?	?

1 = Excellent, 2 = Good, 3 = Fair, 4 = poor

PSU 2018

Prospects for Mechanical Control

Spotted lanternfly, *Lycorma delicatula*

- "The most economical method of control is to destroy the eggs by means of wire-woven gloves and brushes."

Chou, I. A. 1946. A study on *Lycorma delicatula* White. Entomologia et Ars 1: 31-54.

Spotted Lanternfly control:

Brown sticky traps may be useful for nymphs and adults

Choi, D.-S., D.-I. Kim, S.-J. Ko, B.-R. Kang, J.-D. Park, S.-G. Kim, and K.-J. Choi. 2012. Environmentally-friendly control methods and forecasting the hatching time *Lycorma delicatula* (Hemiptera: Fulgoridae) in Jeonnam Province. Korean J. Appl. Entomol. 51: 371-376.

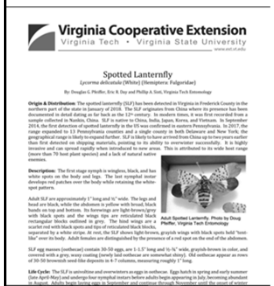
Spotted Lanternfly control:

Tanglefoot on bands controls nymphs during falling, ascending

Scrape egg masses

Spotted Lanternfly resources

- Virginia Tech Fact Sheet (linked in Virginia Fruit web site)



VT Entomology, Virginia Cooperative Extension

Spotted Lanternfly resources

- Virginia Tech Fact Sheet (linked in Virginia Fruit web site)

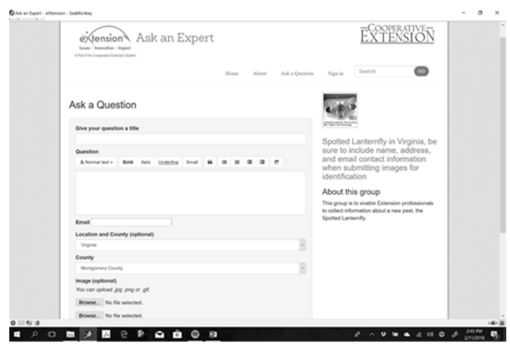
VT Entomology, Virginia Cooperative Extension

Spotted Lanternfly resources

- Web site for reporting finds or suspected finds of SLF!
- https://ask.extension.org/groups/1981/ask.

VT Entomology, Virginia Cooperative Extension

Spotted Lanternfly resources



VT Entomology, Virginia Cooperative Extension

Sampling?

- Plant examination
- Egg mass searches
- Adults attracted to UV
- Mature nymphs and adult females attracted to spearmint oil (utility?)

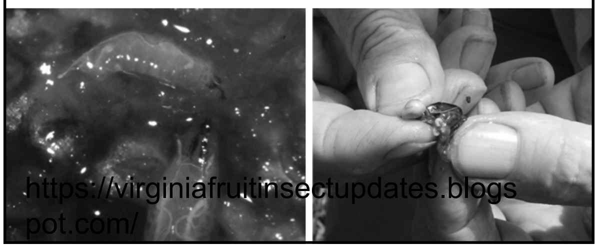
Jang, Y., H.-G. An, H. Kim, and K.-H. Kim. 2013. Spectral preferences of *Lycorma delicatula* (Hemiptera: Fulgoridae). Entomol. Res. 43: 115–122.
Moon, S.-R., S.-R. Cho, J.-W. Jeong, Y.-H. Shin, J.-O. Yang, K.-S. Ahn, C. Yoon, and G.-H. Kim. 2011. Attraction response of spot clothing wax cicada, *Lycorma delicatula* (Hemiptera: Fulgoridae) to spearmint oil. J. Korean Soc. Appl. Biol. Chem. 54: 558-567.

Reporting

- If found in Virginia, please notify:
- Doug Pfeiffer, Dept. of Entomology dgpfeiff@vt.edu
- Eric Day, Insect Identification Laboratory, idlab@vt.edu
- https://ask.extension.org/groups/1981/ask

Appreciation to:

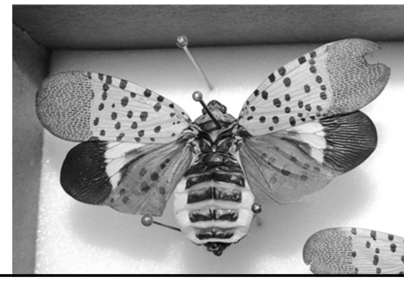
Virginia Wine Board
Southern Region Small Fruit Consortium



https://virginiafruitinsectupdates.blogspot.com/

Questions?

https://virginiafruitinsectupdates.blogspot.com/



Grape disease management updates

Mizuho Nita, Assistant Professor

AHS AREC, Virginia Tech

For SRSFC Agent training/IPM updates

Front Royal, VA

19 March 2018

Virginia Tech Invent the Future®

Copy of slides will be available at grapepathology.blogspot.com

Outline

- Recent fungicide field trial results
- Overall grape disease management tips
- Resources

Powdery Mildew trials

Cultivar: Chardonnay planted in 2012

Application timing

1) pre-bloom (1 Jun)
2) at bloom (10 Jun),
3) fruit set (23 Jun), and
4) bb, pea-size berry (30 Jun)

Assessment - 11 Jul

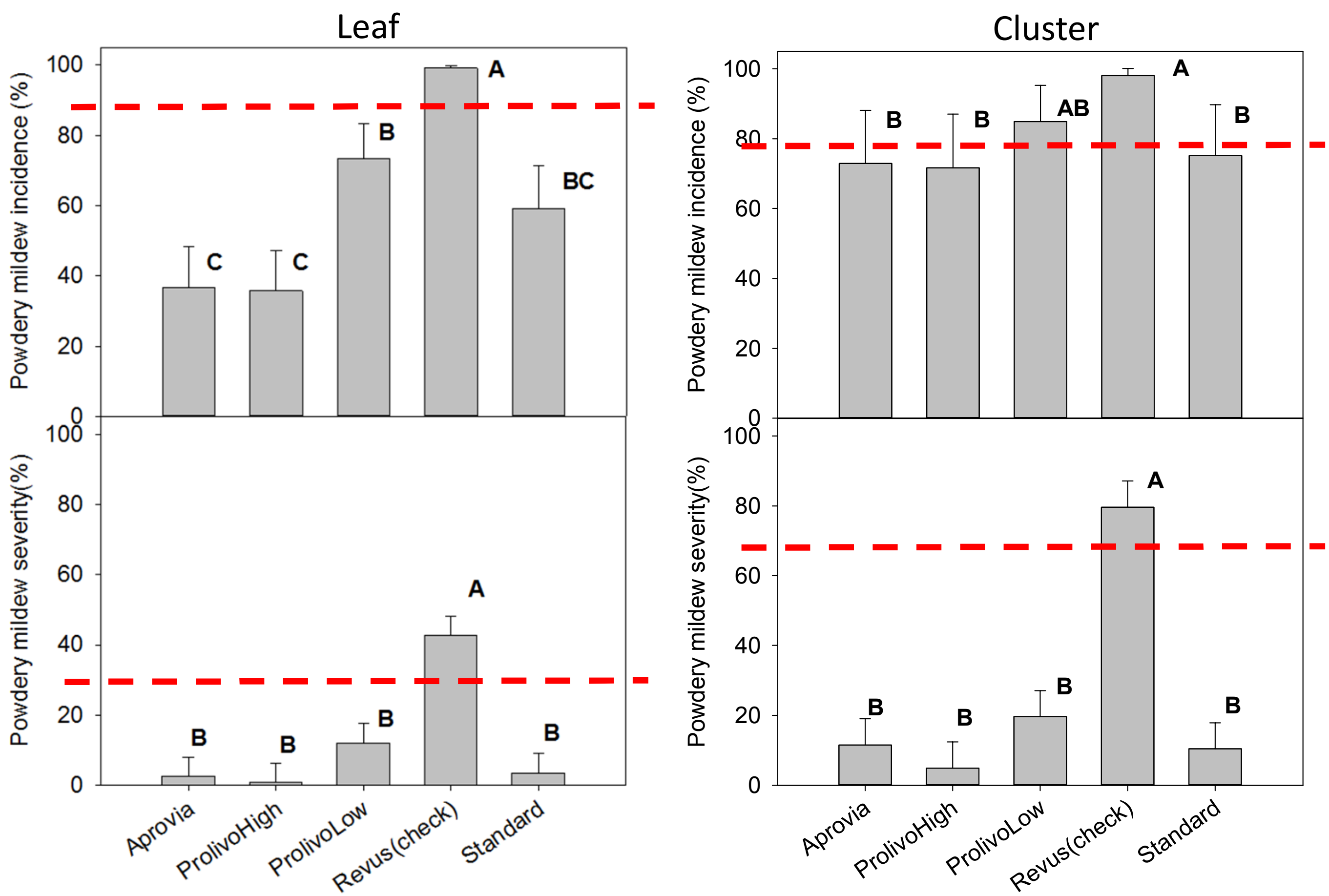
Aprovia (Syngenta)

- SDHI (group 7)
- A.I. = Benzovindiflupyr (aka Solatenol)
- 10.5 oz/A
  - up to 3 applications, but please remember that the SDHI group is prone to fungicide resistance
- 21 day PHI
- For Phomopsis, Black rot, and Powdery mildew
  - It should work for Botrytis, but Botrytis is NOT listed due to a concern for fungicide resistance…

Prolivo/Property (Summit Agro USA/ ISK)

- A.I.: pyriofenone (FRAC = U8)
- The same mode of action as Vivando
- Should be very good against powdery mildew
- Should be ready for 2018

2016 results: Both Aprovia (solatenol, 9 fl oz) and Prolivo (pyriofenone) applied at high rate (5 fl oz) resulted in significant reductions of powdery mildew on both leaf and cluster



Oso (aka Tavano 5%SC) (Certis) and Double Nickel (Certis)

Oso (Certis)

- Polyoxin D zinc salt
- 0-day PHI
- 4-hour REI
- 3.75-13 fl oz/A
- Against various fungal diseases including Botrytis, Powdery mildew, Alternaria (late season general rot)

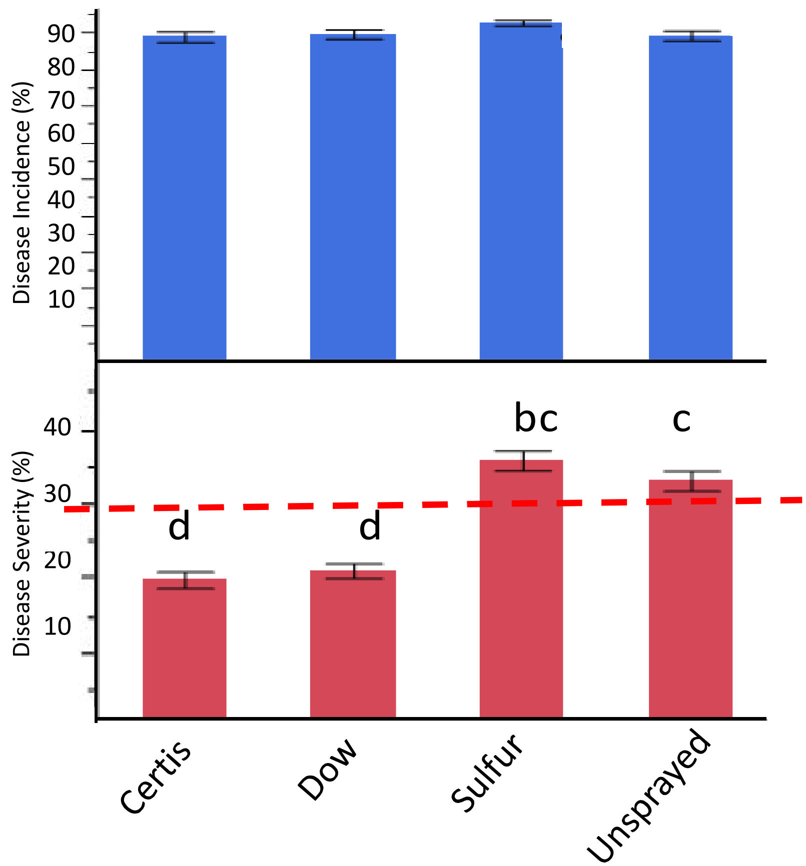
OSO™ 5%SC FUNGICIDE

Double nickel (Certis)

- *Bacillus amyloliquefaciens* strain D74
- 0-day PHI
- 4-hour REI
- 0.25 – 3 lb /A
- Against various fungal diseases including Botrytis, Powdery mildew, late season general rot

DoubleNickel55™
BIOFUNGICIDE
Water Dispersible Granular Biofungicide

Powdery mildew trial, 2015

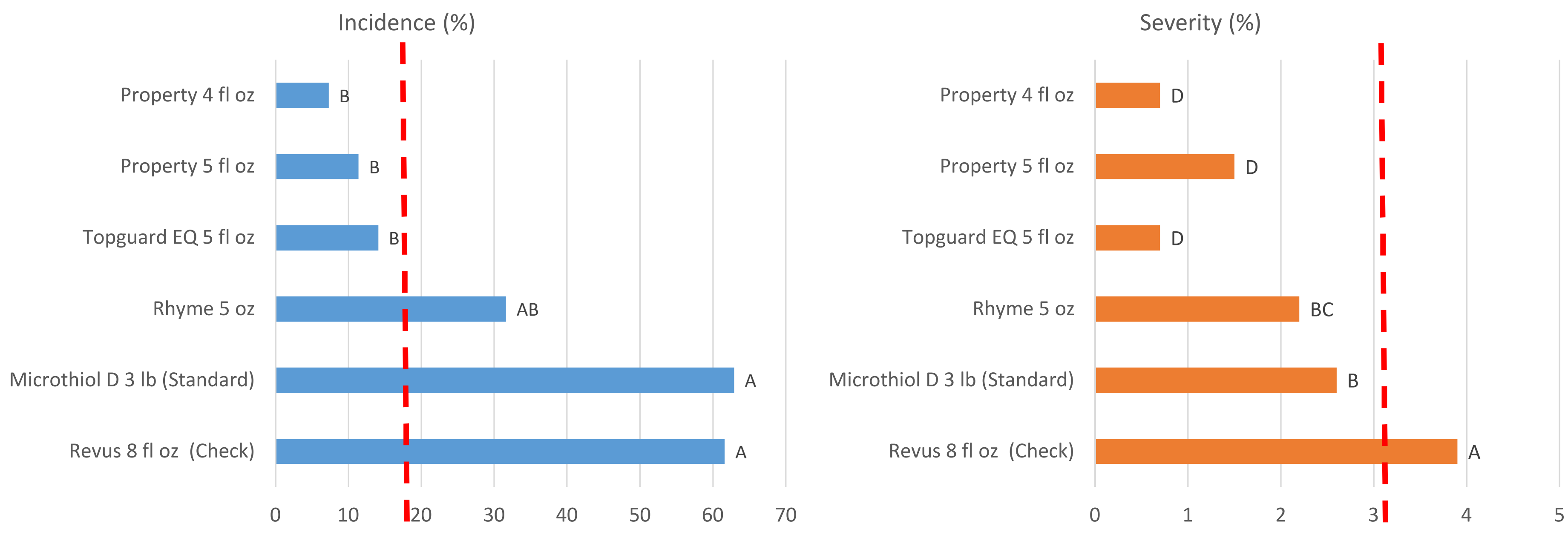


Double Nickel + Champ alt. with Oso + Prophyt, and Quintec alt. with Rally provided significant reduction in powdery mildew severity... Sulfur by itself was not good enough – probably because of a longer than usual spray interval (~12-14 days)

Topguard EQ and Rhyme (Valent)

- Topguard EQ
  - Azoxystrobin (FRAC = 11) + Flutriafol (FRAC = 3)
  - Black rot, powdery mildew (5-6 fl oz)
  - Powdery mildew, Phomopsis (8 fl oz)
  - Botrytis (suppression only – 8 fl oz)
  - REI = 12 hours (5 days for cane girdling and turning)
  - PHI = 14 days
- Rhyme
  - Flutriafol (FRAC = 3)
  - Powdery mildew, black rot (4-5 fl oz)
  - REI = 12 hours (5 days for cane girdling and turning)
  - PHI = 14 days

Topguard EQ worked better than Rhyme, probably due to two MOA



Downy Mildew trials

Cultivar: Chardonnay
planted in 2009

- Application timing
  - at bloom (6 Jun)
  - fruit set (15 Jun)
  - bb-size (29 Jun)
  - pea-size (12 Jul)

Assessment: 19 Jul

Ranman (ISK)

- **Ranman** (FRAC code 21).
- It is a good protective material without any kickback activities
- The rate is 2.1-2.75 fl oz/A
- REI = 12 hrs
- PHI = 30 days.

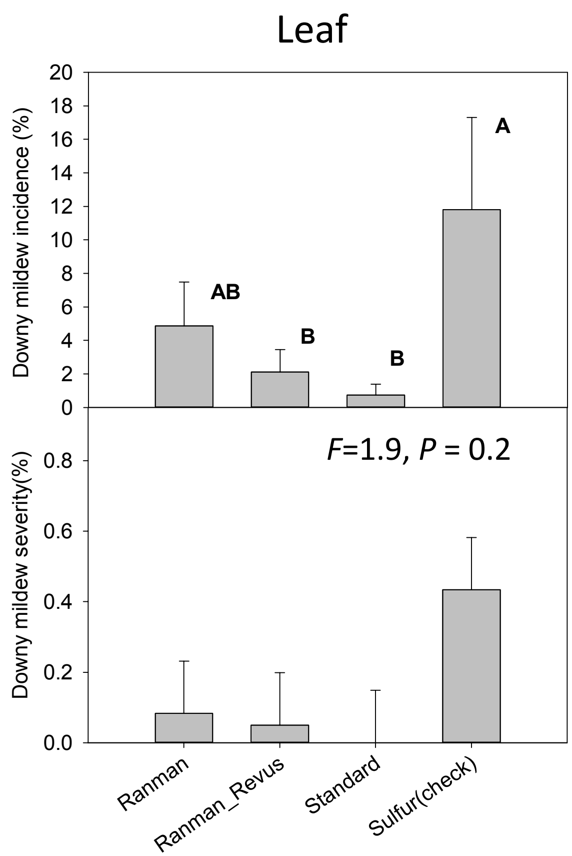
GROUP	21	FUNGICIDE

RANMAN®
FUNGICIDE

Downy mildew trial, 2016

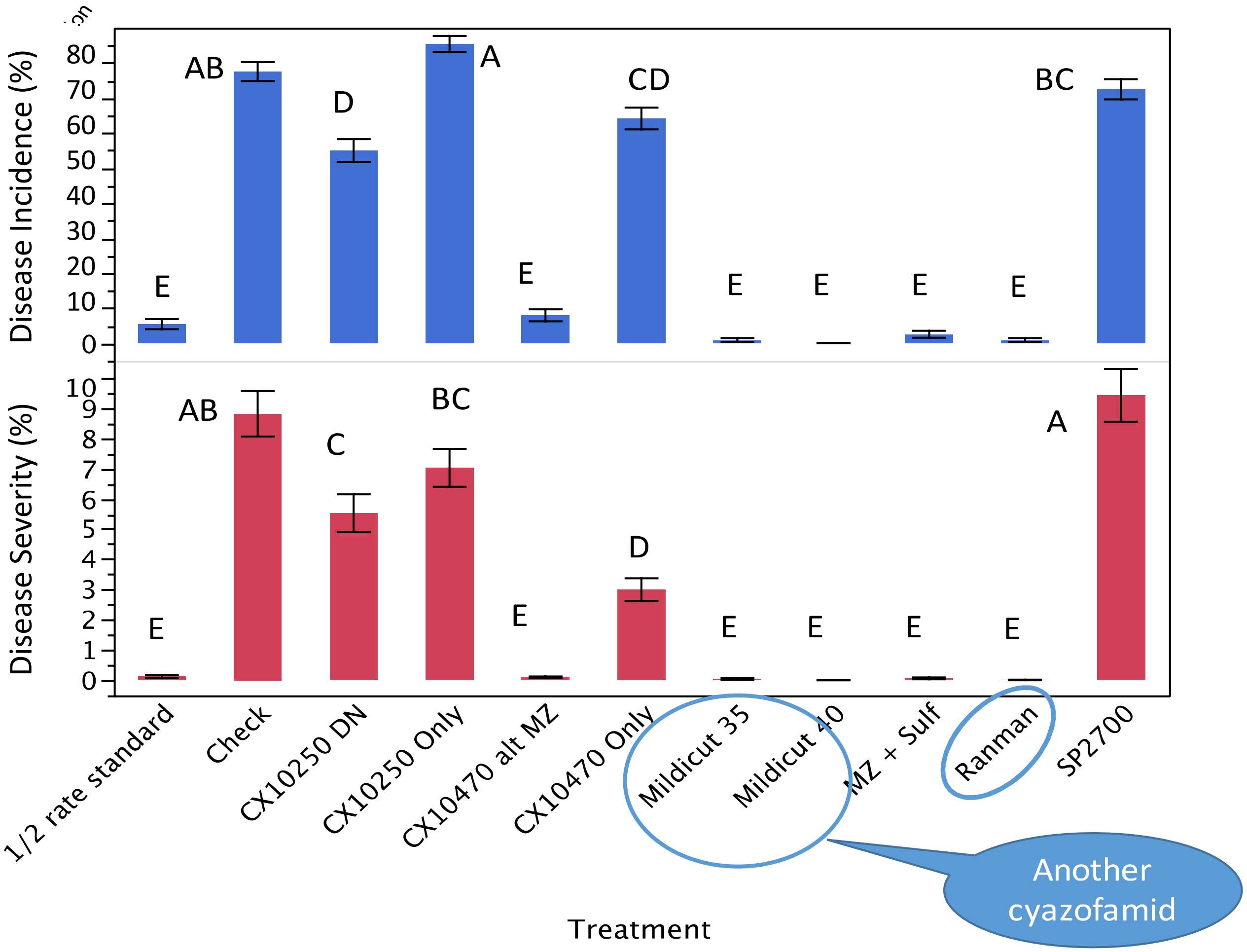
No cluster downy mildew development

The lack of treatment difference was probably due to low level of disease development



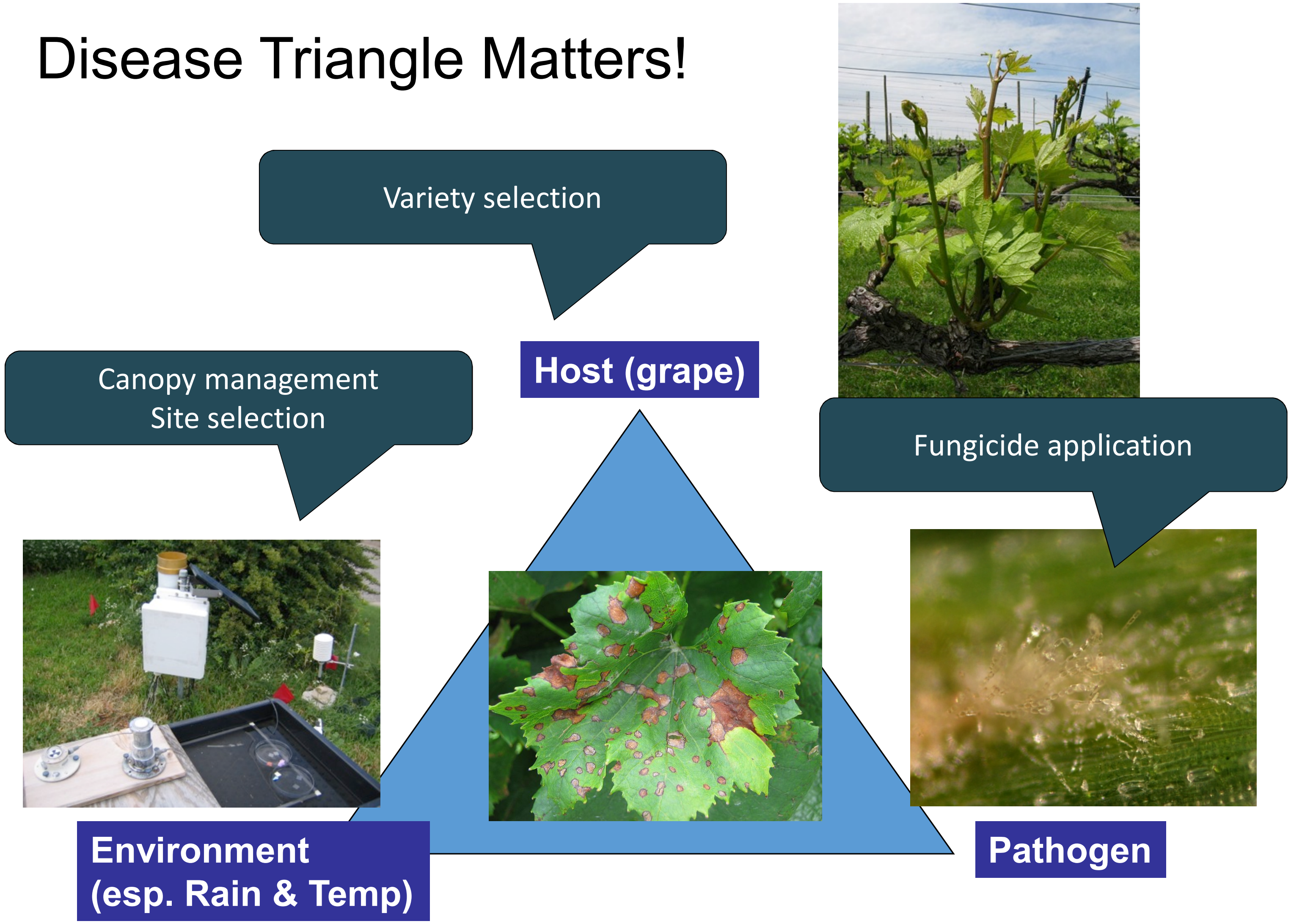
Although it was numerically lower, Ranman (cyzofamid) by itself resulted in non-significant difference from the check. Ranman alternated with Revus (mandipropamid) and standard (mancozeb alt. with ziram) showed very good efficacies.

Downy mildew trial, 2014



Grape disease management tips

Disease Triangle Matters!



In order to minimize the number of fungicide application, you need to establish a tactic where you will use all the tools available to you

- Use of Genetic Resistance
  - Cultivar Selection
- Cultural Control
  - Site selection
    - Air, sun, water, soil
  - Sanitation
    - Use of certified material
    - Clean up
  - Planting density
- Chemical Control
  - Type of fungicide
  - Timing of application
- Biological Control
  - Some agents are available, but results are not consistent

Integrated Pest Management (IPM)

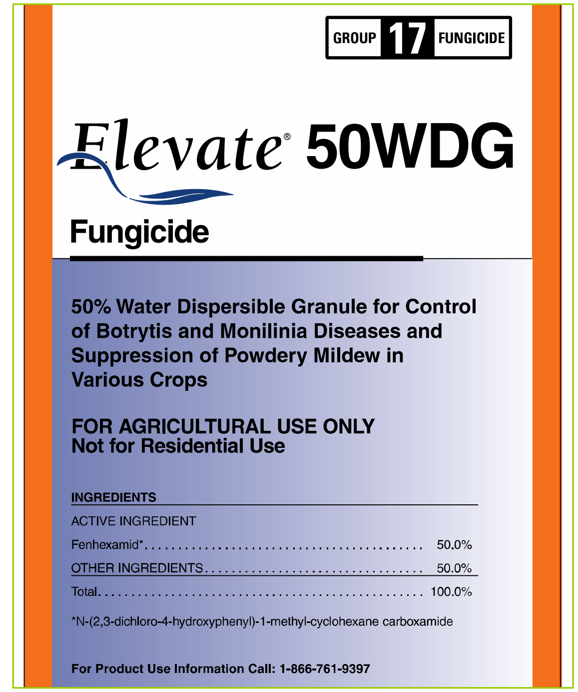
Fungicide resistance

- After several years of use, some of fungicides, especially newer ones, become less effective due to
  - Selection of more resistant population by applying the same chemical
  - Mutation of target gene and/or gene function
- Many of new fungicides are targeting a specific gene or gene function
  - Highly specific and thus often safer to other organisms.
  - Other benefits such as movement of the chemical into plant tissues
- The target pathogen can develop a resistance to the function = <u>mode of action (MOA)</u> = how the pesticide kills or inactivates the target pathogen, which is listed as FRAC code

FRAC (Fungicide Resistant Action Committee)

http://www.frac.info/

MOA	TARGET SITE AND CODE	GROUP NAME	CHEMICAL GROUP	COMMON NAME	COMMENTS	FRAC CODE
A: nucleic acids metabolism	**A1** RNA polymerase I	PA – fungicides (PhenylAmides)	acylalanines	benalaxyl benalaxyl-M (=kiralaxyl) furalaxyl metalaxyl metalaxyl-M (=mefenoxam)	Resistance and cross resistance well known in various Oomycetes but mechanism unknown. **High risk. See FRAC Phenylamide Guidelines for resistance management**	**4**
			oxazolidinones	oxadixyl		
			butyrolactones	ofurace		
	A2 adenosin-deaminase	hydroxy-(2-amino-) pyrimidines	hydroxy-(2-amino-) pyrimidines	bupirimate dimethirimol ethirimol	Medium risk. Resistance and cross resistance known in powdery mildews. Resistance management required.	**8**
	A3 DNA/RNA synthesis (proposed)	heteroaromatics	isoxazoles	hymexazole	Resistance not known.	**32**
			isothiazolones	octhilinone		
	A4 DNA topoisomerase type II (gyrase)	carboxylic acids	carboxylic acids	oxolinic acid	Bactericide. Resistance known. Risk in fungi unknown. Resistance management required.	**31**



- An international committee that consists of members from the chemical industry
- They organize fungicides into groups based on the MOA
- They also report cases of fungicide resistance

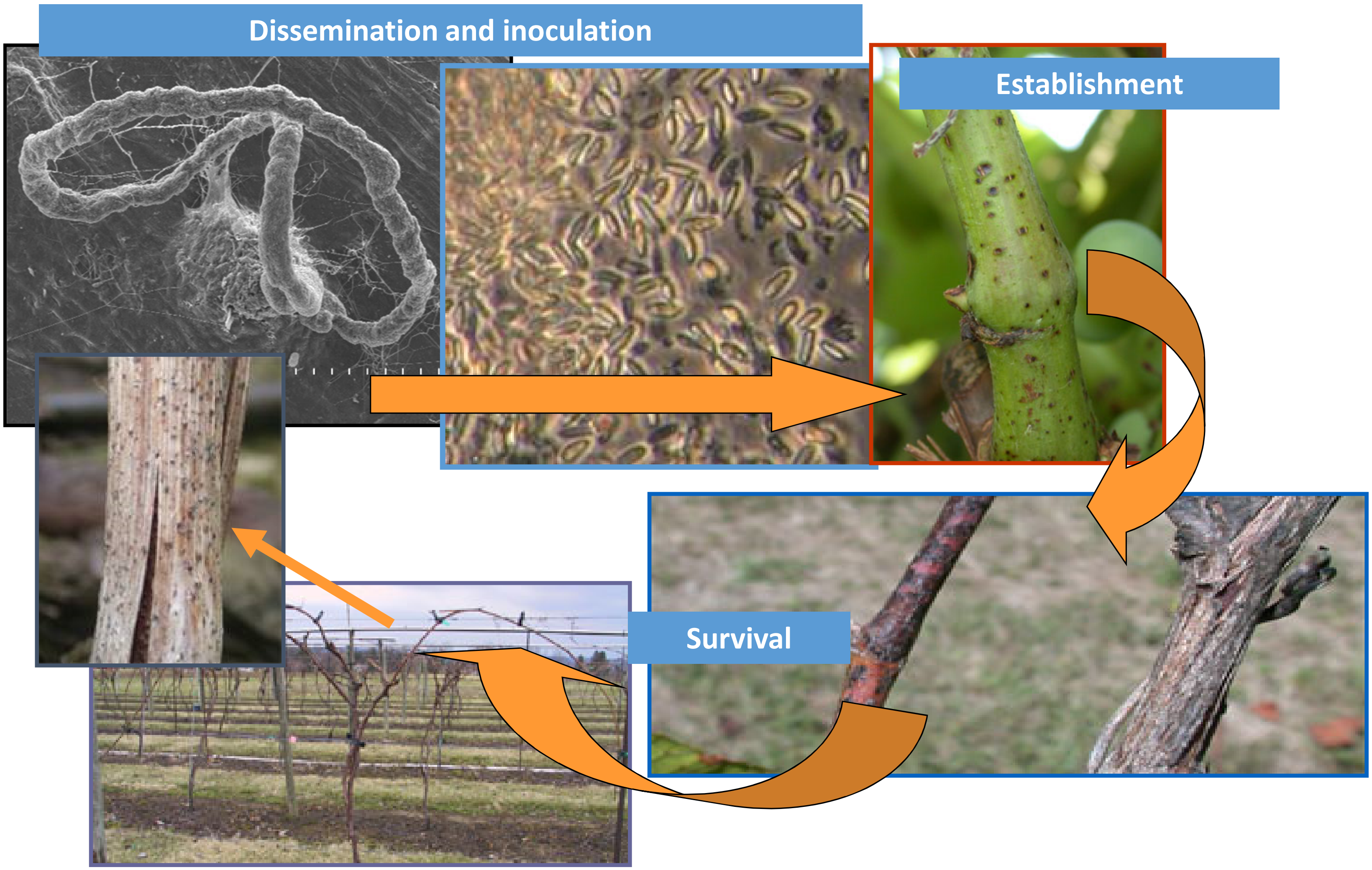
We (VA) have seen many cases of fungicide resistance in the past two decades: How to manage it?

- Protect your vines
  - Do not wait until you see diseases!!!
- Use appropriate material(s) for target disease(s)
- Use the recommended rate
  - Make sure that your sprayer provides a good coverage
- Mix with a relative low-risk fungicide (FRAC = M#)
- Rotate MOA
  - Limit the use of moderate and high risk materials to twice a season (no matter what the label says)

Phomopsis cane and leaf spot of grape

- A fungal disease caused by *Phomopsis viticola*
- It can infect shoots, leaves, berries, rachis
- Often not a big threat; however, up to 30% loss of crop in S. Ohio (Erincik et al. 2000)
  - It is difficult to measure its economical significance
- Protective fungicide applications (and selective pruning) are common means of control

Disease cycle (monocyclic disease)



Highlights of Phomopsis biology and management

- The fungus is active in 40-50F (early season!)
- First 2-3 applications with Mancozeb (or captan) aiming for new shoots is the key for the management
  - You may need to repeat frequently, if the weather is warm and wet so that you can cover new growth.
- No curative fungicides
- Dormant application of lime sulfur (10 gal/A) provided about 30% reduction in disease incidence
  - Is it worth it?
  - **Sulforix claims that it only requires 1-2 gal/A**
    - **If you would like to test, please let me know!!**
  - Copper did not provide control

Protective application is the best for management of Phomopsis cane and leaf spot

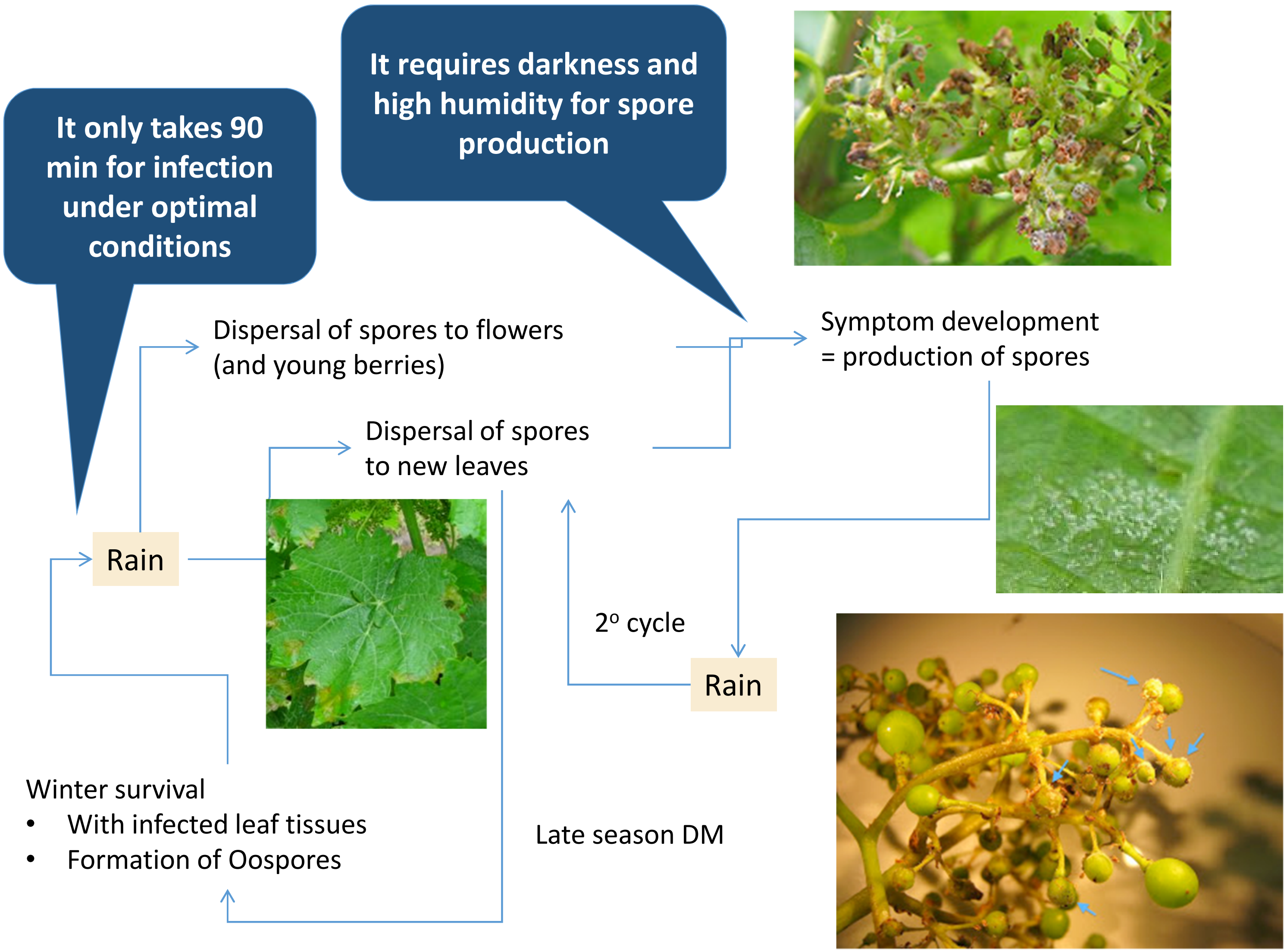
- Good materials
  - Mancozeb (Group M3), Ziram (Group M3), and Captan (Group M4)
- Fair
  - QoI/Strobilurins (Abound, Flint, Group 11), Topsin-M (thiophanate-methyl, Group 1), Pristine (pyraclostrobin + boscalid (Group 11 and 7), and ~~Adament (trifloxystrobin + tebuconazole)~~
- Poor
  - Fixed copper (Group M1), sulfur (Group M2), **lime sulfur** (Group M2)
    - For organic production use either fixed copper or lime sulfur (for foliar application, use a low rate (1 pt/100 gal water, see label)

Downy Mildew

- It can infect leaves and berries, berry infection can cause serious damage
- Heavy leaf infection can cause a defoliation

Oily spot appearance on the upper surface

Pictures taken from Organic grape production guide: OSU, Ellis and Nita 2004

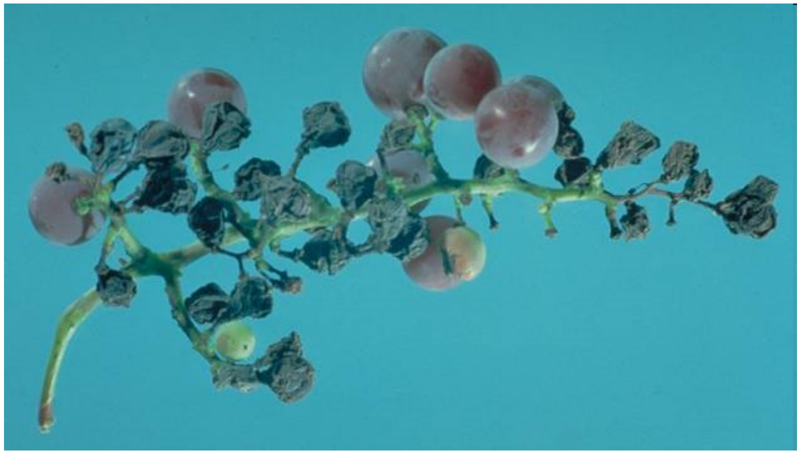

It only takes 90 min for infection under optimal conditions
It requires darkness and high humidity for spore production
Dispersal of spores to flowers (and young berries)
Symptom development = production of spores
Dispersal of spores to new leaves
Rain
2º cycle
Rain
Winter survival
• With infected leaf tissues
• Formation of Oospores
Late season DM

Downy Mildew Management

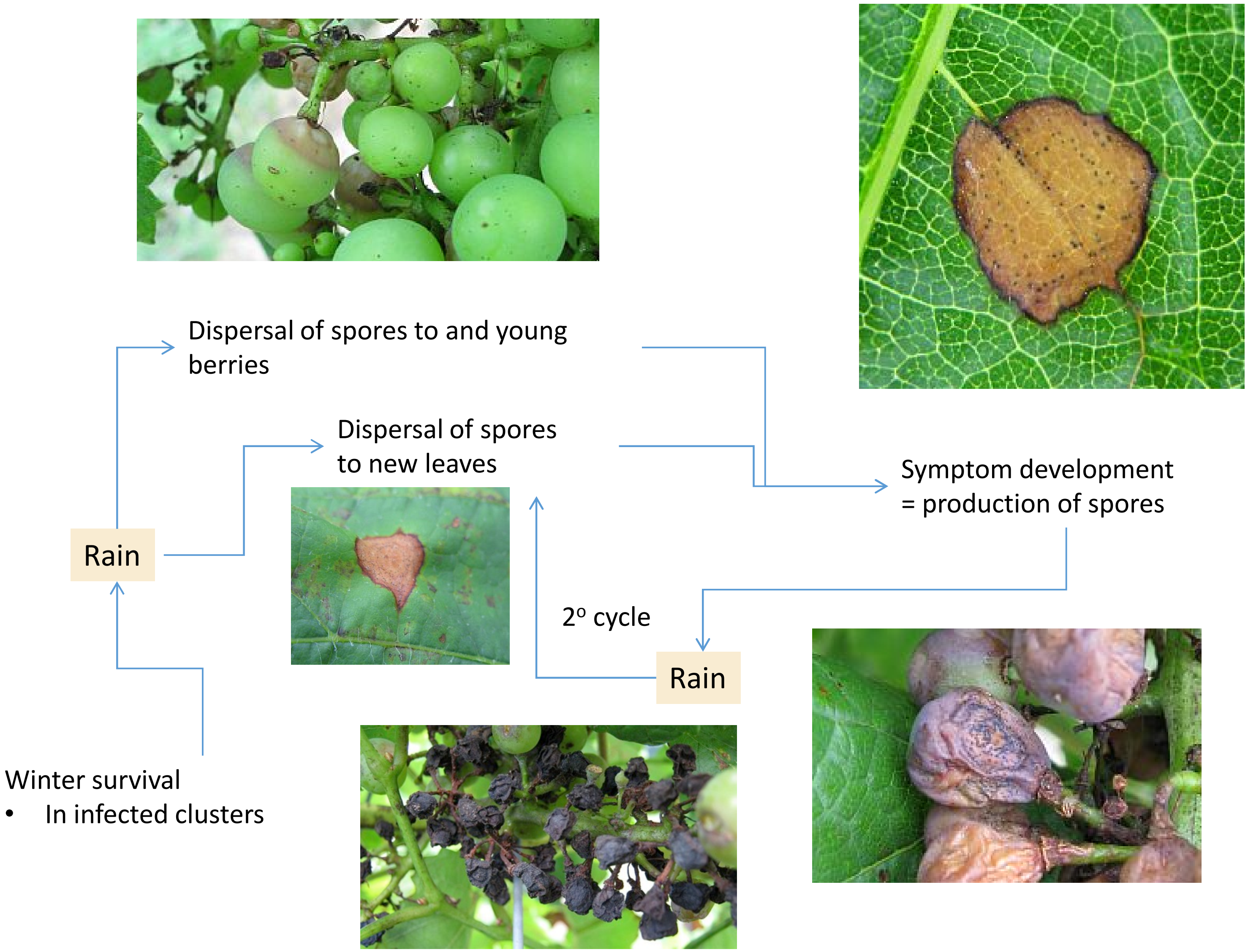
- Preventative fungicide application
  - Mancozeb (Dithane, Penncozeb, Gavel, etc. Group M3), Ranman (Group 21), **Revus/Forum (Group 40)**, Zampro (Group 40+45), captan (Group M4), copper (Group M1)
- Curative fungicide application
  - Phosphite (Prophyt, Phostrol, etc. Group 33), **Ridomil products** (Group 4), ~~Presidio (Group 43),~~ Tanos (Group 11 and 27)
    - note: we did not find a good result with Tanos in VA), both ~~Presidio~~ and Tanos need a mixing partner
    - Grape has been dropped from Presidio label: as long as you have the old label listing grapes, it is legally OK to use it.
  - QoI fungicides (Flint, Sovran, Abound, etc.) are no longer effective in VA vineyards.

Black Rot

- It is a fungal disease caused by *Guignardia bidweillii*.
- The fungus tends to be active in relatively higher temperature ranges.
- The fungus produces two types of spores: ascospores (airborne and rain splashed) early in the season and conidia (rain splashed) in later.
- It can infect leaves and berries, berry infection can cause serious damage



Picture taken from Organic grape production guide
OSU, Ellis and Nita 2004


Dispersal of spores to and young berries
Dispersal of spores to new leaves
Symptom development = production of spores
Rain
2° cycle
Rain
Winter survival
• In infected clusters

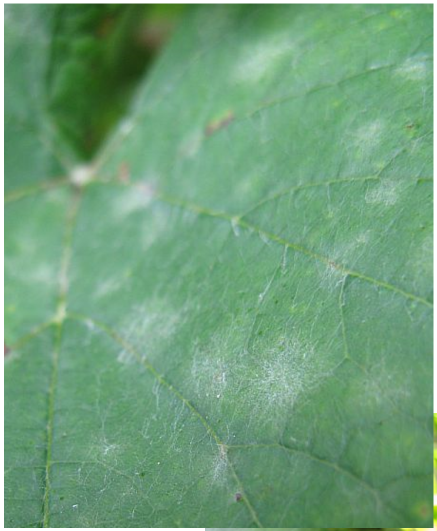
Black Rot Management

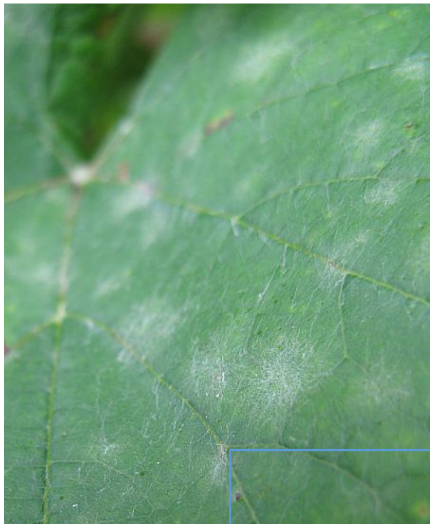
- Sanitation by removing old bunches from the vines
  - The fungus survives in crop debris, hanging berries from the last year is known to be the best source of inoculum.
- Good air circulation
- The critical timing of protection is from pre-bloom to 5 weeks after bloom (probably 2-3 sprays), berries become resistant after this period.
  - Once infection takes place, it takes about 2 weeks to produce spores at an average temperature above 70F (21C) (takes about 3 weeks at 60F (15C)).

Black Rot Management

- Preventative fungicide application
  - Mancozeb, DMI/Sterol-inhibitors (Rally, Mettle, etc, Group 3), Strobilurins (QoI, Pristine, Abound, Flint, Group 11)
- Curative fungicide application:
  - Myclobutanil is known to have a good curative (kick-back) activity against black rot fungus. It has an efficacy up to 6 days after infection.
  - Azoxystrobin does have some curative activity against black rot fungus; however, the efficacy is not as good as that of myclobutanil.

Powdery Mildew





2° cycle

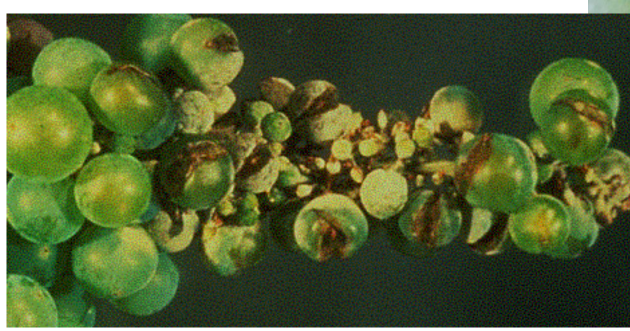
Dispersal of spores
to new leaves

Symptom development
= production of spores

Dispersal of spores to and
young berries

Winter survival

- On bark, leaf, berries



Powdery Mildew Management

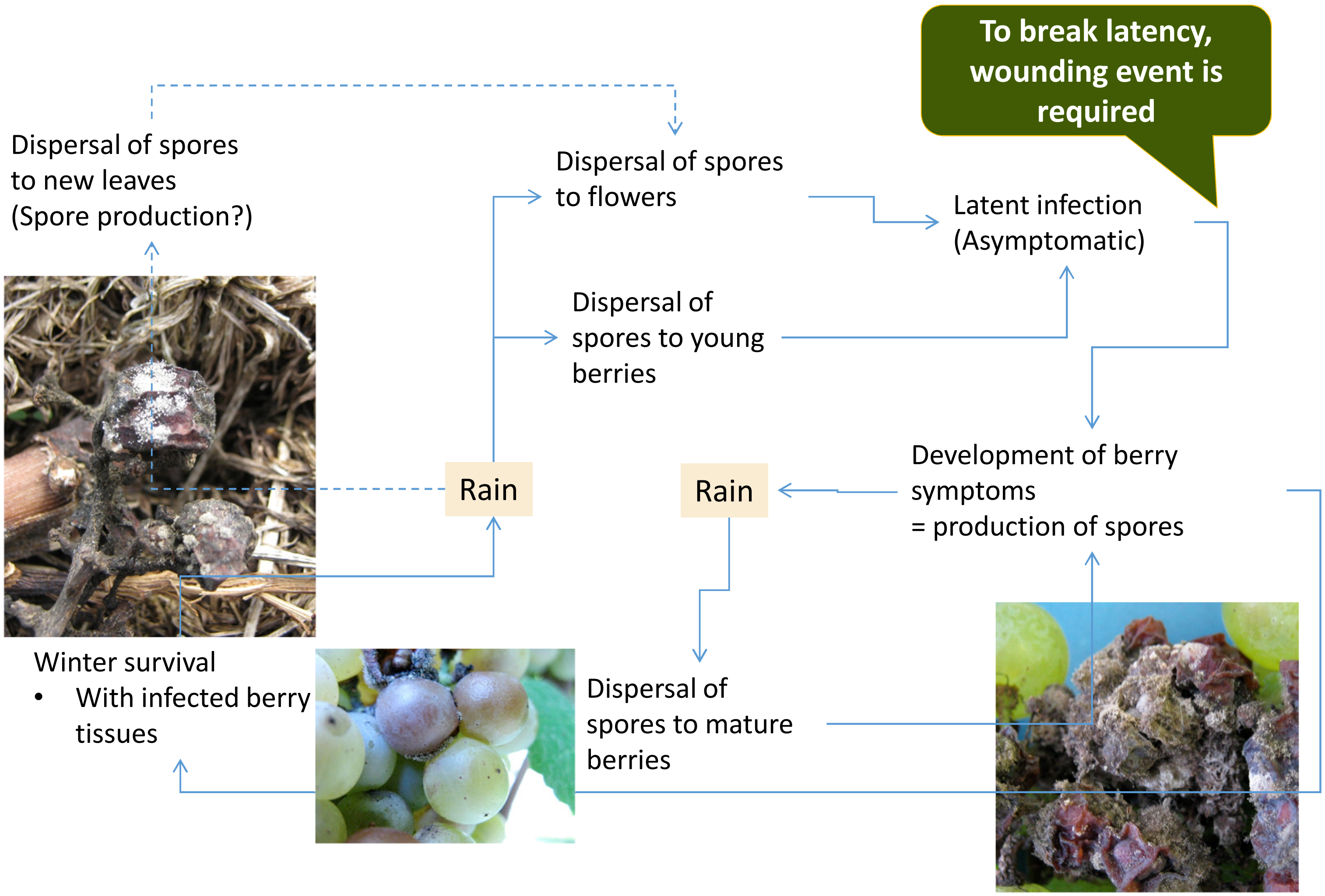
- Good air circulation
- Good light penetration
- Chemical management
  - The grape berries can become resistant to the infection by this fungus once it matures. It happens after 4-5 weeks after bloom for *V. vinifera* varieties. <u>However, rachis tissue does not become resistant.</u> Thus, the critical timing of protection is from pre-bloom to 4 weeks after bloom for protection of berries.
  - Spring rain promote ascospore discharge: early season protection could be important

Powdery Mildew Management

- Preventative fungicide application
  - Sulfur (M2), Fixed copper (M1), **<u>DMI</u>** (Sterol-inhibitor, Rally, Mettle, etc, 3), **<u>Quintec</u>** (13), Vivando and Prolivo/Property (U8), SDHI (Pristine, Endura, Luna Experience, Kenja, Aprovia, etc., 7), Torino (U6), etc.
    - Torino works, but not as effective as others. Good mixing partner to sulfur to have an extra kick
- Curative fungicide application:
  - Stylet Oil (Group M) [early season, some varieties shows phytotoxicity];
    - DO NOT mix oil with sulfur or captan!!!
  - Potassium salt products (Group M) [requires through coverage, expensive]

Botrytis Bunch Rot

Disease cycle of Botrytis bunch rot



Botrytis Management

- Good air circulation/Canopy management
  - Long wetness event (> 15 hr) is often associated with disease development
- Cluster management (leaf removal to promote reduce compactness, e.g., Vinoles), but you also need to avoid sunburn.
- Management of powdery mildew early in the season, and insect management (both are for preventing wounds on berries)

Botrytis Management

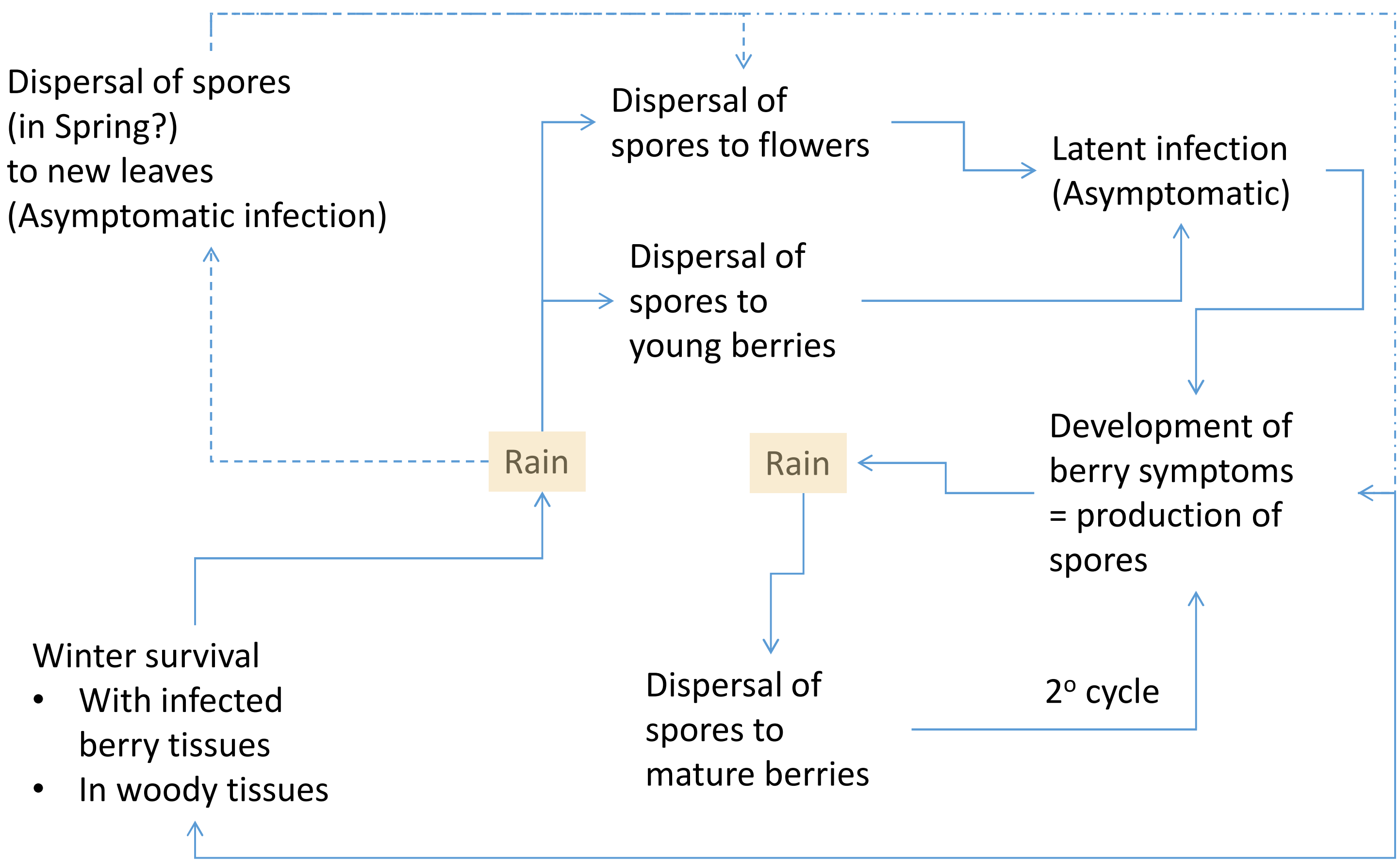
- Preventative fungicide application
  - Group 2: iprodione (Rovral/Meteor),
  - Group 7 (SDHI): **boscalid** (Endura), Luna Experience, Kenja
  - Group 9: cyprodinil (Vanguard, Inspire super, Switch)
  - Group 12: cyprodinil + fludioxinil (Switch)
  - Group 11 (QoI): I would not count on them
  - Group 17: fenhexamid (Elevate)
  - Group M4: Captan – fair activity, but it will be a good mixing partner!

  These fungicides are tested for curative activity in the lab. They had some efficacy within 12 hr of infection; however, it is a lab experiment using detached berries (i.e., I wouldn't risk your vines.)

Ripe rot pathogens cause latent infection

- Although the “rot” may appear late in the season, actual infection can happen much earlier
- After the infection event, the pathogens resides in infected tissue without showing symptoms = latent infection
- Caused by two species complexes that consist of more than 40 species
  - *Colletotrichum acutatum*
  - *Colletotrichum gloeosporioides*
- We identified at least 7 species in VA with average of 2.7 species per vineyard = you are dealing with multiple species

Disease cycle of ripe rot



Bottom line for ripe rot management

- Pre-bloom: no special spray for ripe rot
- At bloom: protect flowers with mancozeb or a QoI (Pristine, Flint, Abound), mix with Botrytis material(s)
- Post bloom: Keep using mancozeb until the 66-day PHI, then switch to Ziram (21-day PHI), QoI or captan
  - Use a QoI if you suspect captan is not providing a control
  - Note: there are known QoI resistance cases of ripe rot pathogens (very high rate among VA vineyards)
  - *There are many chemicals that seem to have "fair" efficacy (Copper, DMI, Phosphite, SDHI, Rovral, etc.) Mix and Rotate!!*

Multiple year/location study indicated that a single MOA is not effective for ripe rot management
MOA mixtures and alternation is highly recommended

Alternation and mixing partners for mancozeb/ziram or captan (Timing: bloom and one or more spray at or after berry touch)		
Moderate level of reduction	Low level of reduction	No or limited effect
• Aprovia (Benzovindiflupyr, FRAC= 7) • Cueva (Copper (M1)) • Intuity (mandestrobin, (11)) • Luna Experience (Fluopyram (7) + tebuconazole (3)) • Viathon (Phos acid (33) + tebuconazole (3))	• Elevate (fenhexamid (7)) alt. w/ Rovral (iprodione (2)) • PhD (polyoxin-D (19)) • Switch (cyprodinil (9) + fludioxonil (12))	• Endura (Boscalid (7)) • Oso (polyoxin-D (19)) • Rally (myclobutanil (3))

Resources on Grape Disease Management

- My blog
  - Seasonal updates as well as repository for meeting notes, etc.
  - Grapepathology.blogspot.com
- I will upload today's presentation!
- Twitter: @grapepathology
- Facebook:GrapePathVATech

VCE's Pest Management Guide (PMG)

- It covers not only diseases, but also insects and weeds
- Updated every year

Diseases and Insects in Vineyards

Douglas G. Pfeiffer, Extension Entomologist, Virginia Tech
Anton B. Baudoin, Plant Pathologist, Virginia Tech
J. Christopher Bergh, Extension Entomologist, Alson H. Smith Jr. AREC
Mizuho Nita, Extension Plant Pathologist, Alson H. Smith Jr. AREC

Additional information on pest and beneficial species identification is available online at *http://www.virginiafruit.ento.vt.edu/*. Application rates: The rate per acre column gives rates for low-volume or concentrate applications. Sprays may be applied as semi-concentrate (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) 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	10.0 gal	Only necessary where anthracnose, Phomopsis, or powdery mildew have been a **serious** problem. Lime sulfur can reduce overwintering inoculum of these diseases.
Mealybugs	Applaud 70DF Venom 20SG Assail 30SG Provado Solupak Baythroid 2EC Movento 2SC	9.0-12.0 oz 0.44-0.66 lb (foliar) 1.13-1.32 lb (soil) 2.5 oz 0.8-1.0 oz 2.4-3.2 fl oz 6.0-8.0 fl oz	If a problem at harvest in the previous year. If a delayed dormant spray does not provide a adequate control, a summer application may be made. Baythroid targets only crawlers. Movento prebloom only in table grapes.
Bud Swell			
Grape flea beetle	Danitol 2.4EC or	8.0 fl oz	If adult beetles are present in damaging numbers. **See Table 3.4 for Restricted Entry**

Southeastern Regional IPM guide
http://www.smallfruits.org/SmallFruitsRegGuide/

- Another version of the management guide
- Why so many? - there are many ways to look at pest management

2014 Southeast Regional Bunch Grape Integrated Management Guide

Commodity Editor
Mizuho Nita (Virginia Tech)

Section Editors
Pathology; Mizuho Nita (Virginia Tech)
Entomology; Hannah Burrack (North Carolina State University)
Doug Pfeiffer (Virginia Tech)
Weed Science; Wayne Mitchem (North Carolina State University)
Vertebrate Management and Grape Culture; David Lockwood (University of Tennessee)
Pesticide Stewardship and Safety; Bob Bellinger (Clemson University)

Senior Editors
Phil Brannen (University of Georgia)
Powell Smith (Clemson University)

Up-coming VCE meetings 2018

17 April 2018
Vineyard IPM workshop at Early mountain Vineyards (Central Virginia)

6 June 2018
"Beginner's" Grape Growing workshop
Virginia Tech's AHS Jr. Agricultural Research and Extension Center, Winchester VA

VIRGINIA TECH™

Basics of Blackberry Disease Management

Phillip M. Brannen

Plant Pathology Department

University of Georgia

THE UNIVERSITY OF GEORGIA

COOPERATIVE EXTENSION

Colleges of Agricultural and Environmental Sciences & Family and Consumer Sciences

2015 Southeast Regional Caneberries Integrated Management Guide

Commodity Editor
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Weed Science; Wayne Mitchem and Katie Jennings (North Carolina State University)
Vertebrate Management; David Lockwood (University of Tennessee)
Culture; Gina Fernandez (North Carolina State University)
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Senior Editors
Phil Brannen (University of Georgia)
Powell Smith (Clemson University)

Contributions were also made by Ed Sikora (Auburn University), Steve Bost (University of Tennessee), and Dan Horton (University of Georgia).

Recommendations are based on information from the manufacturer's label and performance data from research and extension field tests.

Because environmental conditions and grower application methods vary widely, suggested use does not imply that performance of the pesticide will always conform to the safety and pest control standards indicated by experimental data.

This publication is intended for use only as a guide. Specific rates and applications methods are on the pesticide label, and these are subject to change at any time. Always refer to and read the pesticide label before making any application! The pesticide label supersedes any information contained in this guide, and it is the legal document referenced for application standards.

Blackberry Disease Problems (Potential)

- Double blossom (Rosette)
- Botrytis gray mold
- Viruses
  - Dagger nematode
- Orange rust
- Leaf and cane rust
- Phytophthora root rot
- Spur blight
- Crown gall
- Cane blight
- Oak root rot
- Anthracnose
- Orange blotch
- Septoria leaf spot
- Cercospora and/or Pseudocercospera

General Considerations for Disease Management

- Destroy wild brambles within 600 feet of the production area.
- Bramble fields should be located in direct sunlight with good air circulation.
- Purchase certified virus-free plants when available.
- Avoid Phytophthora and other root rots by using raised beds (8-12 inches high). Install drain tile if necessary.

General Considerations for Disease Management

- 2-4% organic matter is recommended; consider use of manure or green manure crops to increase OM.
- Do not plant immediately following crops of potato, tomato, or eggplant, since Verticillium inoculum may be available for infection. Rotate with non-vert crops for 3-4 years before planting brambles.

Seasonal ‘at a glance’ fungicide spray schedule options for brambles										
Developmental Stage	**Delayed Dormant**	**Shoots 6” long till Pre-Bloom**	**Early bloom (5-10%)**	**Full Bloom**[a]	**Petal Fall**	**Cover Sprays**	**Pre-Harvest**	**Harvest**	**After Harvest**
Disease (Registered fungicide)	**Anthracnose, Spur Blight, Cane Blight** (Lime Sulfur or Copper)	**Anthracnose, Cane Blight, Spur Blight, and Leaf Spots** (Copper, Cabrio, Abound, Pristine, and Captan) **Rusts** (Rally, Abound, Cabrio, Pristine, Orbit, Tilt) **Powdery Mildew** (Sulfur, Rally, Cabrio, Abound, Pristine) **Phytophthora Root Rot** (Ridomil, phosphorous acid-based products)	**Botrytis** (Rovral, Nevado, Iprodione, Elevate, Switch, Pristine) **Rosette** (Switch, Abound, Pristine) **Powdery Mildew** (Rally, Cabrio, Abound, Pristine) **Rusts** (Rally, Abound, Cabrio, Pristine, Orbit, Tilt) **Anthracnose, Cane Blight, Spur Blight, and Leaf Spots** (Cabrio, Abound, Pristine, and Captan)	**Botrytis** (Rovral, Nevado, Iprodione, Elevate, Switch, Pristine) **Rosette** (Switch, Abound, Pristine) **Powdery Mildew** (Rally, Cabrio, Abound, Pristine) **Rusts** (Rally, Abound, Cabrio, Pristine, Orbit, Tilt) **Anthracnose, Cane Blight, Spur Blight, and Leaf Spots** (Cabrio, Abound, Pristine, and Captan)	**Botrytis** (Rovral, Nevado, Iprodione, Elevate, Switch, Pristine) **Rosette** (Switch, Abound, Pristine) **Powdery Mildew** (Rally, Cabrio, Abound, Pristine) **Rusts** (Rally, Abound, Cabrio, Pristine, Orbit, Tilt) **Anthracnose, Cane Blight, Spur Blight, and Leaf Spots** (Cabrio, Abound, Pristine, and Captan)	**Botrytis** (Rovral, Nevado, Iprodione, Elevate, Switch, Pristine) **Rosette** (Switch, Abound, Pristine) **Powdery Mildew** (Rally, Cabrio, Abound, Pristine) **Rusts** (Rally, Abound, Cabrio, Pristine) **Anthracnose, Cane Blight, Spur Blight, and Leaf Spots** (Cabrio, Abound, Pristine, and Captan)	**Botrytis** (Rovral, Nevado, Iprodione, Elevate, Switch, Pristine) **Rosette** (Switch, Abound, Pristine) **Powdery Mildew** (Rally, Cabrio, Abound, Pristine) **Rusts** (Rally, Abound, Cabrio, Pristine, Orbit, Tilt) **Anthracnose, Cane Blight, Spur Blight, and Leaf Spots** (Cabrio, Abound, Pristine, and Captan)	**Botrytis** (Rovral, Nevado, Iprodione, Elevate, Switch, Pristine) **Rosette** (Switch, Abound, Pristine) **Powdery Mildew** (Rally, Cabrio, Abound, Pristine) **Rusts** (Rally, Abound, Cabrio, Pristine, Orbit, Tilt) **Anthracnose, Cane Blight, Spur Blight, and Leaf Spots** (Cabrio, Abound, Pristine, and Captan) **Cane Blight (see notes)**	**Phytophthora Root Rot** (Ridomil, phosphorous acid-based products) **Cane Blight** (see notes) **Orange Cane Blotch** (Copper; see notes and labels) **Powdery Mildew** (Rally, Cabrio, Abound, Pristine) **Rusts** (Rally, Abound, Cabrio, Pristine, Orbit, Tilt) **Leaf Spots** (Captan, Orbit, Tilt)

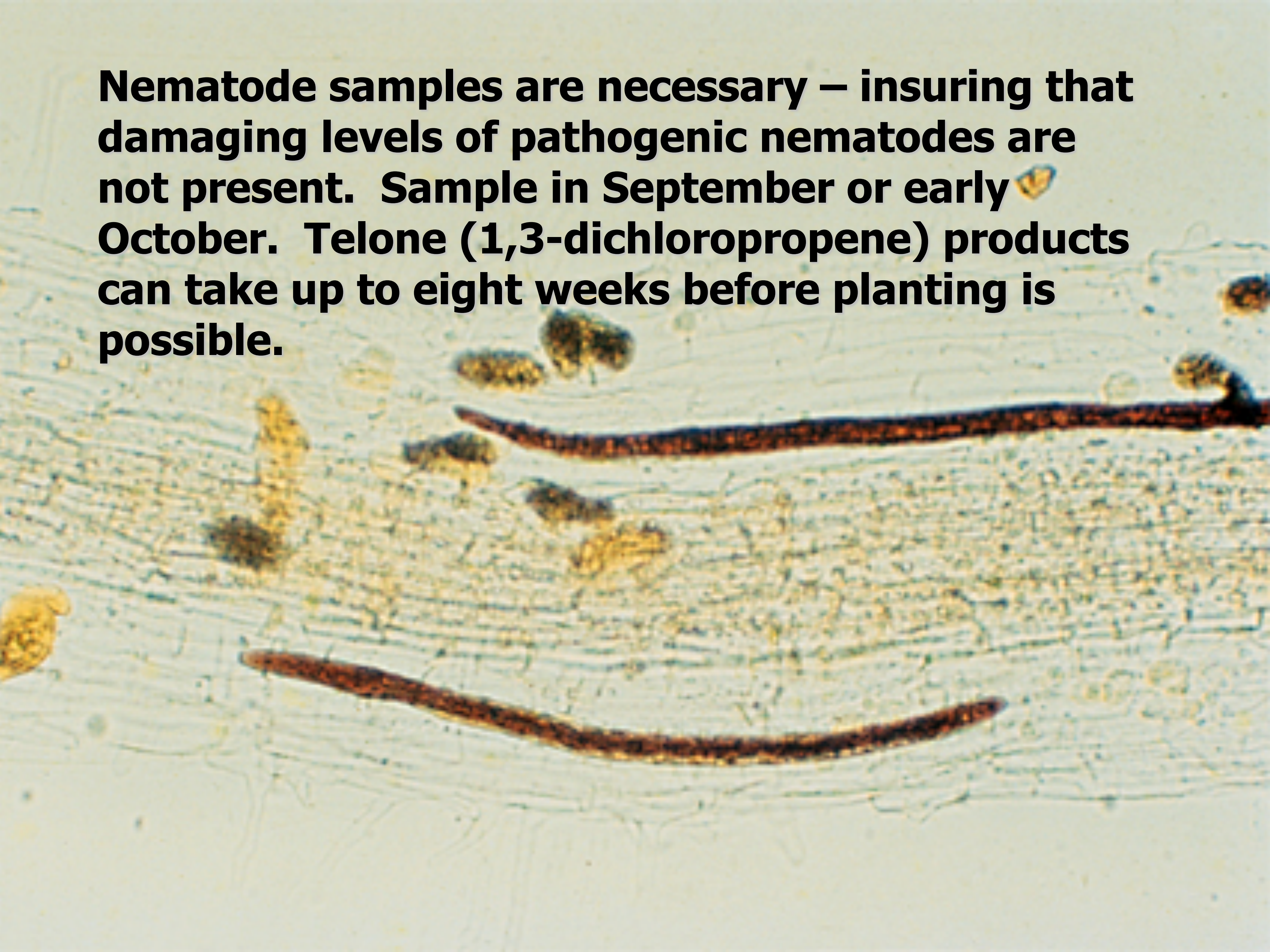
[a]Bramble bloom periods are protracted, so bloom and cover spray can be difficult to define clearly. Do not exceed label rates or spray intervals, but make sure that the pathogens indicated above are addressed with a thorough fungicide program as defined by the variety.

Viruses

- Occur on blackberry and raspberry.
- Tomato ringspot, tobacco ringspot, raspberry bushy dwarf, unknowns.
- Currently no chemicals are available for control.
- Use virus-free plant material (availability is the issue).
- Dagger nematode – vector for nepoviruses
  - Telone, metam sodium – preplant only

Viruses are a major concern for blackberry production. Tissue cultured blackberries are highly recommended.

Nematode samples are necessary – insuring that damaging levels of pathogenic nematodes are not present. Sample in September or early October. Telone (1,3-dichloropropene) products can take up to eight weeks before planting is possible.



Crown Gall
(*Agrobacterium tumefaciens*)

- **Blackberry and raspberry problem.**
- **Tissue cultured plants will not have this (initially).**
- **Wound pathogen.**
  - **Gramoxone ???**
- **Biological control is effective (applied at transplanting).**
  - **Isolates K84 and 1026 [Galltrol and NoGall]**


Phytophthora Root Rot

– mefenoxam [Ridomil]; (applied as a drench or through drip tape)

– phosphonate fungicides [Prophyt, etc.]; (generally applied as a foliar application)


Anthracnose

(*Elsinoe veneta*)

- **The fungus survives the winter on old canes.**
- **Remove old fruiting canes and infected primocanes and destroy (bury or burn) the tissue.**
- **Copper compounds and lime sulfur (delayed dormant only) are registered. Double blossom sprays should be effective if resistance has not occurred.**

Double Blossom Control Measures

- Plant resistant cultivars (Navaho and Apache are examples – thornless).
- Eradicate wild blackberries in the vicinity.
- Prune out rosetted stems (side stems) in the early spring before buds open.
- Apply fungicides.

Fungicides for Double Blossom

- **Apply to prevent spread from infected flowers to the primocanes. Most rosette infection occurs during bloom.**
- **Start the program when the first double blossom is observed. Requires scouting. Continue through entire bloom period.**
- **Control shows up the following spring.**

Fungicides for Double Blossom

- Abound is registered for control of this disease, and it does have good to excellent activity.
- Pristine does not have double blossom on the label, but it also has good to excellent activity.
- Switch is also effective.
- Cabrio and other fungicides may have some impact, but sufficient data is not available for recommendations at this time.

Fungicides for Control of Rosette

Treatment and rate/A	Rosette incidence (%)	Rosette severity (%)
Untreated	100	52
Benlate 12 fl.oz.	89	22
Pristine 1.45 lb	45	2
Abound 0.9 fl.oz.	34	1
Abound 1.5 fl.oz.	5	0.1

Buckley and Waters; 2002

Resistant Cultivars

Cultivar and breeding selection	Rosette incidence (%)	Rosette severity (%)
Shawnee	100	52
Kiowa	100	19
Chickasaw	99	24
Apache	0	0
Navaho	0	0

Buckley and Waters; 2002

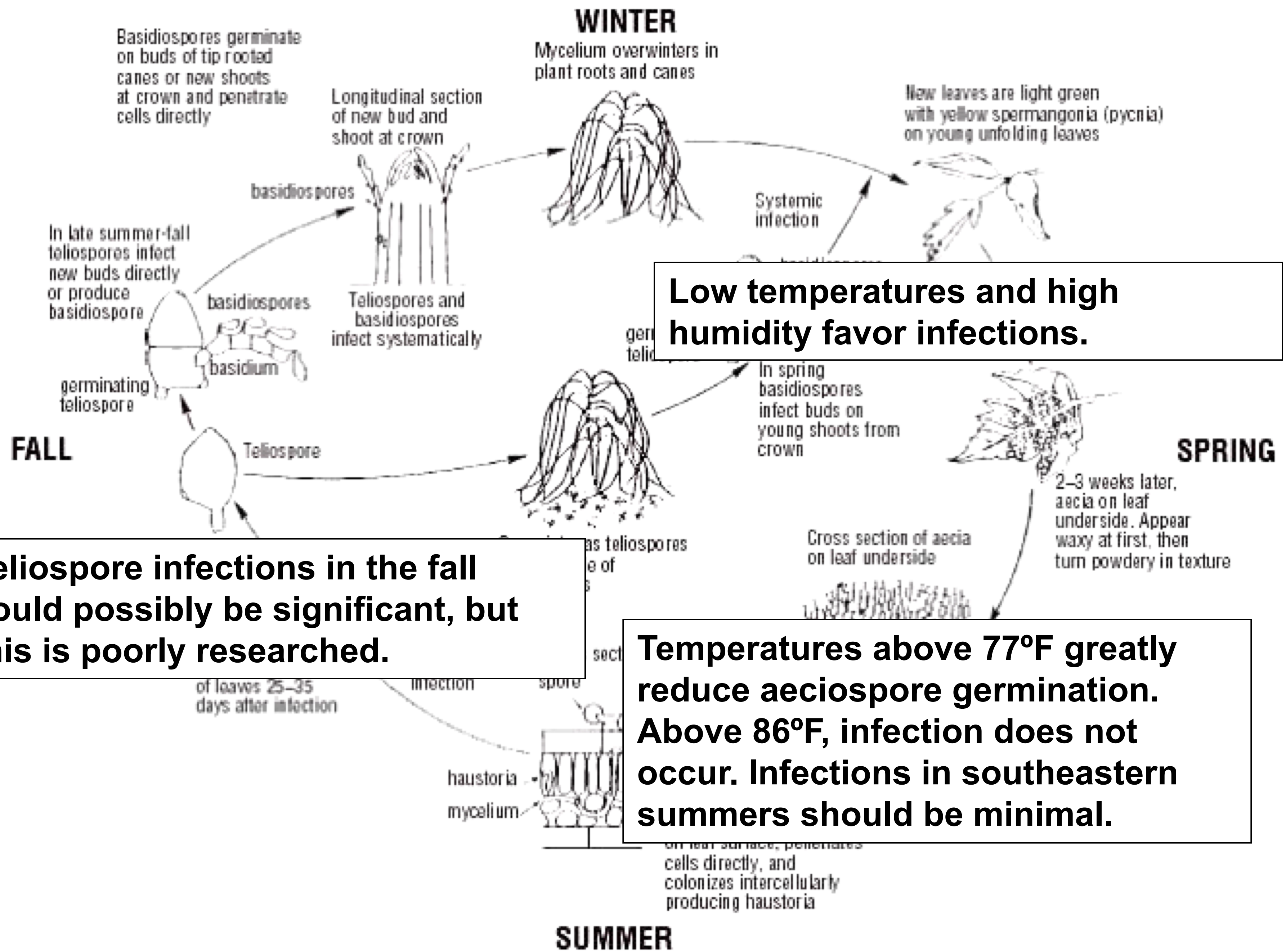
Blackberry Resistance to Double Blossom (Rosette)

Highly Susceptible	Susceptible	High Resistance
Chickasaw (thorned)	Kiowa (thorned)	Navaho (thornless)
Shawnee (thorned)	Arapaho ??? (thornless)	Apache (thornless)
Black Satin	Rosborough (thorned)	Humble
Choctaw (thorned)	Hull (thornless)	
	Chester (thornless)	
	Loch Ness	

Orange Rust
(*Arthuriomyces peckianus* and *Gymnoconia nitens*)

- **Can be a major problem in blackberry (erect and trailing types).**
- **Navaho, Darrow, Humble and purple and black raspberry are very susceptible. Red raspberries are resistant in theory.**

Rust diseases can always be confused, as the symptoms/spores are similar. Orange rust is normally observed at bud break and early leaf development, but in 2012, cane and leaf rust was also observed early, causing major confusion.



Low temperatures and high humidity favor infections.

Teliospore infections in the fall could possibly be significant, but this is poorly researched.

Temperatures above 77ºF greatly reduce aeciospore germination. Above 86ºF, infection does not occur. Infections in southeastern summers should be minimal.

General Considerations for Disease Management

- Destroy wild brambles within 600 feet of the production area.
- Bramble fields should be located in direct sunlight with good air circulation.
- Purchase certified plants when available.
- Rogue and TOTALLY DESTROY all plants that show orange rust symptoms (early-season job). Disease confirmation is required.
- Destroy old floricanes immediately after harvest.
- Maintain excellent weed control.

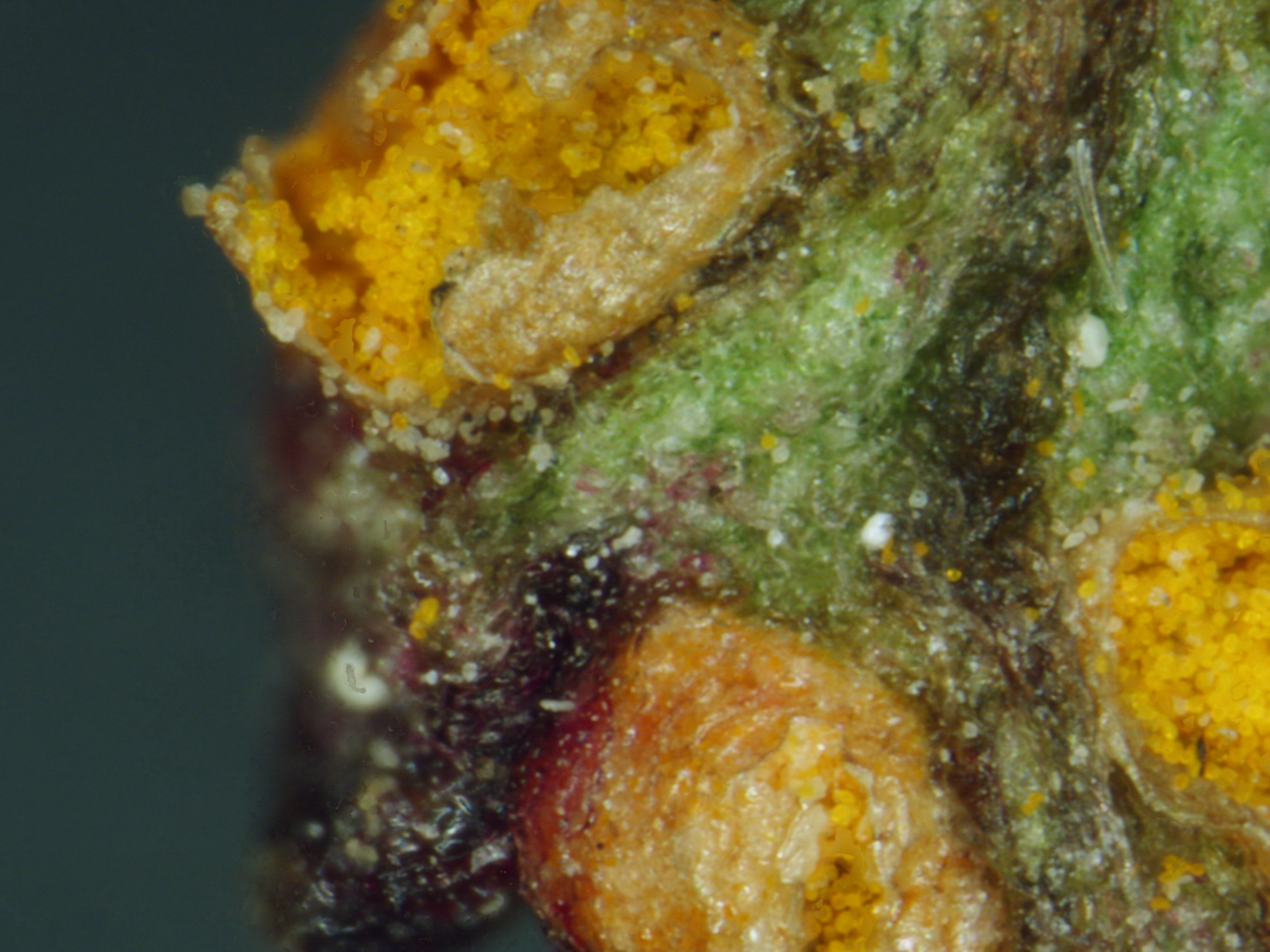
Arkansas Floricane-Fruiting Varieties

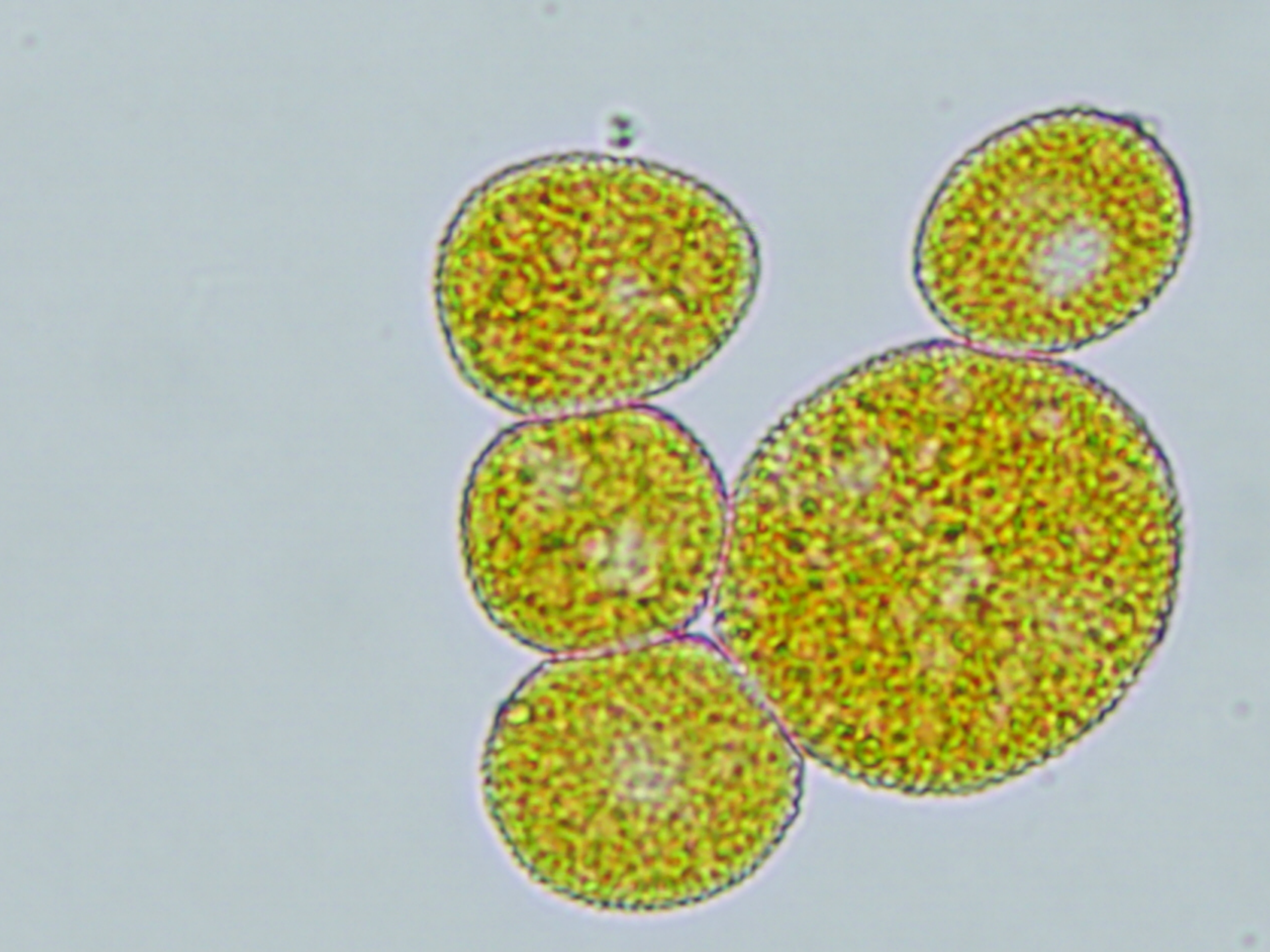
Variety	Resistance comment
Apache	No orange rust observed
Arapaho	No orange rust observed
Chickasaw	No orange rust observed
Choctaw	Orange rust resistant
Kiowa	No orange rust observed
Natchez	No orange rust observed
Navaho	Susceptible
Osage	No orange rust observed
Ouachita	No orange rust observed
Shawnee	Orange rust resistant

For all practical purposes, 100% control of orange rust may require fungicide applications from budbreak till leaf drop, with the exception of summer, when temperatures make infection difficult.

- Fungicide applications should be initiated as early as bud break and should continue on a 10-14 day interval, depending on disease pressure and diseases to be controlled.
- Applications may be made up to the day of harvest with most fungicides
- Observe resistance management restrictions and total number of applications.

Trade Name	Active Ingredient	Chemical Class	Manufacturer
1. Orbit, etc.	Propiconazole	DMI	Syngenta/ Various
2. Abound	Azoxystrobin	Strobilurin	Syngenta
3. Rally, etc.	Myclobutanil	DMI	Dow/Various
4. Pristine	Pyraclostrobin + Boscalid	Strobilurin + SDHI	BASF
5. Quilt Xcel	Azoxystrobin + Propiconazole	Strobilurin + DMI	Syngenta
6. Cabrio (suppression)	Pyraclostrobin	Strobilurin	BASF





Leaf and Cane Rust (*Kuehneola uredinis*)

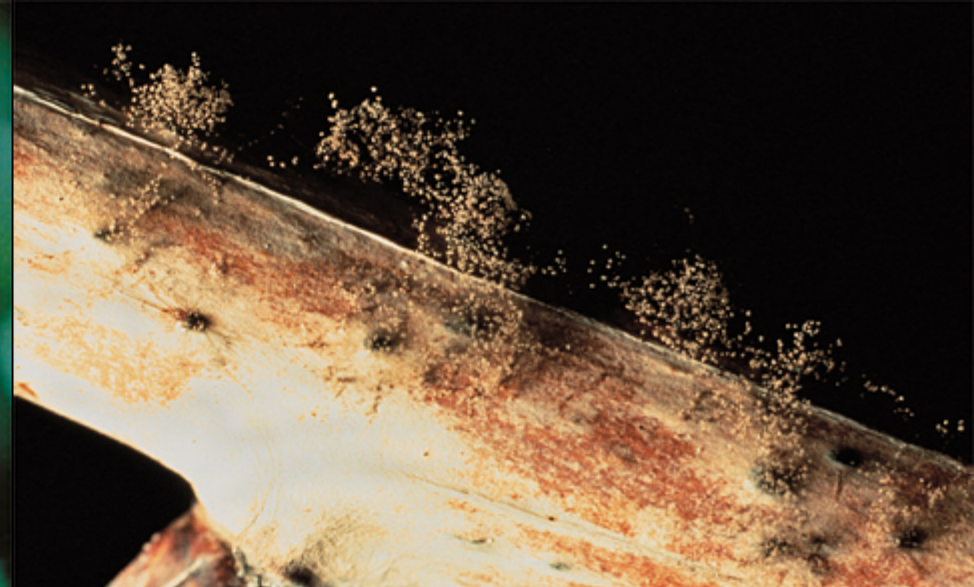
- **Blackberry problem – rust pustules on canes in spring – canes are rendered unproductive.**
- **Shawnee, Choctaw and some older cultivars are susceptible.**


Conclusions

1. Orange rust and other rusts can be controlled with diligent management, both cultural and chemical.
2. Season-long control, to include any time that leaves are present and in which temperatures do not preclude infection, may be necessary.
3. Roguing and destroying infected plants immediately after leaf expansion (early in the spring) is required for good disease management.
4. Sure identification is critical to management of this disease.

Botrytis Gray Mold
(*Botrytis cinerea*)

- **Blackberry and Raspberry problem**
  - **Blackberry stamen blight causes incomplete/distorted or dried up berries**
  - **Raspberry bloom and fruit rot problem**
- **Cultural – Prune for open growth**



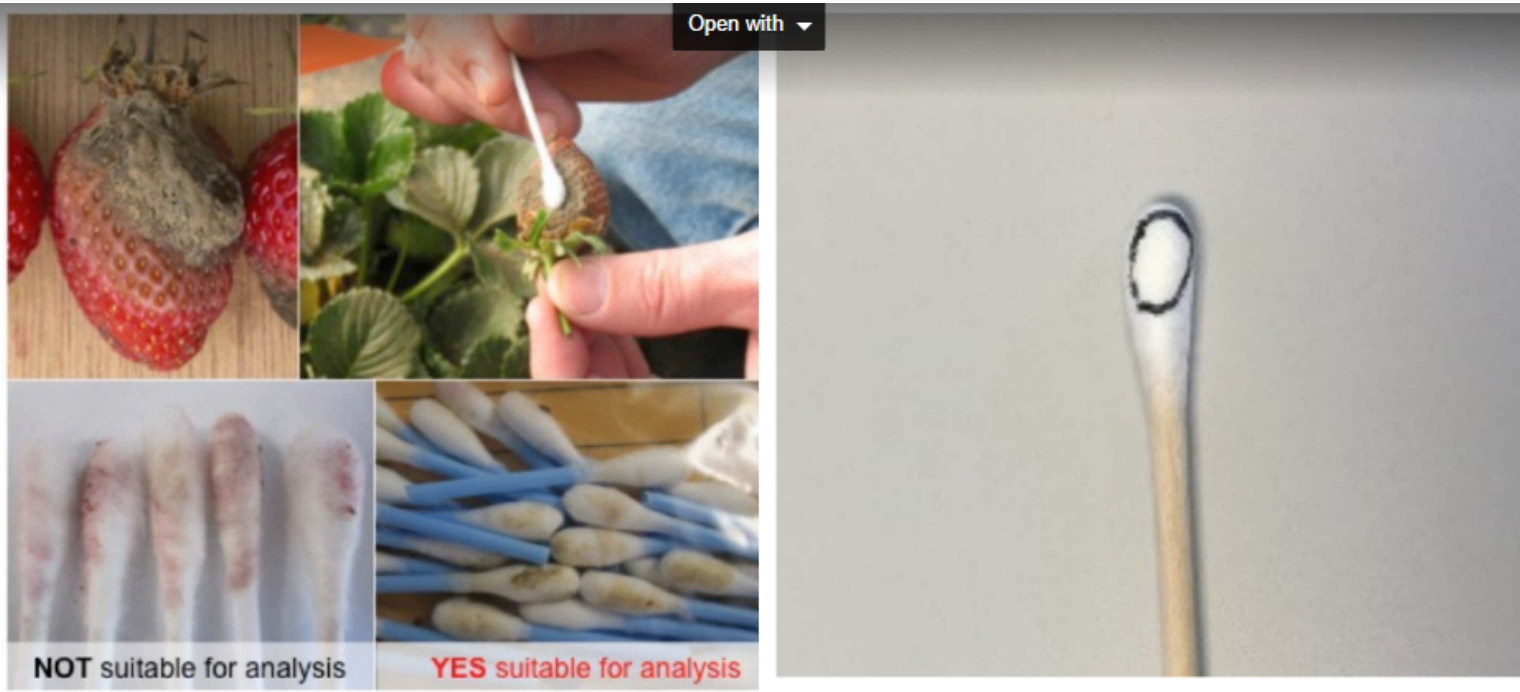


Figure 3. Use cotton swabs to carefully collect spores from symptomatic fruit (upper left) without getting strawberry juice on the swab (lower left). The swab should look lightly gray, a tiny bit of gray color is sufficient for analysis. If the spores cannot readily be seen, mark the area with a sharpie (right).

Mail the flowers or the 10 swabs together with information about the origin of the sample (Farm name, state), your name, phone number, and e-mail to:

Guido Schnabel
Clemson University
105 Collings St/220 BRC
Clemson, SC 29634
cell (864) 643 7131

Late-Season/Post-Harvest Rots

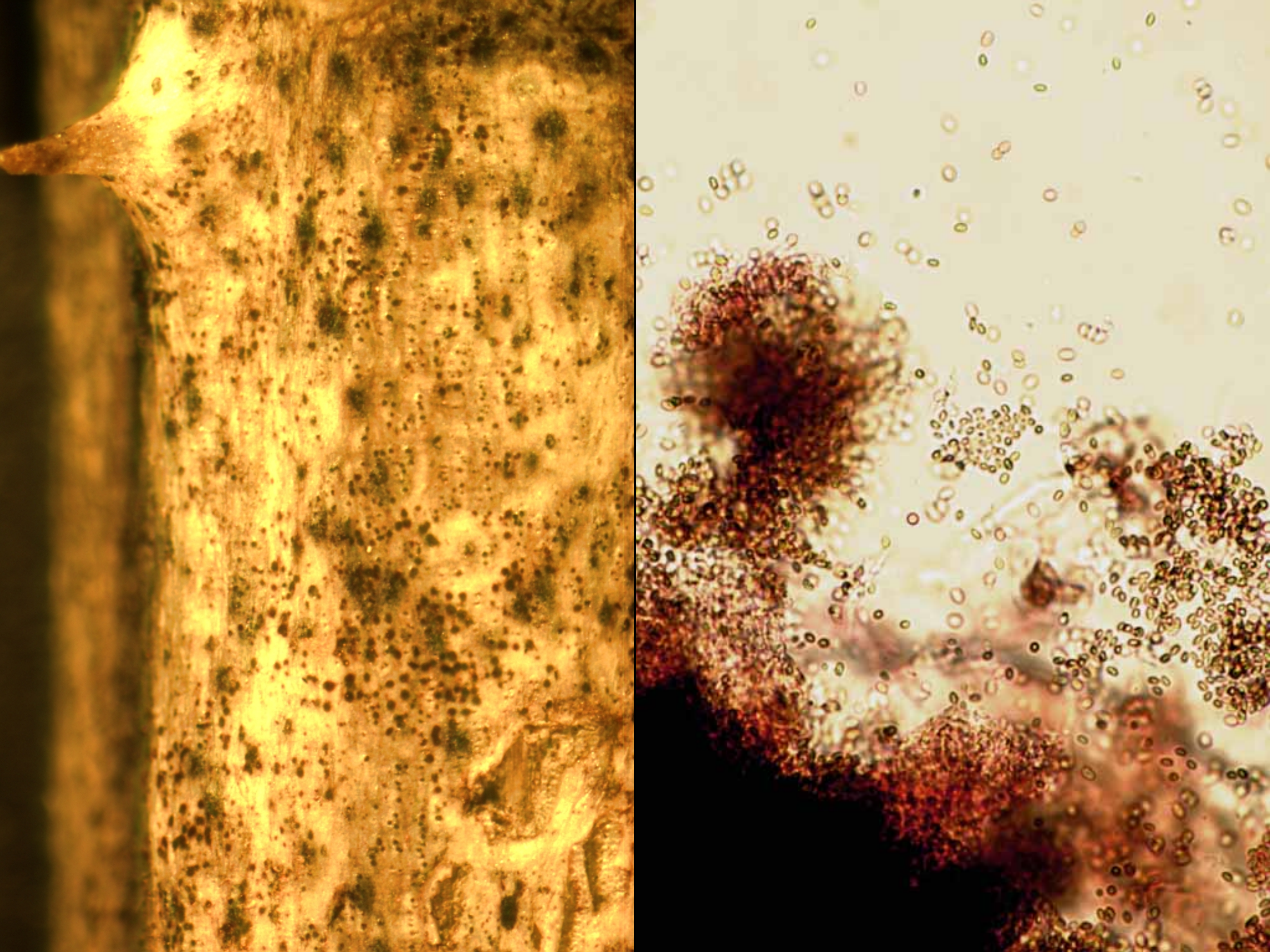
Treatments	% Botrytis Fruit Rot (6 DAH)	% Botrytis Fruit Rot (9 DAH)
UTC	64.7 a	100.0 a
Switch	0 b	60.7 d
Pristine	0 b	69.8 c
Elevate	0 b	79.7 bc
Rovral	0 b	81.5 bc
CaptEvate	0 b	89.5 ab

Ross, Krewer, and Brannen; 2006

Cane Blight

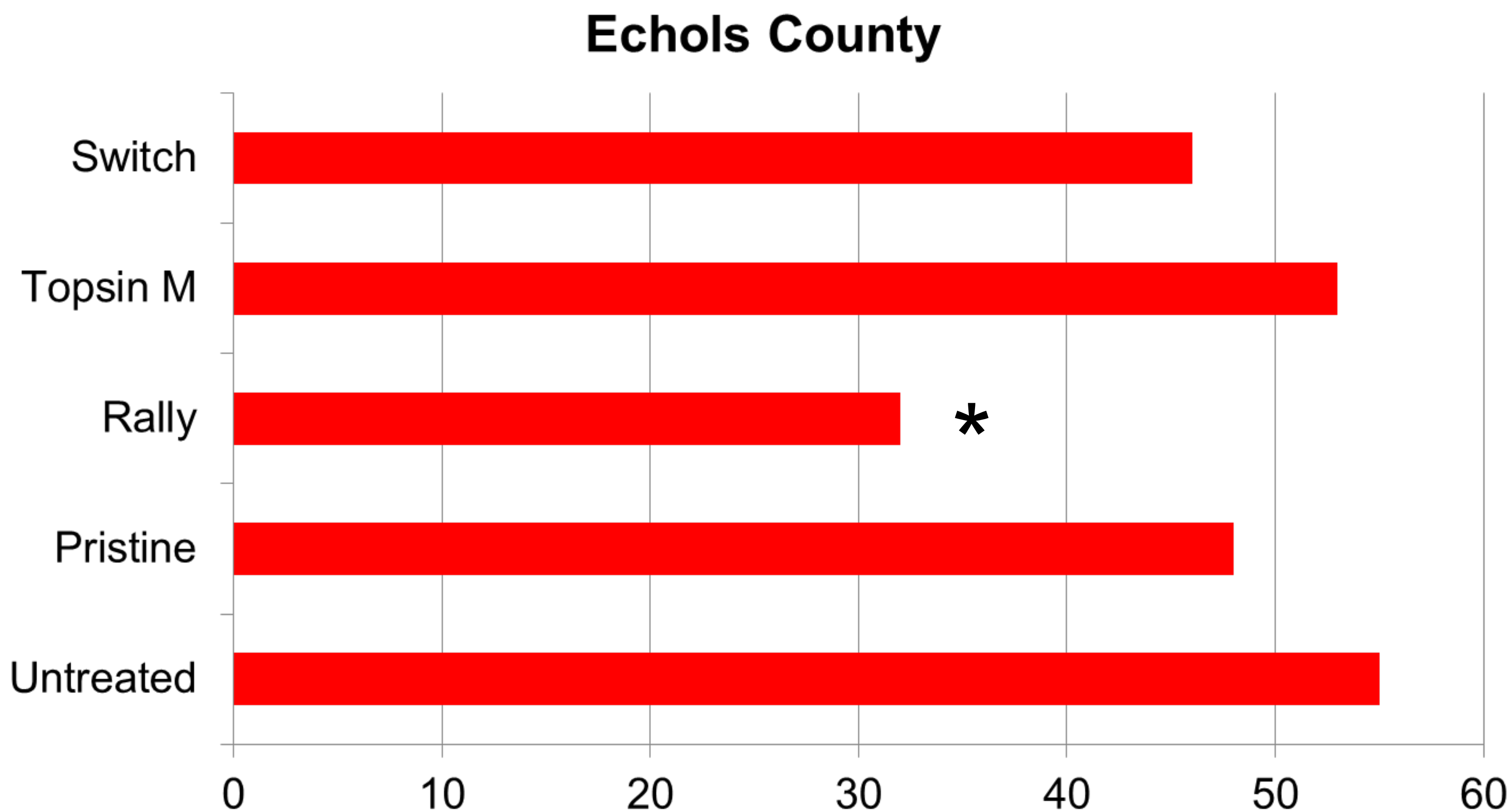
(*Leptosphaeria coniothyrium*)

- Major pathogen of blackberries
- Wound pathogen
- Especially aggressive in wet years



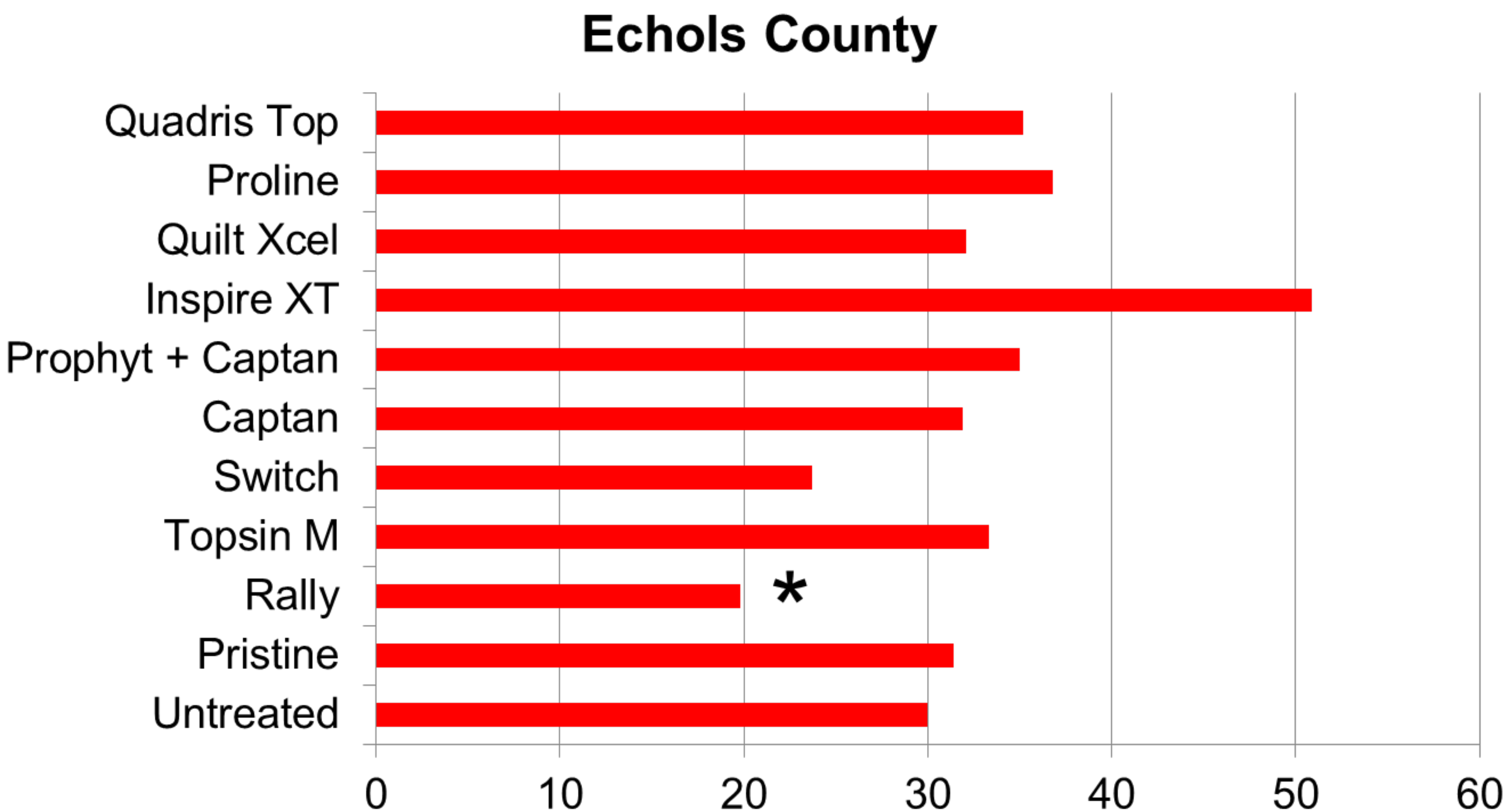
Botryosphaeria cane
canker of blackberry

Incidence of Cane Blight (2013)



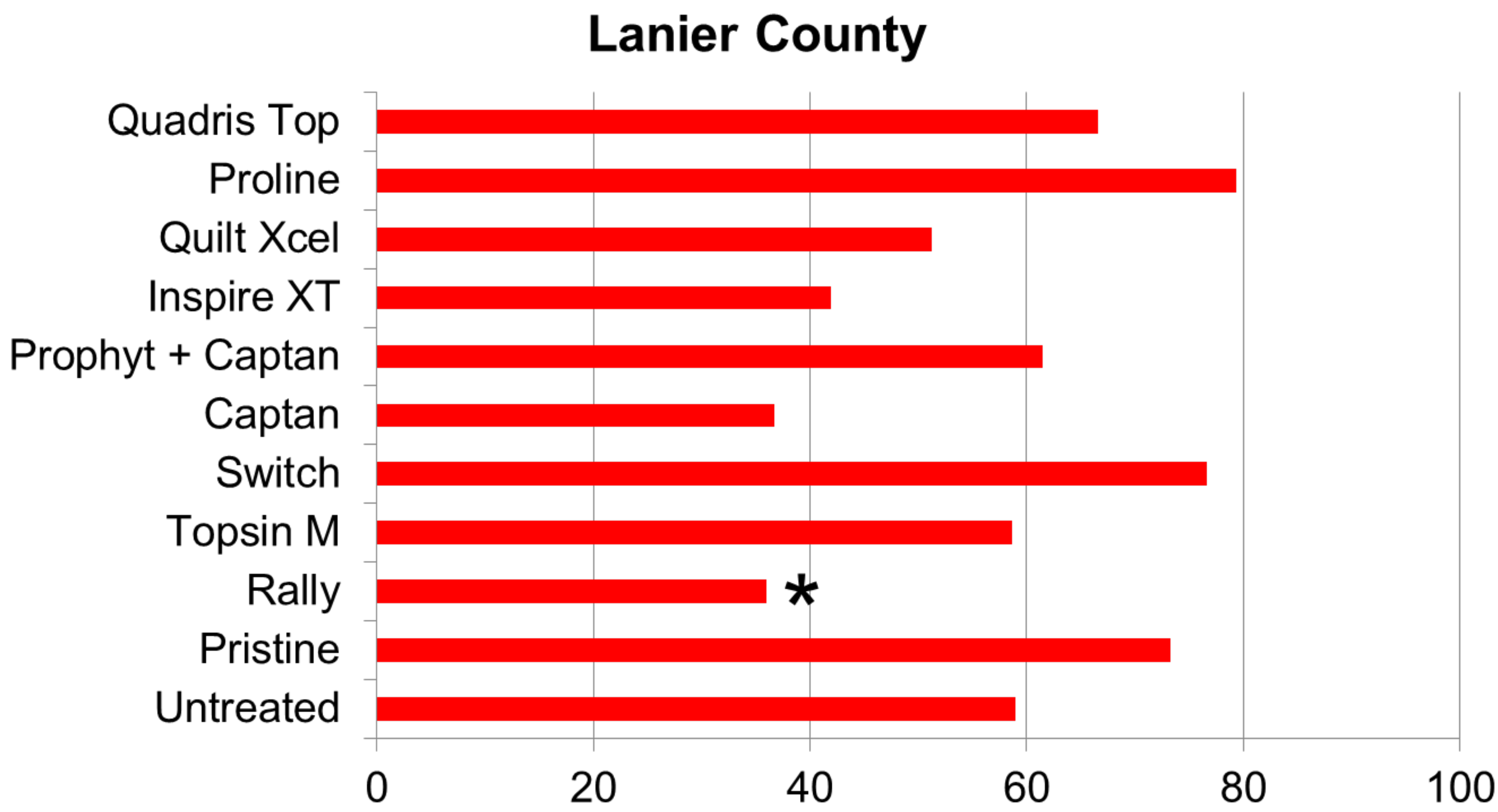
Justin Shealey

Incidence of Cane Blight (2014)



Justin Shealey

Incidence of Cane Blight (2014)



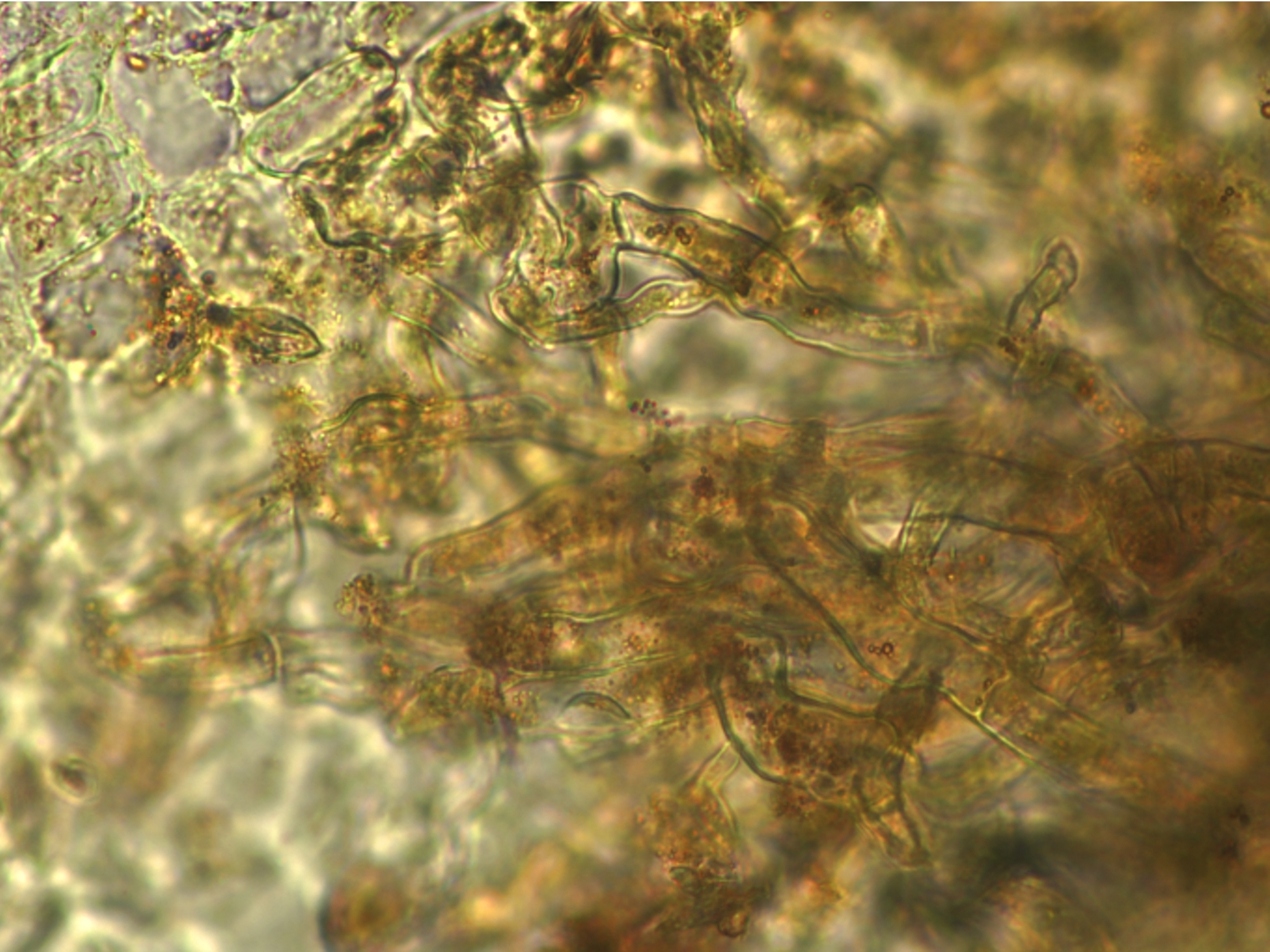
Jeremy Taylor

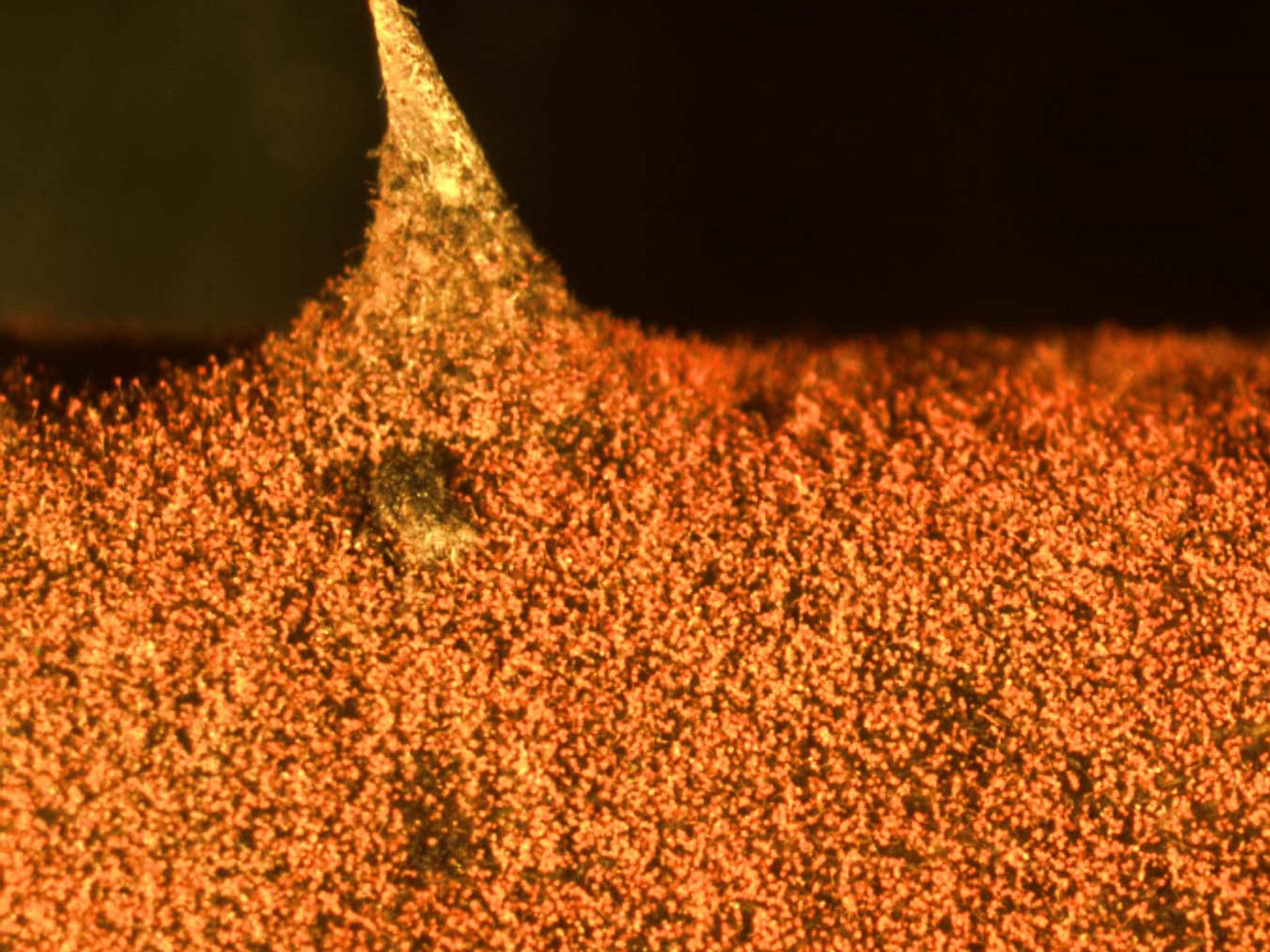
Treatment and rate/A	Days after first application	Cane blight incidence (%)*	Lesion length/cane (inches)**
Inspire XT 4.16EC 7 fl oz	0, 15, 30, 48, 60	25.5 c	2.8 c
Quilt Xcel 2.2SE 20 fl oz	0, 15, 30, 48, 60	35.6 bc	2.6 c
Quadris Top 29.6SC 8 pt	0, 15, 30, 48, 60	40.5 b	3.7 b
Pristine 38WG 20 oz	0, 15, 30, 48, 60	59.5 a	6.3 a
Cabrio 20EG 14 oz	0, 15, 30, 48, 60	60.7 a	7.0 a
Captan 80WDG 2.5 lb	0, 15, 30, 48, 60	62.0 a	7.2 a
Non-treated	Not Applicable	63.0 a	7.5 a

*Means within a column followed by the same letter are not significantly different as determined by Fisher's protected LSD test (α = 0.05).

**Lesion length was averaged over all affected canes in a treatment.

M. Rahman; West Virginia University





Septoria Leaf and Cane Spot

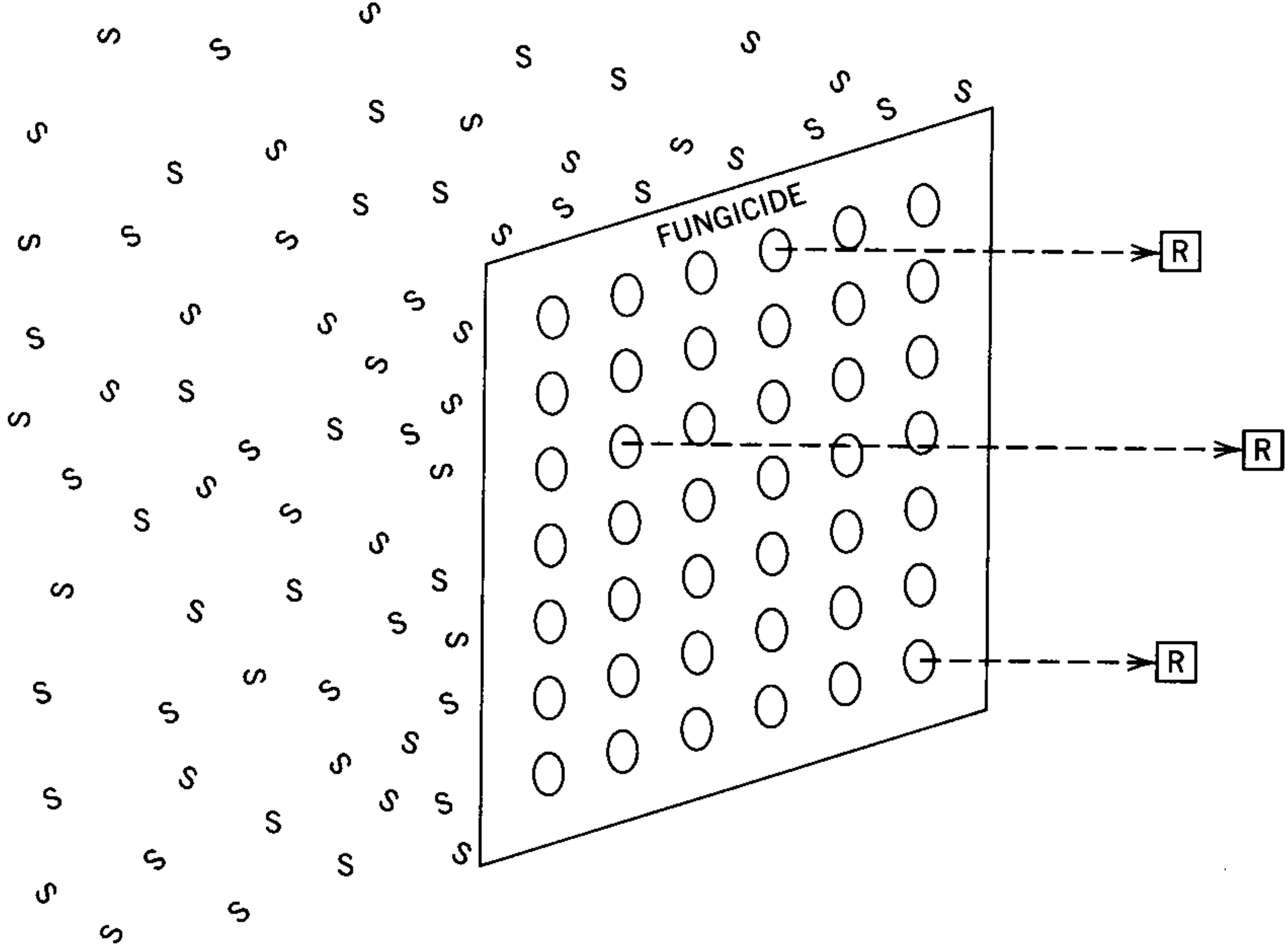
J.W. Pscheidt, OSU

Treatment, product rate/A	Time of Application[z]	Incidence [y] (%)	Severity [x]
Tanos, 10 oz	A, B, C	65.0 c[w]	5.0 bc[w]
Tanos, 10 oz + Kocide 3000, 12 oz	A, B, C	60.0 c	3.25 ab
Abound, 10.8 fl oz	A		
Kocide 3000, 12 oz	B		
Pristine, 20.75 oz	C	21.25 ab	1.5 a
Tanos, 10oz	A		
Kocide 3000, 12 oz	B		
Pristine, 20.75 oz	C	8.75 a	1.5 a
Aim 40EW, 6.4 fl oz	A, B		
Pristine, 20.75 oz	C	35.0 b	2.0 a
Untreated check	Not applicable	92.5 d	5.75 c

[z] Application dates: A = 19 Apr, B = 30 Apr, C = 17 May
[y] Incidence: percentage of primocanes with leaves showing disease symptoms
[x] Severity rated on a scale of 0-10 where 1= 10% leaf area affected, 10 = 100% leaf area affected
[w] Means within a column followed by the same letter do not differ significantly based on Fisher's protected LSD ($P \leq 0.05$)

J. DeFrancesco and D. Kaufman; 2007

Pseudocercospora or Cercospora leaf spot



R = resistant S = sensitive

Principles of Resistance Management

- Alternating sprays with fungicides from different classes (different modes of action) is an important means of resistance management.
- Tank-mixing of different fungicides is also an acceptable method of resistance management, and both methods are employed.
- Many fungicides are limited to a set number of applications per year in order to improve their long-term survival. Follow the label recommendations.

Blackberry Schedule

Year 1

- ***Prior to planting***, fumigation with Telone II @ 35 gallons/Acre in November
- Use tissue-cultured plants to avoid viruses and crown gall (extra costs)

Year 1 and each year thereafter

Shoots 6 inches long

Rally @ 2 oz

Copper (Kocide) @ labeled rate or Captan

Early Bloom

Switch @ 14 oz

Captan 50 W @ 4 lb

Rally @ 2 oz

Full Bloom

Pristine @ 23 oz

Petal Fall

Switch @ 14 oz

Captan 50 W @ 4 lb

Rally @ 2 oz

Cover Spray1

Pristine @ 23 oz

ProPhyt @ 4 pt

Cover Spray2

Switch @ 14 oz

Captan 50 W @ 4 lb

Rally @ 2 oz

Cover Spray 3

Switch @ 14 oz

Captan 50 W @ 4 lb

Rally @ 2 oz

Preharvest

Pristine @ 23 oz

Harvest

Pristine @ 23 oz

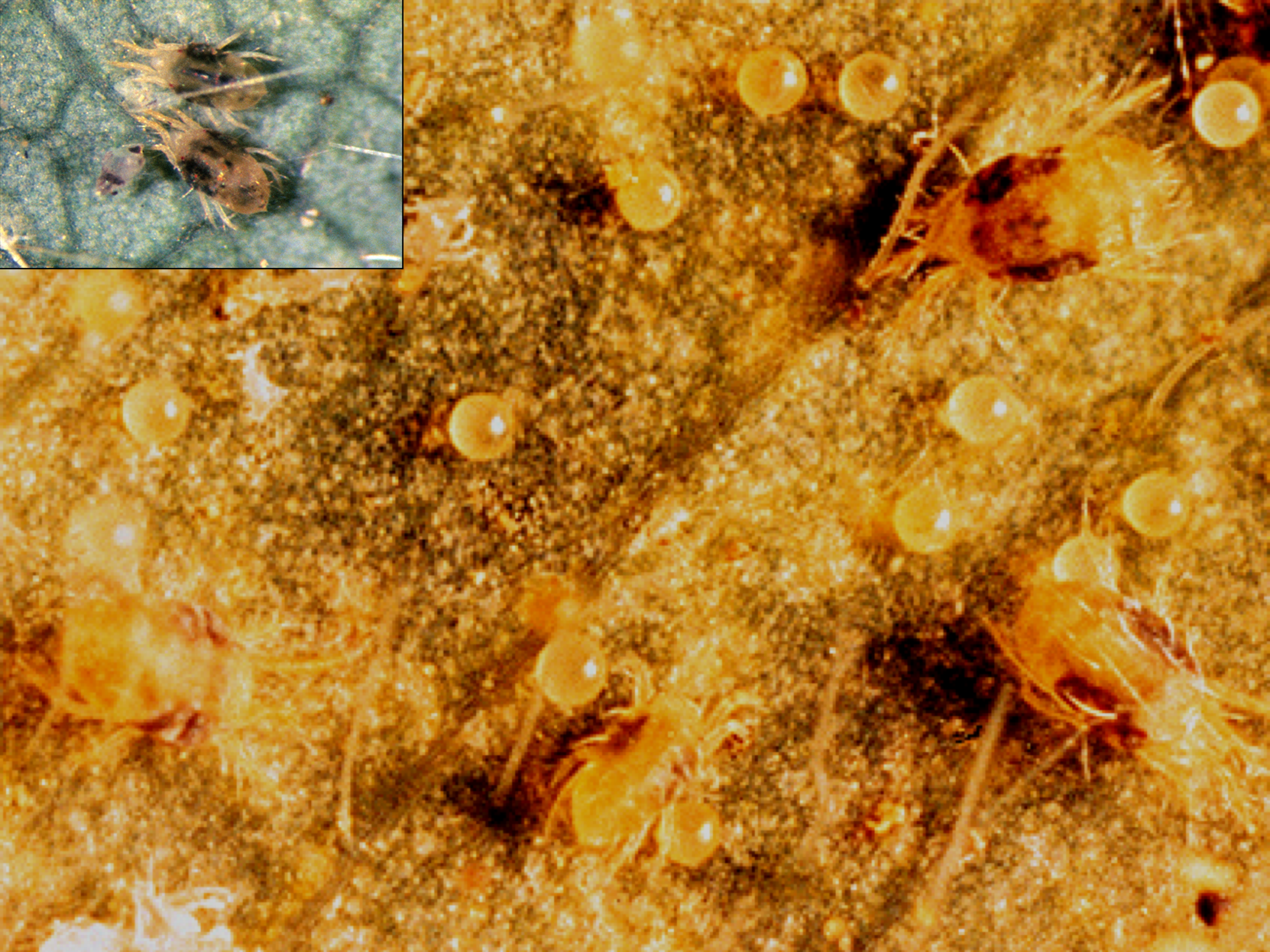
After Harvest

ProPhyt @ 4 pt applied monthly for orange cane blotch until you run out of sprays as per the label.
Pruning (Spray after each pruning with either Rally or Pristine if we have any left from the cover sprays; do not exceed label amounts per year; try to incorporate in-season pruning with these fungicide applications for other diseases [e.g. leaf spots])

Year 2 and each year afterwards (not applied in year 1)

Late Dormant

Lime sulfur @ 16 gallons/acre (ahead of green tissue) or copper



Dormant pruning and vine training considerations

Tony K. Wolf, Viticulturist, Virginia Tech

I. Dormant pruning vs. vine training

1. Distinct practices, but the two practices can't be entirely separated

II. Why prune?

1. Primary means of crop control: problems with over-cropping: reduced: reduced sugar accumulation in fruit; reduced fruit/wine pigmentation, poor wood maturation; decreased vine size; increased likelihood of winter injury.
2. Maintenance of vine architecture – aids positioning of fruiting and renewal nodes.

III. What to retain?

1. Consideration must be given to training system: cordon vs. head training and spur vs. cane pruning
2. Retain wood borne near canopy exterior, moderate diameter and internode length, good color
3. Complications due to winter injury
   a. assessing winter injury: trunks, cane and buds
   b. compensating for winter injury – typically entails retaining more wood/buds
   c. http://www.nysaes.cornell.edu/hort/faculty/pool/trunkinjury/tihtml/trkinjtablecontents.html

IV. How many buds or nodes to retain?

1. Vine age is a consideration
2. Vine size:
   - capacity for fruit and wood production in 2018 determined by performance in 2017, and earlier
   - Measure cane prunings to determine vine pruning weights: "balanced pruning" may be desirable when cane pruning weights are less than 0.3 lbs/foot of canopy
   - For larger vines, aim for 4 to 6 nodes per foot of canopy (20 to 30 buds per vine, at 5' vine spacing)
   - Bud retention will also be affected by variety and cluster size (e.g., < for Seyval, > for Pinot gris)

V. When to prune?

1. Can be done anytime after fall defoliation
2. Risk of bud damage increases after bud swell in following spring
3. "Bleeding" of sap from pruning wounds in inconsequential
4. "Double-pruning" should be used if:
   - Prospect for spring frost damage or potential for wound infection by fungal trunk disease pathogens
   - Unskilled labor used to "hedge" vines first, follow-up labor (more skilled) fine tunes the bud count
   - Double pruning can also be used to gain a few days of spring frost compensation in spring (delays budding)

VI. Other considerations

1. Removal of killed or damaged cordons
2. Crown gall
3. Eutypa dieback, Botryosphaeria, etc. infection of large pruning wounds
4. Phomopsis cane and leaf spot-infected canes
5. Make a written or mental record of areas of vineyard that need vigor stimulation (e.g., more N)
6. Brush removal vs. brush chopping in the vineyard (pros and cons)

II. Pros and cons of selected training systems

Terminology:

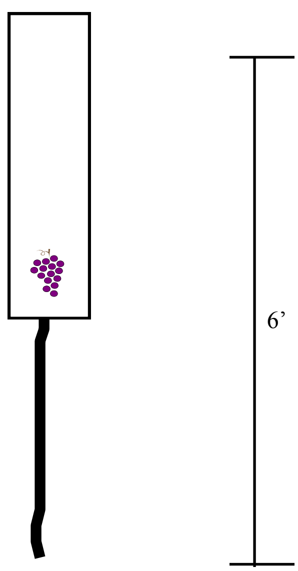
Training: The spatial arrangement in which we retain dormant, bearing units (nodes) and train shoots during the ensuing vegetative cycle.

Trellising: The physical structure used to support and maintain the training system.

A. Non-divided canopy training systems:

1. Bi-lateral cordon, Vertical Shoot Positioned (VSP)

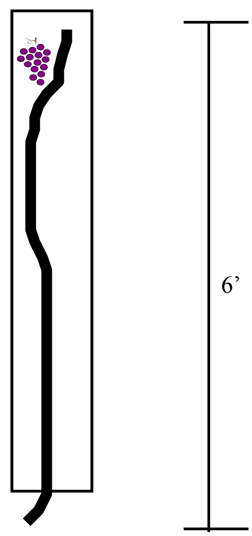
- a "standard" system found in Virginia
- cordons located 36 to 42 inches above the soil
- adapted to upright-growing varieties
- adapted to mechanization
- simple concept, relatively cheap installation
- shoot position to maximize vine performance
- pruned to 0- to 3-node spurs



1. Bi-lateral cordon, VSP

2. High, bi-lateral cordon

- similar to low-cordon, but requires downward shoot positioning to form thin canopy
- may observe increased fruitfulness due to increased sun exposure of renewal region
- cordons located on top wire
- adapted to procumbent-growing varieties
- adapted to mechanization
- simple concept, relatively cheap installation
- spurs retained on lower 180° of cordon; pruned alternately long (5 to 6 nodes) and short (1-node) to aid downward shoot positioning.

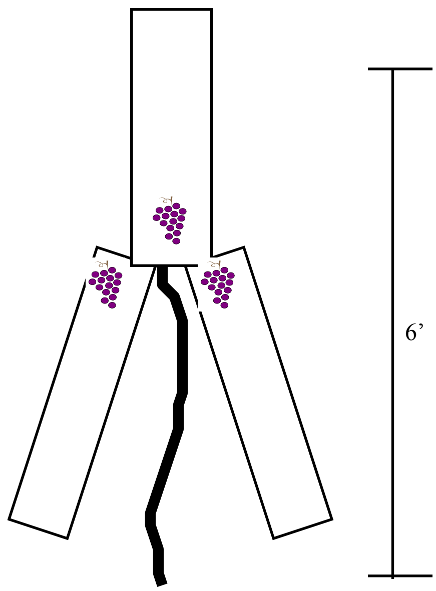


2. High, bi-lateral cordon

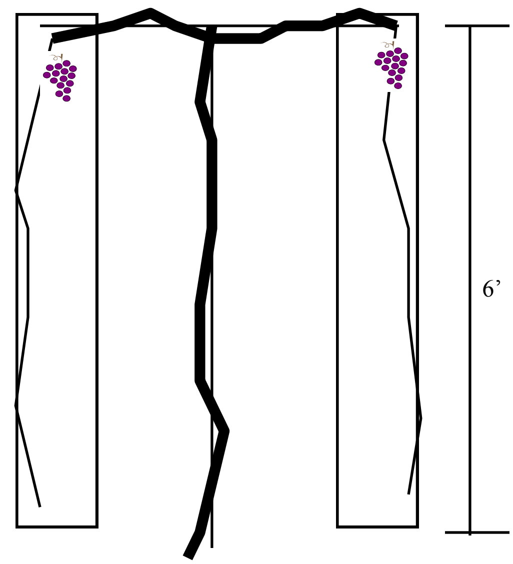
B. Divided canopy training systems:

3. Smart-Dyson Ballerina

- a "hybrid" between divided and non-divided
- well suited to existing Casara systems
- cordons located 36 to 42 inches above the soil
- upper canopy formed with aid of catch wires
- 2 lower curtains positioned down at 45° angle
- adapted to mechanization
- relatively cheap means of increasing shoots per foot of row without increasing shoot density *per foot of canopy*
- suitable for vinifera and hybrids



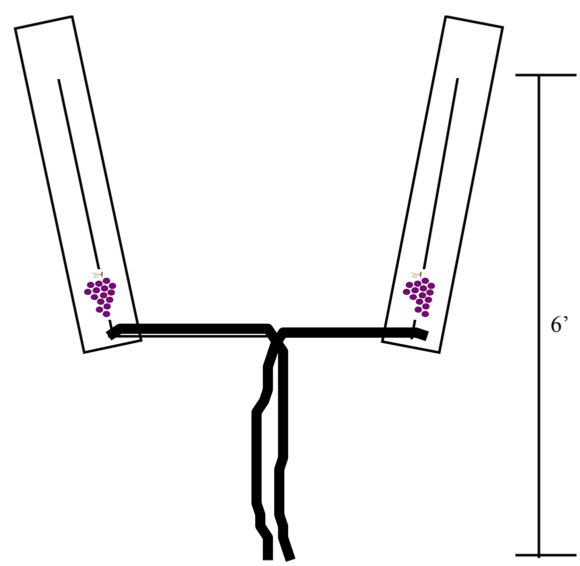
3. Smart-Dyson Ballerina



4. Geneva Double Curtain

4. Geneva Double Curtain
- quadrilateral cordons at top of trellis and supported by 4’ wide cross-arms
- *or bi-lateral cordons on alternate vines*
- cordons pruned (lower 180°) to 5- or 6-node spurs alternated with 1-node renewals
- shoot positioning to form two discrete curtains is essential: first done between bloom and fruitset; with repeat about 3 weeks later. Requires 20 to 40 hours/acre. No benefits if shoot positioning is not performed.
- Use only where vine vigor is expected to produce cane prunings of ≥ 0.4 lb/foot of row
- adapted to mechanization
- suitable for vinifera, hybrids, and American type grapes. Shoots of strongly upright growing vinifera will require extra effort to form downward growing shoots.
- good yields and fruit quality
- relatively cheap trellis material costs
- Leave some leaves above the cordon (sunburn)

5. Open lyre
- quadrilateral cordons located 36 to 42 inches above the soil
- canopies separated with aid of catch wires
- not well suited to mechanization
- suitable for vinifera and hybrids
- good yields and fruit quality
- very expensive to install and manage
- cordons must be at least 4’ apart at base
- lateral growth into center must be trimmed

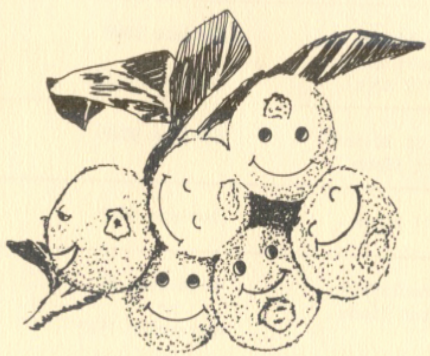


Field Identification and Management of Blueberry Diseases in the Southeast

Phillip M. Brannen

University of Georgia Plant Pathology Department

1985 BLUEBERRY SPRAY GUIDE



Paul Bertrand — Extension Plant Pathologist

Dan L. Horton and H C Ellis — Extension Entomologists

Cooperative Extension Service
The University of Georgia — College of Agriculture

COMMERCIAL BLUEBERRY INSECT AND DISEASE SPRAY GUIDE

TIME OF APPLICATION	MATERIAL	RATE PER ACRE	PEST CONTROLLED	REMARKS
When green tips on vegetative buds first show	Benlate 50WP	1 lb.	Twig Blight	If mummy berry disease becomes established in your field, Funginex is essential in the pre-bloom sprays.
	Funginex 1.6EC	24 ozs.	Mummy Berry	
Pre-bloom (apply every 7-10 days)	Benlate 50WP	1 lb.	Twig Blight	
	Funginex 1.6EC	24 ozs.	Mummy Berry	
10 to 20 percent Bloom	Benlate 50WP	1 lb.	Flower Blight Mummy Berry Twig Blight	
Full Bloom	Benlate 50WP	1 lb.	Flower Blight Mummy Berry	
Immediately after Bloom	Difolatan 4F	2 qts.	Anthracnose	This spray and the following spray is very important for insect control. Do not use Parathion within 14 days of harvest; Guthion within 3 days; Malathion within 1 day of harvest.
	or			
	*Parathion 15WP	3 lbs.		
	or			
	Sevin 50WP	3 lbs.		
	or			
	*Guthion 50WP	1 lb.	Plum Curculio	
	or		Fruit Worms	
	Malathion 25WP	4 lbs.	Leaf Rollers	
10 to 14 days after above spray	Difolatan 4F	2 qts.	Anthracnose Leaf Spots	Do not use Benlate or Difolatan within 21 days of harvest.
	plus			
	Benlate 50WP	1 lb.		
	plus			
	One of the Insecticides above		Plum Curculio Fruit Worms	Note: Additional sprays may be required for late-season generation of the cranberry fruitworm.

*Guthion and Parathion are highly toxic materials for use only by trained applicators.

2013 Southeast Regional Blueberry Integrated Management Guide

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Phil Brannen (University of Georgia)

Powell Smith (Clemson University)

www.smallfruits.org

Contributions were a … (University of Georgia), John Meyer … Georgia), Phil Harr…

Recommendations are … extension field tests.

Because environmental conditions and grower application methods vary widely, suggested use does not imply that performance of the pesticide will always conform to the safety and pest control standards indicated by experimental data.

This publication is intended for use only as a guide. Specific rates and application methods are on the pesticide label, and these are subject to change at any time. Always refer to and read the pesticide label before making any application! The pesticide label supersedes any information

1. TRANSPLANT DISEASES

2. ISSUES AND DISEASES ASSOCIATED WITH SITE OR CULTURE

3. PERENNIAL DISEASES

4. ANNUAL DISEASES

1. TRANSPLANT DISEASES

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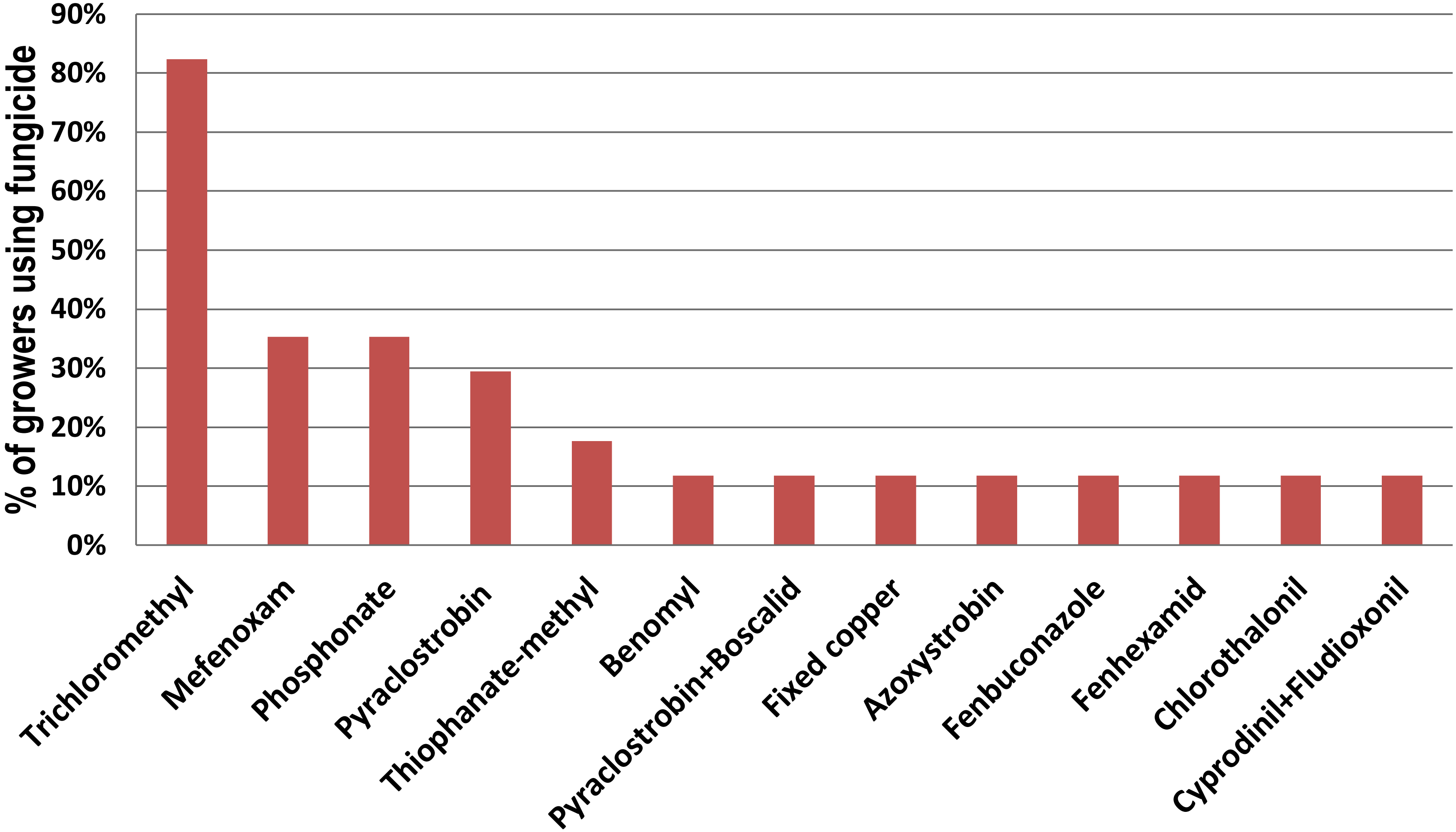
Fungicide Usage



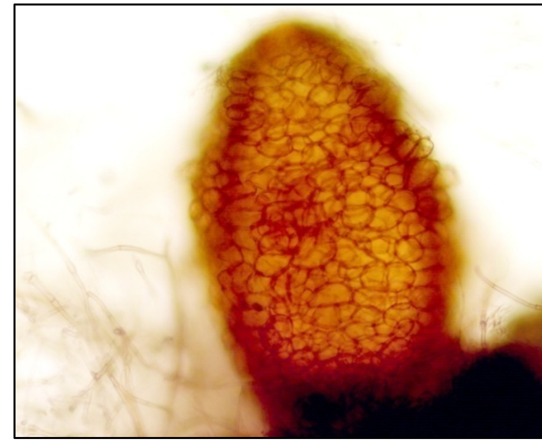
Not registered for this usage pattern

Cylindrocladium Stem and Root Rot

Symptoms:

- Circular blighted patches
- Defoliation
- Stem lesions
- Root rot
- Death

Signs: Perithecia



<u>Sexual stage:</u>
***Calonectria* sp.**

Forms on necrotic tissue

Signs: Conidia

Long thin conidia with 1-3 septae

Rhizoctonia

- 2004 survey by Dr. Cameron Whiting
  - 15 - 35% recovery of Rhizoctonia from blueberry cuttings
- 2006 UGA Plant Disease Clinic
  - 30% of blueberry root rot samples had Rhizoctonia
- 2008 survey
  - Rhizoctonia found in 17.6% of nurseries

Rhizoctonia

- **Symptoms and signs:**
  - Defoliation
  - Stem lesions
  - Root rot
  - Death
  - Arial blight


Rhizoctonia root rot


Crown gall


Crown gall


Red ringspot virus is transmitted through propagation.


Botryosphaeria diseases are also readily
transmitted through propagation.

1. TRANSPLANT DISEASES

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Water, soil, and nematode samples should be collected prior to establishment, and soil and water samples should be collected yearly. Tissue analysis should be conducted at a minimum from new growth in the summer each year. More often may be warranted. Bark (greenhouse mix test) is also required in bark beds.


Iron chlorosis is caused by high soil pH.


Low organic matter


Low organic matter


Drought


Drowning


Justin Shealey


Justin Shealey


Jeremy Taylor


Jeremy Taylor


"SMOKEY'S FRIENDS DON'T PLAY WITH
forest fires...
Ben Shirley

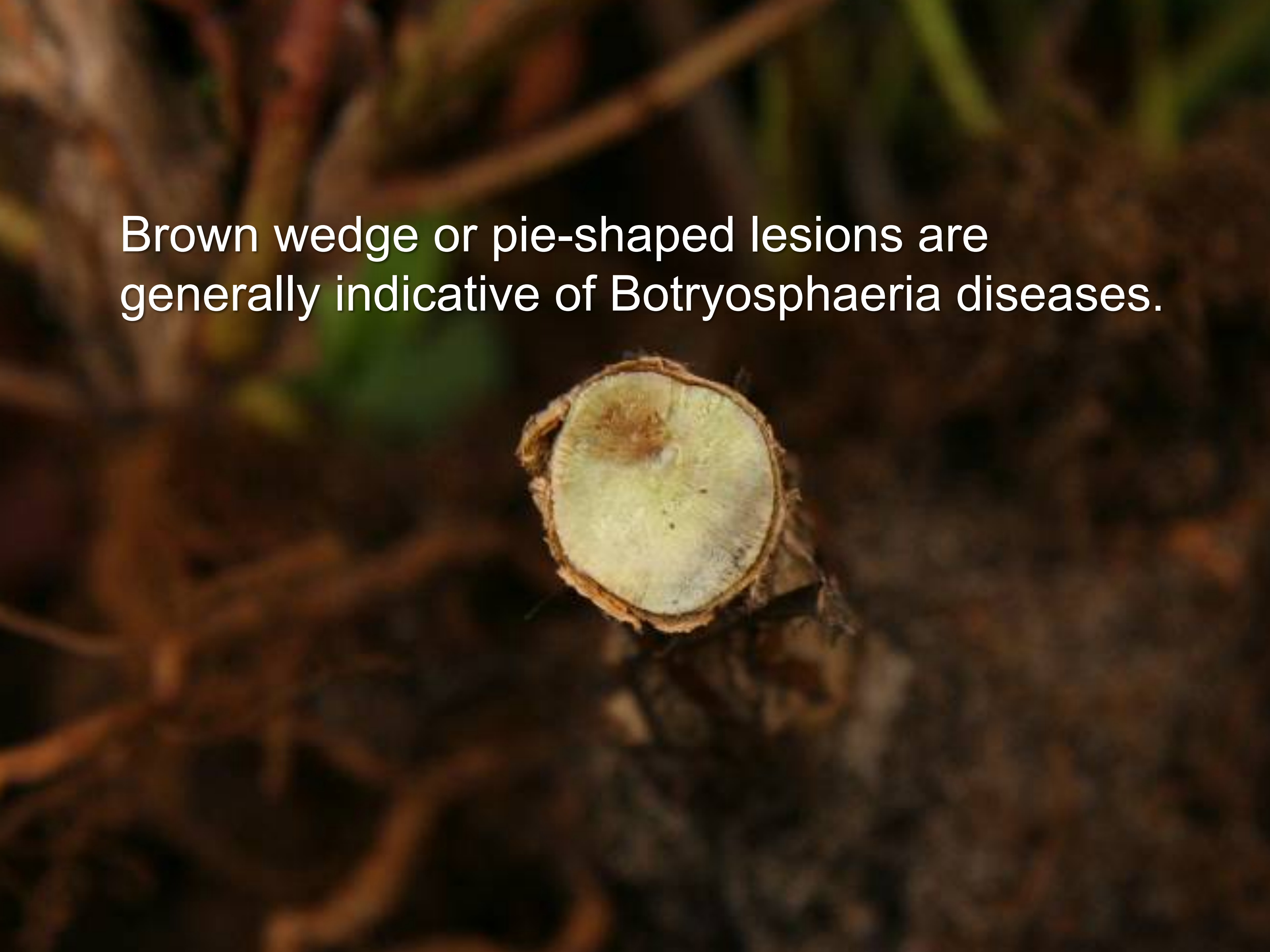

Bill Cline


Cold damage


Bill Cline


James Jacobs

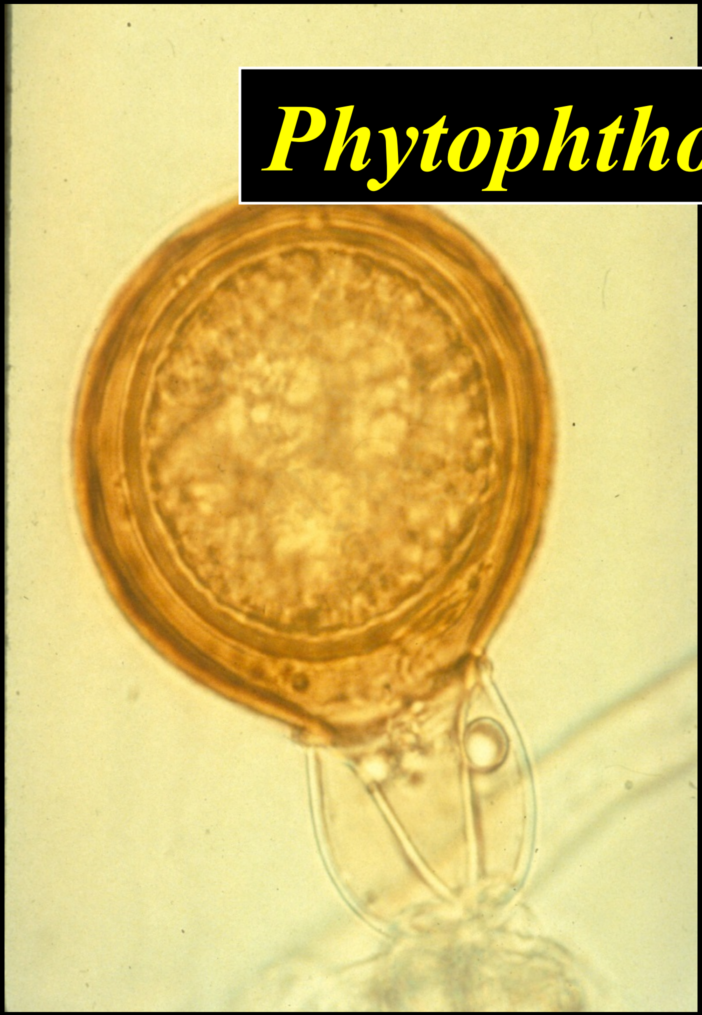

Botryosphaeria can result from cold injury.


Brown wedge or pie-shaped lesions are generally indicative of Botryosphaeria diseases.

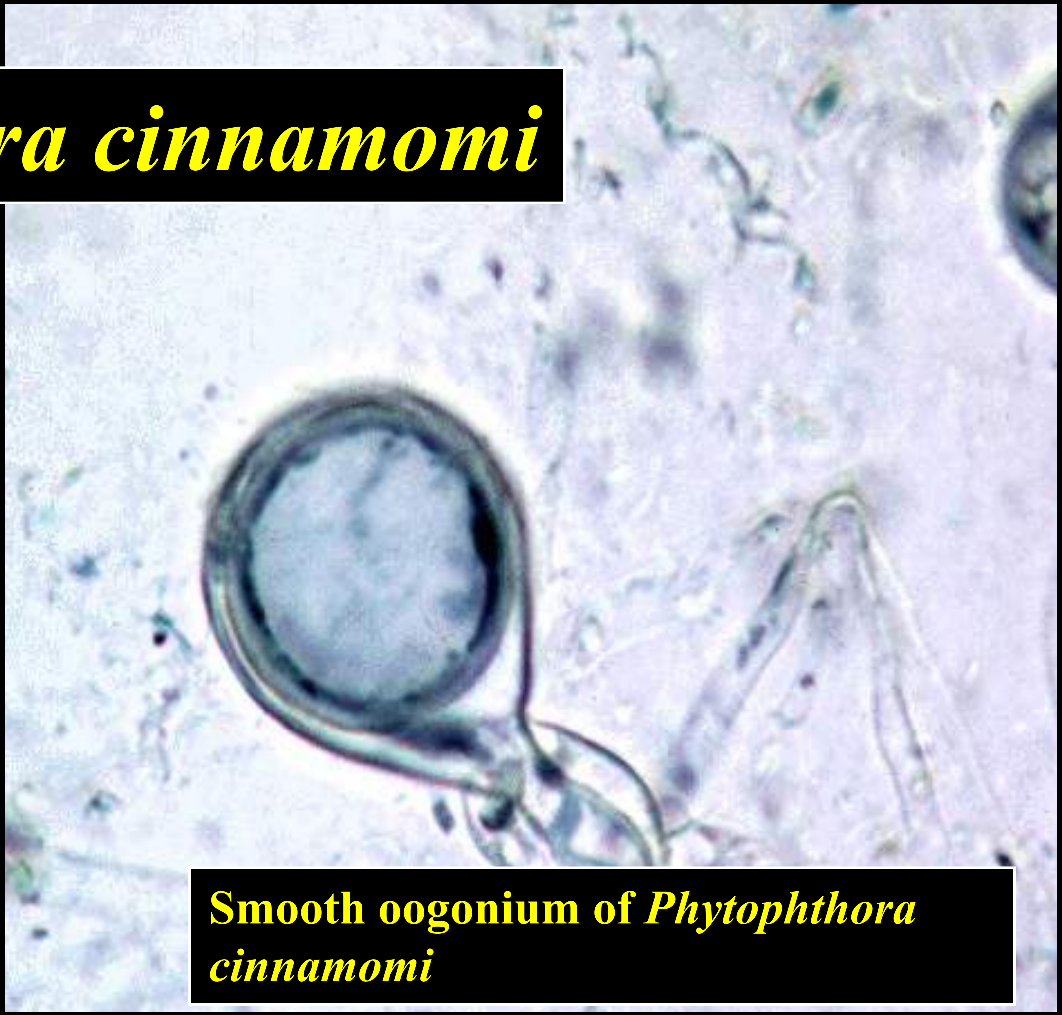
Phytophthora Root Rot
(*Phytophthora cinnamomi*)

- Major problem in Southern highbush; can be a problem in rabbiteye as well.
- Drainage is critical.
- Phosphonates (e.g. Prophyt and similar materials) and Ridomil Gold™ (Metalaxyl/Mefanoxam) are registered for control.
- Neither product is very effective at “cleaning up” infected plants.
- *Pythium* species can also be an issue in wet conditions.

Phytophthora cinnamomi



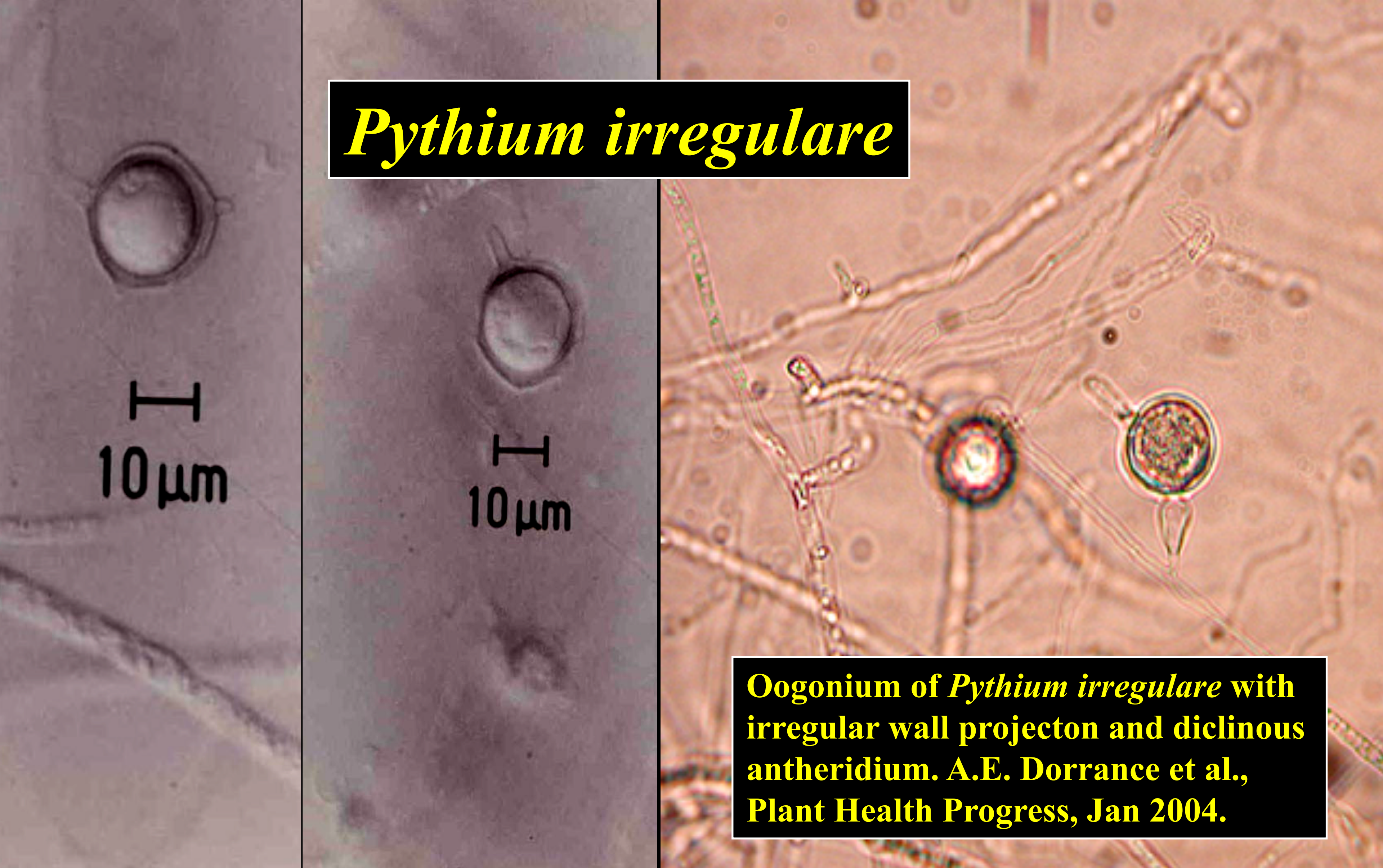
Zentmeyer, G.D. 1980. *Phytophthora cinnamomi* and the Diseases it Causes. APS.



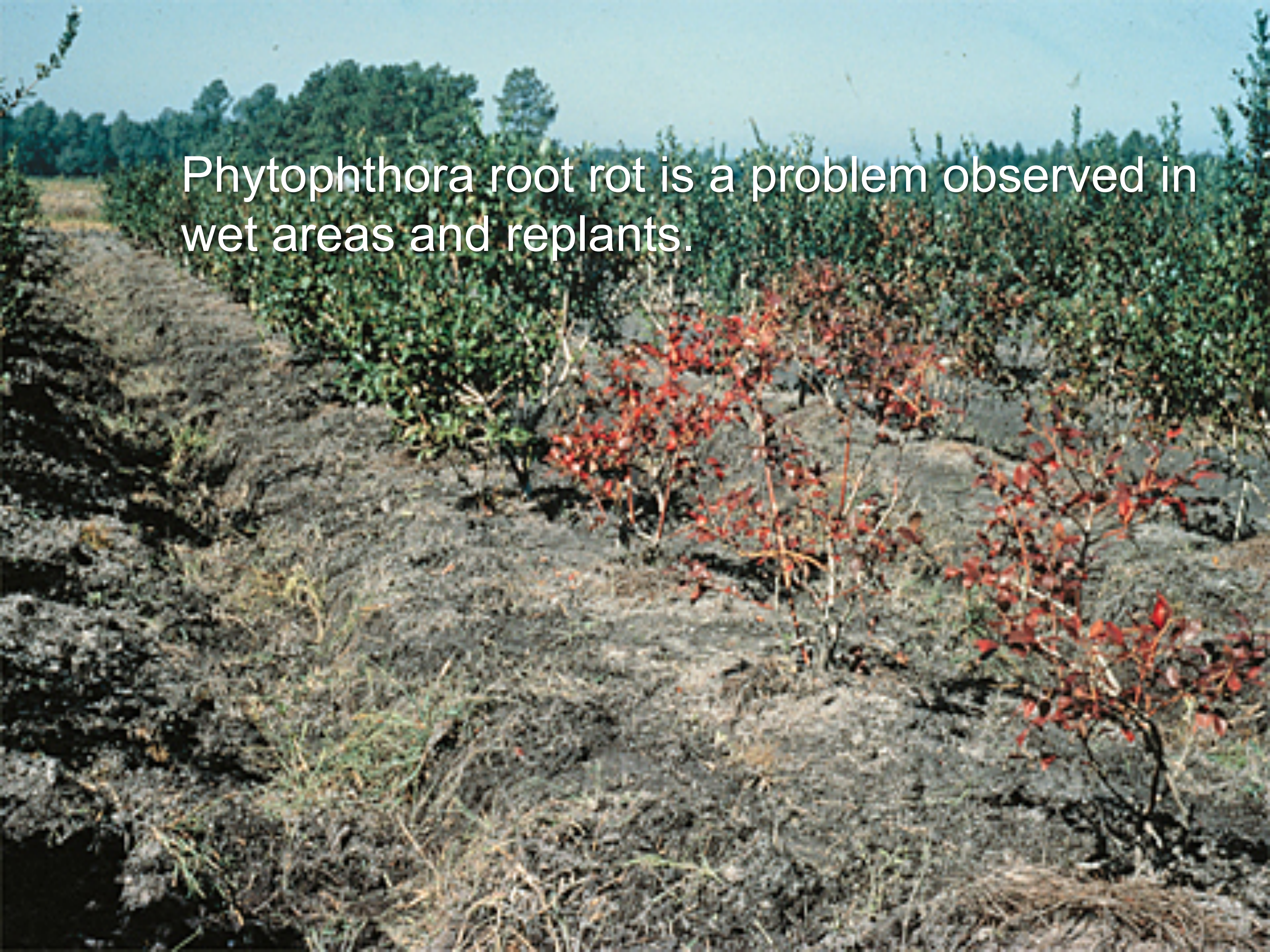
Smooth oogonium of *Phytophthora cinnamomi*

CABI Compendia

Pythium irregulare



Oogonium of *Pythium irregulare* with irregular wall projecton and diclinous antheridium. A.E. Dorrance et al., Plant Health Progress, Jan 2004.


Phytophthora root rot is a problem observed in wet areas and replants.

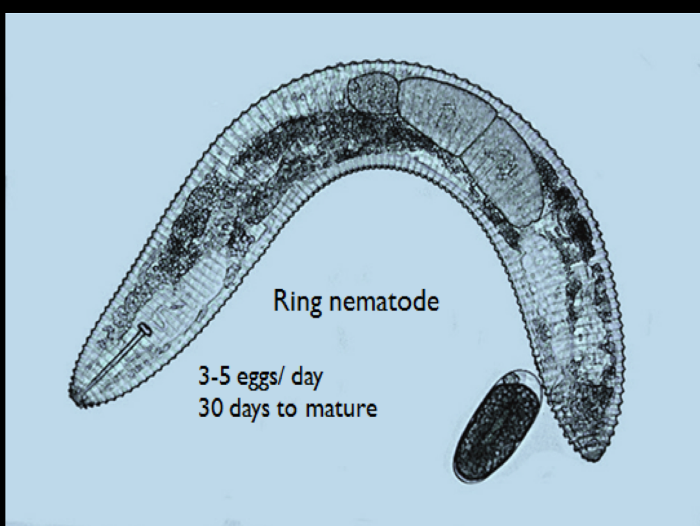

ALIETTE
PROPHYT
RIDOMIL
CONTROL


6400

Table 1. Survey of frequency and abundance of plant-parasitic nematodes on blueberry in southeast Georgia on two dates.

		April–May 2010			October–November 2010		
Nematode genera	Percent frequency[a]	Abundance[b]	Standard deviation	Maximum density[c]	Abundance	Standard deviation	Maximum density
Mesocriconema	55	251	590	5,248	348	604	3,776
Hoplolaimus	11	77	183	856	75	112	568
Tylenchorhynchus	10	15	17	68	10	16	52
Hemicycliophora	7	40	42	136	29	51	196
Paratrichodorus	7	13	15	60	2	4	16
Helicotylenchus	5	24	17	52	18	60	225
Belonolaimus	3	4	7	20	7	8	24
Dolichodorus	2	19	21	60	15	25	64
Xiphinema	2	14	10	26	160	265	676
Tylenchus	1	115	116	244	32	55	96

[a] Total number of samples in which the nematode genus was detected on either survey date divided by the total number of samples collected = 283 samples, multiplied by 100 to convert to a percentage.
[b] Sum of nematode densities per 100-cm^3 soil divided by the total number of samples in which the nematode genus was detected on either survey date.
[c] Maximum nematode density detected per 100-cm^3 soil.



Blueberry on a replant disease site treated with methyl bromide (left) and untreated control (right)

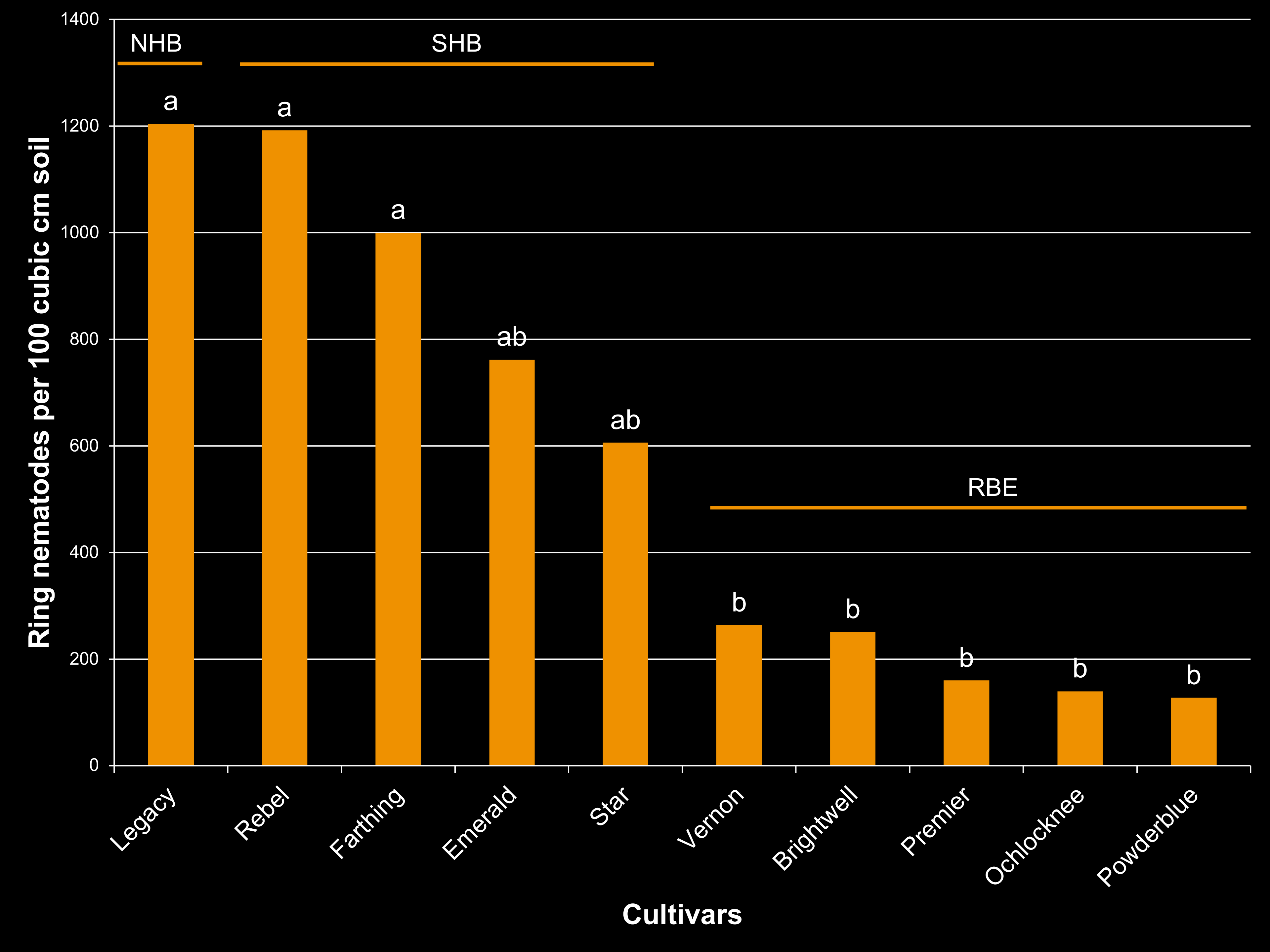
TABLE 2. Survey of frequency and abundance of *Mesocriconema* sp. on blueberry in southeast Georgia on two dates, by county.

			April–May 2010			November 2010		
County	N	Percent frequency[a]	Abundance[b]	Standard deviation	Maximum density[c]	Abundance	Standard deviation	Maximum density
Appling	32	50	216	311	1,224	229	329	1,264
Atkinson	25	36	102	242	744	64	74	204
Bacon	23	70	782	1,444	5,248	517	635	1,792
Berrien	29	59	281	292	872	321	293	864
Brantley	43	53	81	75	268	176	188	608
Clinch	28	68	446	740	2,824	701	1,023	3,776
Coffee	27	59	35	79	324	89	174	552
Jeff Davis	16	38	96	174	440	64	113	280
Lanier	8	63	14	19	44	140	256	596
Pierce	28	71	175	236	856	353	662	2,600
Ware	8	25	3	4	6	6	3	8
Wayne	8	100	342	329	952	1,212	978	2,960

[a] Total number of samples in which *Mesocriconema* sp. was detected on either survey date divided by the total number of samples collected in that county (N), multiplied by 100 to convert to a percentage.

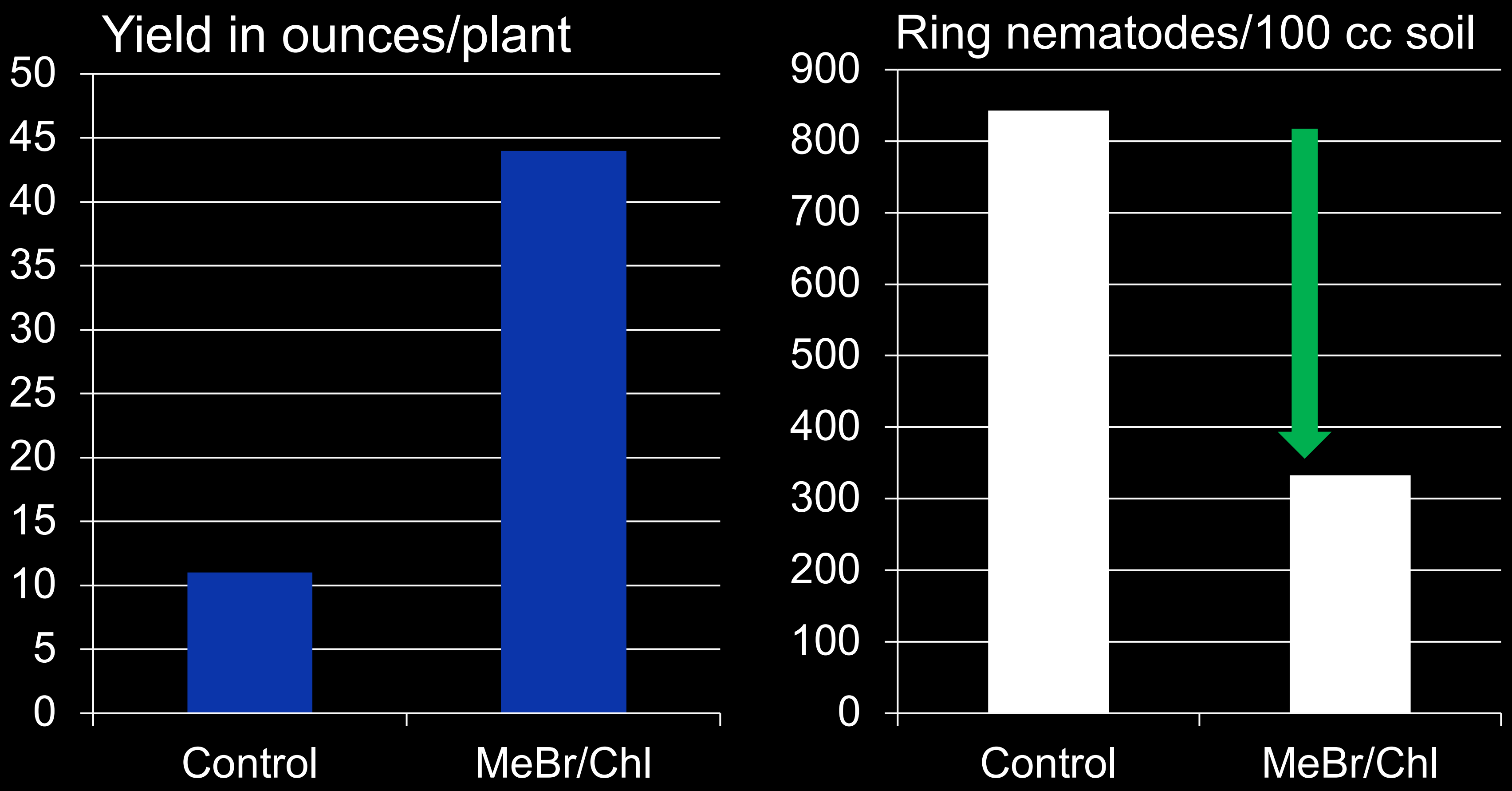
[b] Sum of nematode densities per 100-cm^3 soil divided by the total number of samples in which the nematode genus was detected in the county on either survey date.

[c] Maximum nematode density detected per 100-cm^3 soil.



1400
1200
1000
800
600
400
200
0
Ring nematodes per 100 cubic cm soil
NHB
SHB
RBE
a
a
a
ab
ab
b
b
b
b
b
Legacy
Rebel
Farthing
Emerald
Star
Vernon
Brightwell
Premier
Ochlocknee
Powderblue
Cultivars

Yield of 3-yr-old blueberry plants and ring nematode counts in research plots with and without preplant treatment with methyl bromide/Chl – Clinch County 2011



Conclusions

1. Fumigation is a good recommendation for replant sites, though the degree of impact may be variable.
2. Nematodes likely contribute to stunting associated with replant disorder.
3. Southern highbush varieties are likely more readily colonized by nematodes, and replant disease damage may be more apparent.

1. TRANSPLANT DISEASES

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Bacterial leaf scorch

A small, fastidious, Gram negative, xylem-inhabiting bacterium related to *Xanthomonas* spp.

Tissue specific, confined to tracheary elements, tracheids or vessels

Xylella fastidiosa

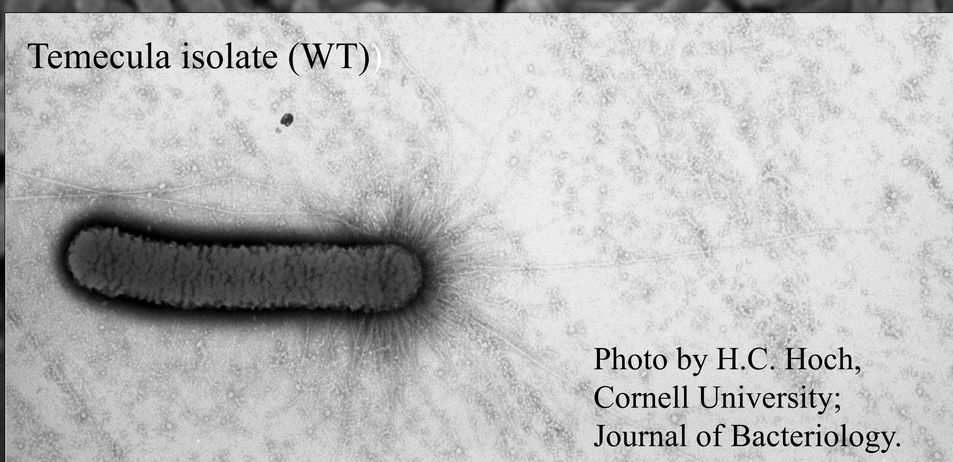
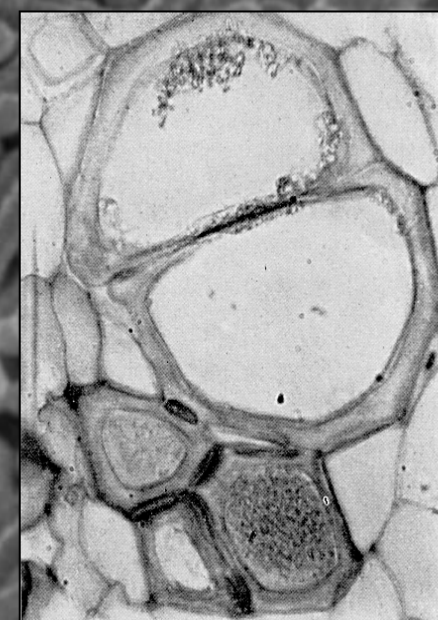


Photo by H.C. Hoch, Cornell University; Journal of Bacteriology. 189:7507–7510.



Bacterial Leaf Scorch Symptoms on Southern Highbush Blueberry

Initial symptoms are marginal leaf scorch (burn) which is similar to that observed in extreme drought. Eventual leaf drop occurs, and young twigs/stems may take on a yellow appearance (yellow twig). After leaf drop, the whole plant eventually dies.


Bacterial leaf scorch


Bacterial leaf scorch


Bacterial leaf scorch

The glassy-winged sharpshooter (*H. vitipennis*) constituted 97% of leafhoppers sampled within bushes season-long at two field sites.

0.25%

Homalodisca insolita

0.77%

Paraulacizes irrorata

0.25%

Oncometopia nigricans

1%

Draeculacephala spp

0.51%

Graphocephala versuta

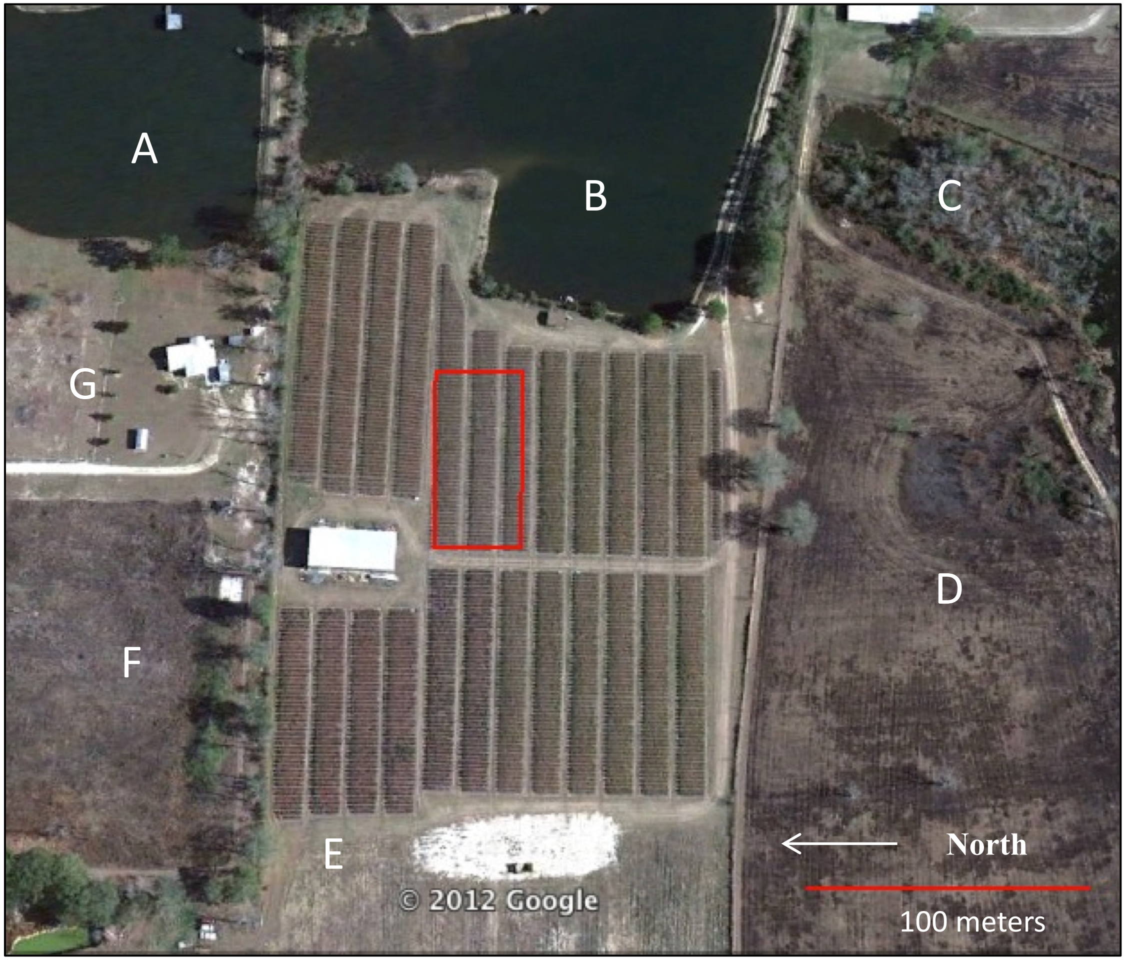
M. Tertuliano


Stunt
B. Cline, North Carolina State Univ., USA

Red ringspot virus is readily transmitted through propagation, does not move, and is not likely insect transmitted.

Necrotic ring blotch is not readily transmitted through propagation, moves rapidly, and is likely insect transmitted.

Blueberry Necrotic Ring Blotch



(A) pond surrounded by causeway with mixed hardwood stand and grass, (B) pond surrounded by mixed pine/hardwood and grass, (C) mixed pine and hardwood shrubs, (D) fallow area with mixed broadleaf and grass weeds, (E) grass, (F) fallow area with mixed broadleaf and grass weeds with mixed pine/hardwood surrounding, and (G) grass with mixed hardwoods and pines surrounding.

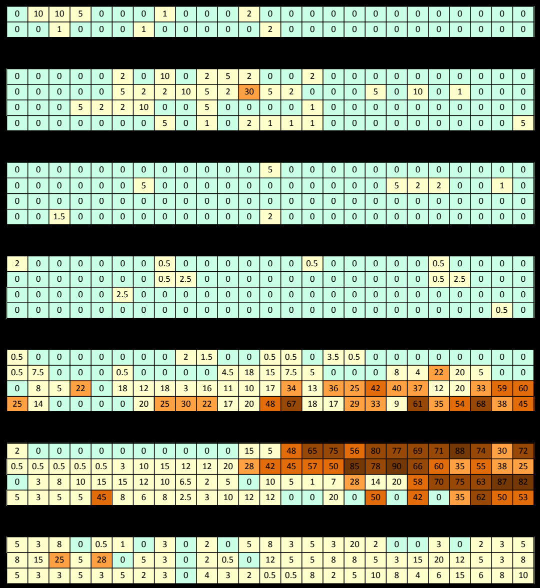
PURPLE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
25	0	0	0	0	0	3	60	0	0	7	0	18	1	0	0	5	0	0	0	0.5	0	1	30	18	0
24	0	0	5	0	3	0	0	0	0	14	9	1	0	0	6	0	0	0	4	0	0	13	0	0	0
23	14	0	2	0	1	0	0	10	0	0	0	25	45	25	8	0	20	0	0	0	2	12	9	0	3
22	0.5	0	2	11	16	7	9	6	0	20	11	0	40	23	25	15	18	1	17	25	3	16	10	17	0
21	1	13	1	13	23	20	30	20	12	0	15	0	20	0	3	0	0	25	11	10	30	25	22	0	3
20	0	15	1	6	8	21	60	18	0	20	5	0	20	0	0	0	0	0	10	0	0	8	0	50	0
19	0.5	0	30	30	1	1	0	0	5	15	19	25	0	0	0	0	30	1	30	2	0	0	0	5	0
18	0	0	15	7	5	0	0	25	25	30	0.5	0	0	0	0	0	12	0	0	0	0	0	18	0	0
17	0	0	8	0	5	0.5	20	0	0	17	1	0	0	0	0	20	40	5	0	7	0	3	0	0	0
16	0	15	0	0	30	0	10	5	0	70	15	0	45	0	1	0	0	5	0	0	8	0	0	0	1
15	0	0	20	0	1	0	0	0	25	20	60	60	50	0	5	0	7	50	0	3	0	0	2	0	1
14	40	0	0	0	2	0	20	0	50	2	0	0	0	12	0	0	0	6	9	0	0	0	0	0.5	12
13	12	0	50	30	70	50	35	50	20	10	15	0	21	35	0	0	0	0	50	3	2	0	0	0	0
12	5	9	60	60	0	20	50	17	0	70	40	2	0	3	0	0	0.5	0	8	30	0	0	0.5	10	11
11	1	0	20	7	20	50	0	0	30	10	9	50	0	0	0	0	0	9	0.5	13	3	35	0	0	10
10	70	20	0	5	0.5	0.5	0	50	0	15	1	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0
9	5	5	0	0	0	1	30	1	0	0.5	0	1	0	0.5	5	0	0	0	1	0	0	2	0	1	0
8	0	0	0	4	10	2	0	0	0	0	0	2	0	0	17	1	0	0	1	0	0.5	0	0	0	0
7	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0.5
6	0	0	0	0	0	0.5	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	10	1
5	2	0	1	0.5	0	0	12	0	0	0	0	0	0	0	0	1	40	0.5	0	0	0	0	0	0.5	0
4	0	15	8	0	0	0	0.5	0	0.5	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0
3	30	0	0	0	0	0	0	0	50	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	5	8	4	15	5	0	0	0	3	0	20	0	0	0	0	0	0	0	0	0	0	0	13	0
1	0	0	0	60	0	0	0	0	0	0	5	30	0	0	0	0	0	0	0	0	0	0	0	0	0

Disease rating scale:

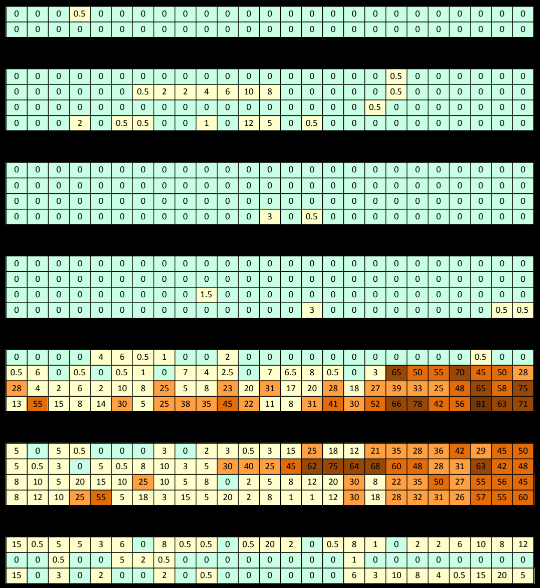
- 0 % = No leaves on plant showing symptoms of necrotic ring blotch
- 0.001 – 19.99% = Very limited symptoms; lesions found sporadically on plant
- 20.00 – 39.99% = Light symptoms; lesions found sporadically on plant
- 40.00 – 59.99% = Plant moderately diseased with moderate number of lesions on lower leaves
- 60.00 – 79.99% = Heavy symptoms; numerous lesions on most leaves in mid to lower canopy extending to upper leaves
- 80.00% or greater = Very heavy symptoms; plant severely diseased with most to all leaves on plant covered with necrotic lesions

Commercial site: Alma (Bacon County – 2011)

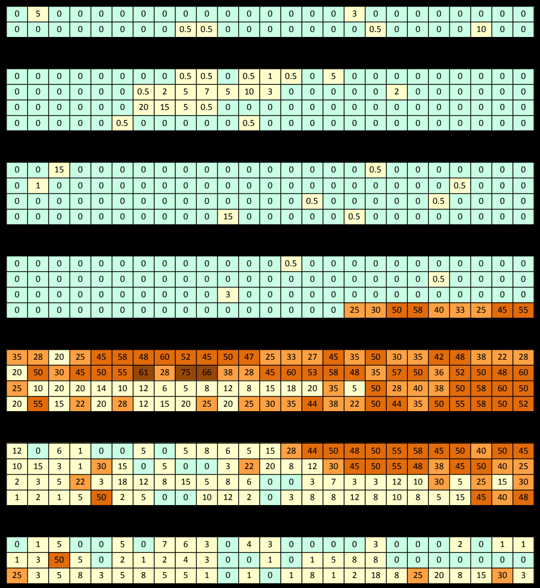
Field aggregation: Enigma, GA 2011



7/23/12



9/25/12



10/16/12

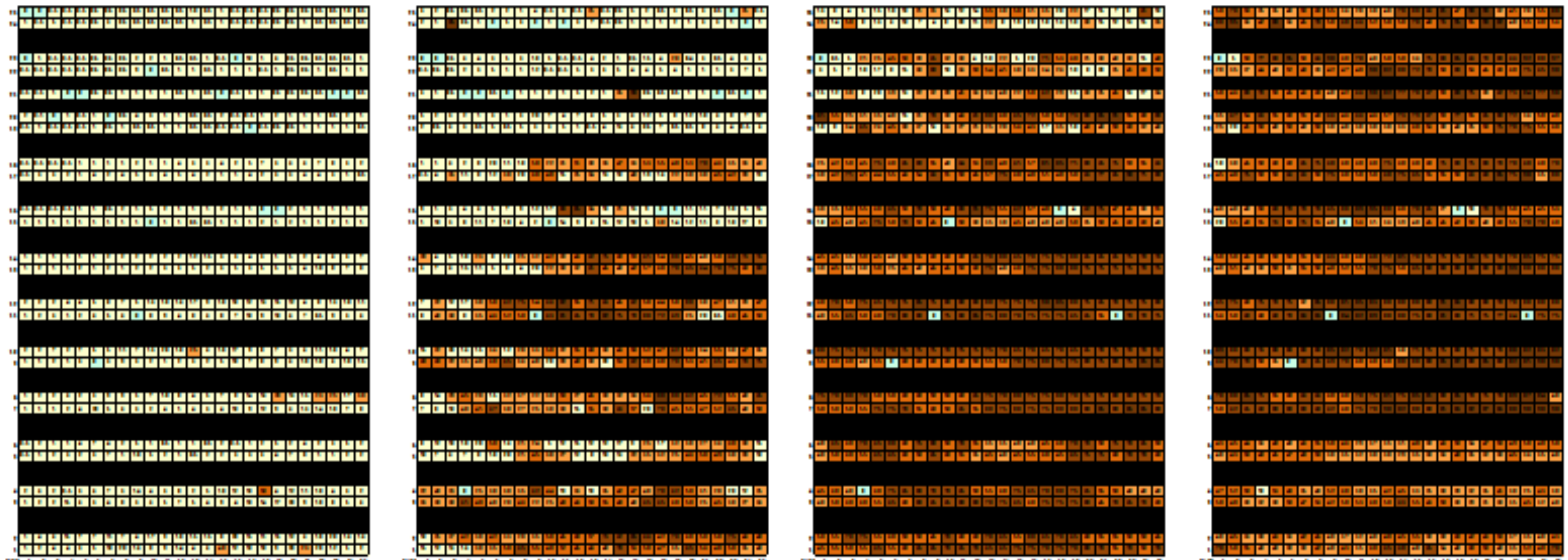


Figure 2.18. Temporal progression of *Blueberry necrotic ring blotch virus* in a 25 X 25 plant block of 'Star' southern highbush blueberry in Willacoochee, GA in 2011. Numbers in each square correspond to the disease severity per plant. Assessment dates were 27 June, 11 July, 26 July, and 13 August (from left to right). **Note:** Blueberry plantings at this site were planted in double-row beds; the black horizontal bars indicate blueberry of different variety.

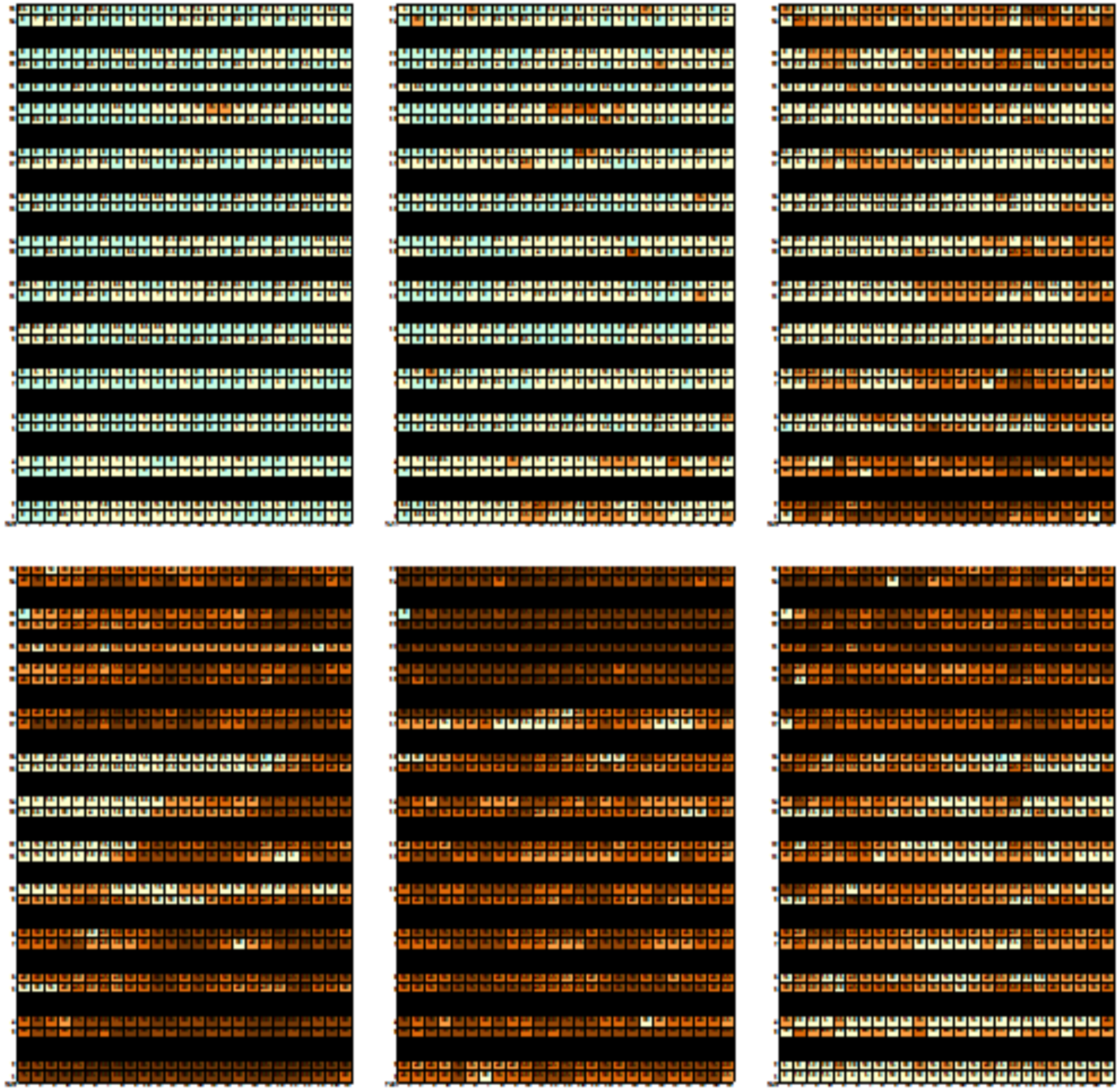
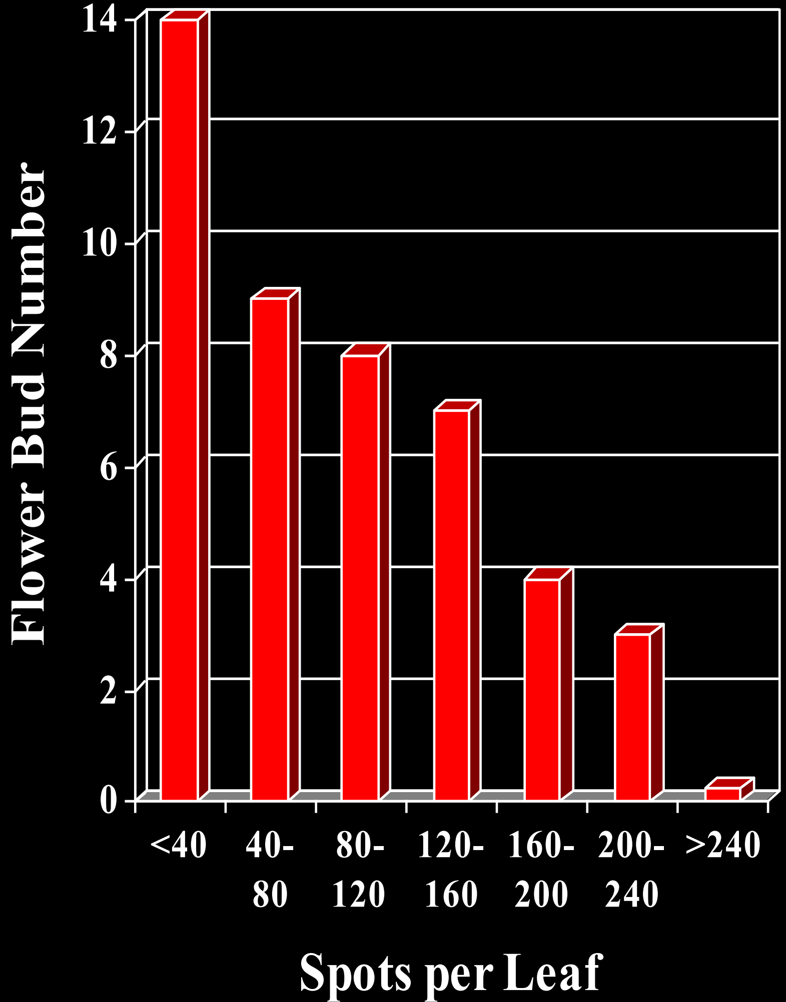
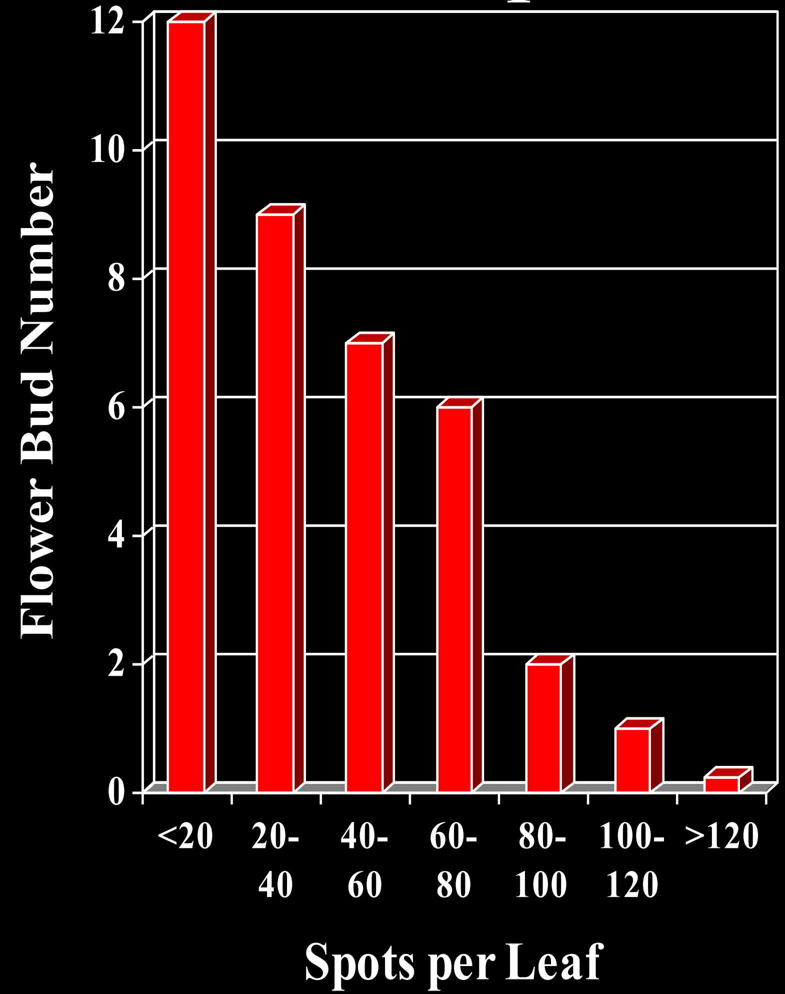


Figure 2.21. Temporal progression of *Blueberry necrotic ring blotch virus* in a 25 X 25 plant block of 'Star' southern highbush blueberry in Willacoochee, GA in 2012. Numbers in each square correspond to the disease severity per plant. Assessment dates were 6 June, 25 June, 9 July, 23 July, 25 September, and 16 October (from left to right, top to bottom). **Note:** Blueberry plantings at this site were planted in double-row beds; the black horizontal bars indicate blueberry cultivar of different variety.

Premiere Data



Bluecrisp Data



Red ringspot virus is readily transmitted through propagation, does not move, and is not likely insect transmitted.

Necrotic ring blotch is not readily transmitted through propagation, moves rapidly, and is likely insect transmitted.

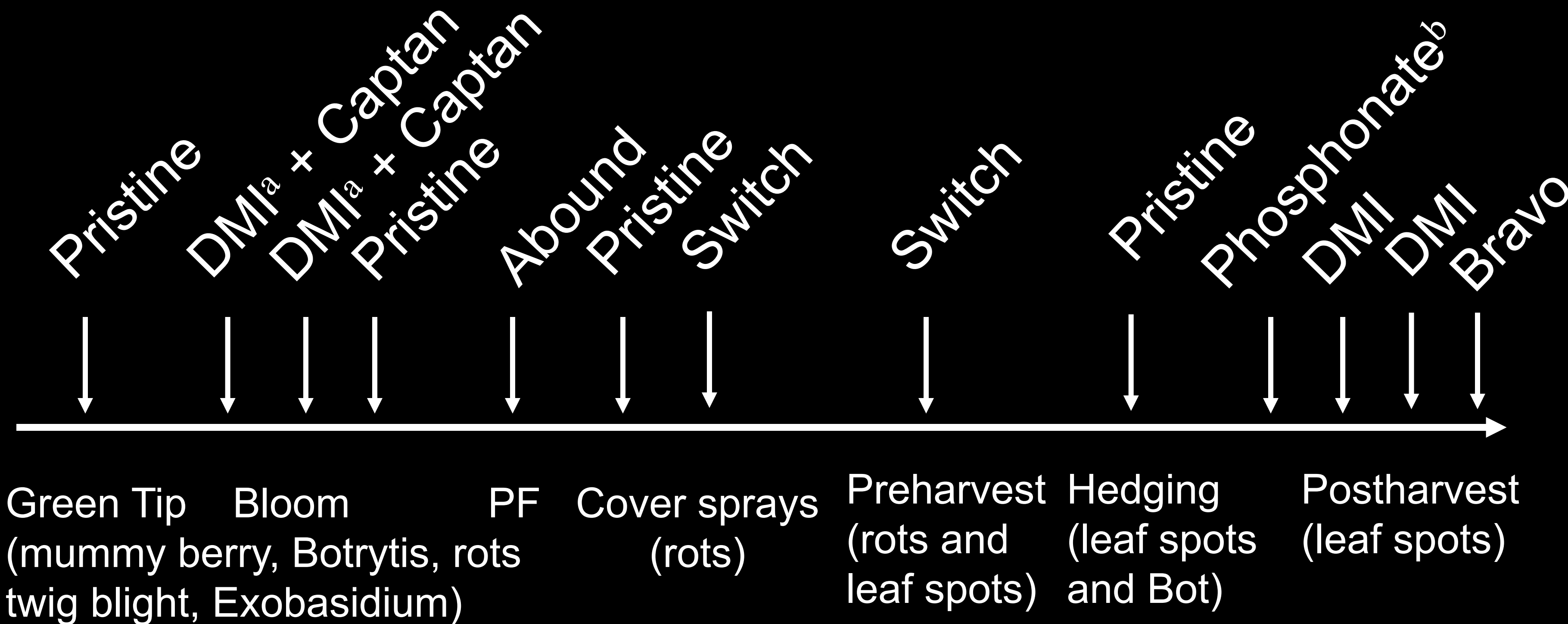
1. TRANSPLANT DISEASES

2. ISSUES AND DISEASES ASSOCIATED WITH SITE OR CULTURE

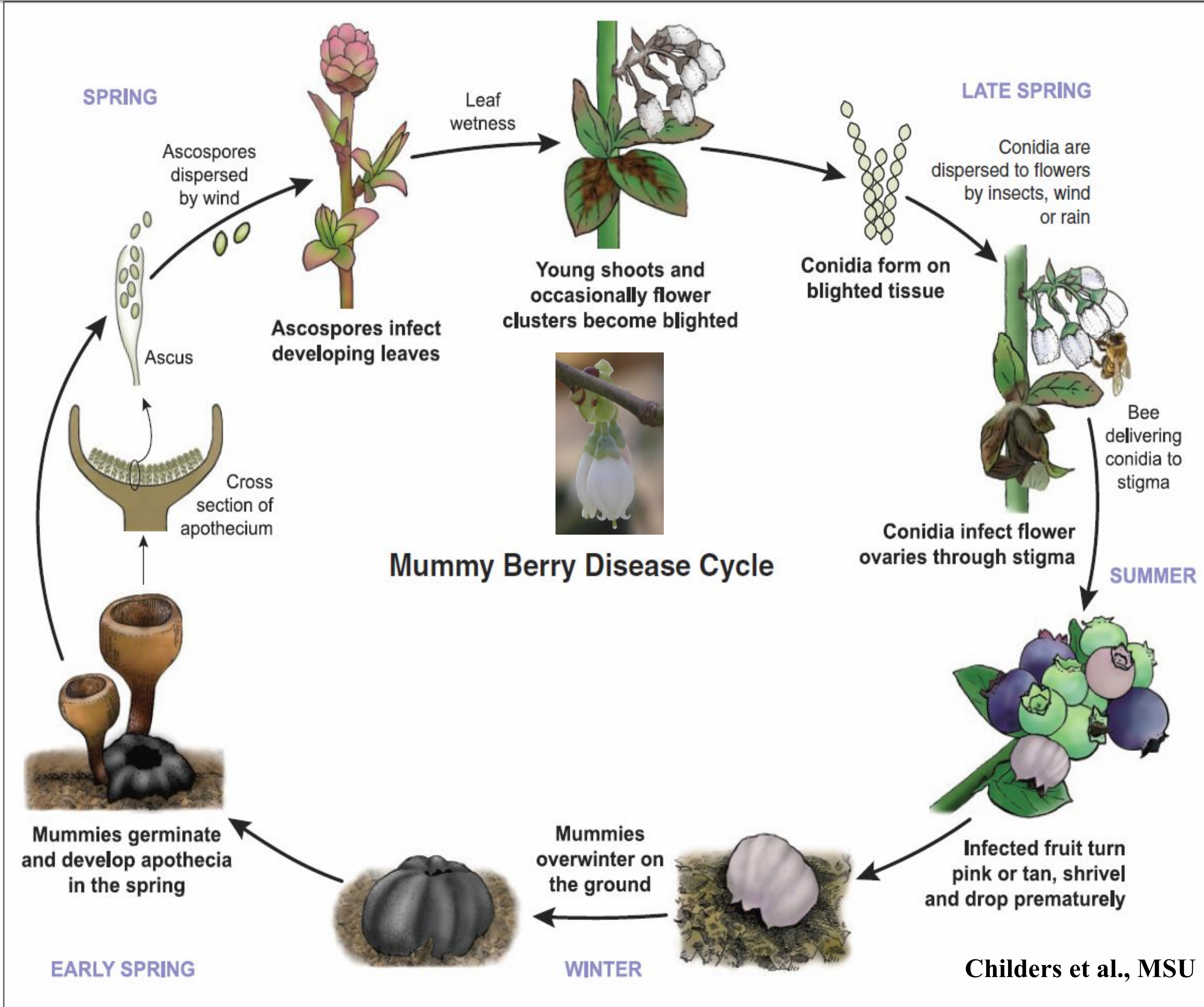
3. PERENNIAL DISEASES

4. ANNUAL DISEASES

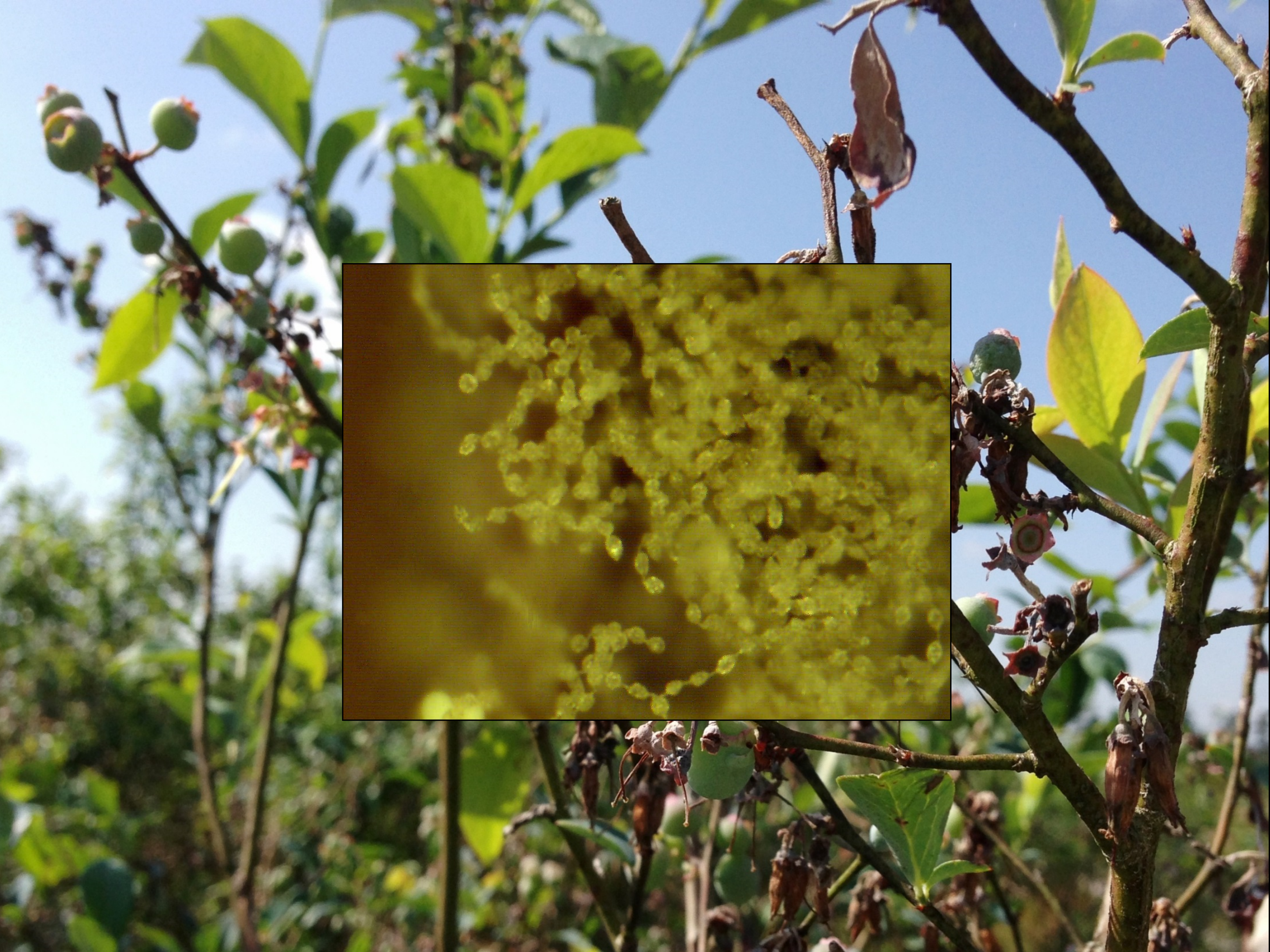
Blueberry Disease Management Strategy



[a]DMIs include Indar, Orbit/Tilt/generics and Quash. Elevate can be added for additional Botrytis management.
[b]Phosponates include materials such as ProPhyt, K-phite, etc.


SPRING
Ascospores dispersed by wind
Leaf wetness
LATE SPRING
Conidia are dispersed to flowers by insects, wind or rain
Ascus
Ascospores infect developing leaves
Young shoots and occasionally flower clusters become blighted
Conidia form on blighted tissue
Bee delivering conidia to stigma
Cross section of apothecium
Mummy Berry Disease Cycle
Conidia infect flower ovaries through stigma
SUMMER
Mummies germinate and develop apothecia in the spring
Mummies overwinter on the ground
Infected fruit turn pink or tan, shrivel and drop prematurely
EARLY SPRING
WINTER
Childers et al., MSU


Mummy berry blight




Mummy berry

Table 2. Fungicide efficacy against shoot and fruit stages of mummy berry infection in blueberry in Michigan.

Fungicide	Active ingredient	Behavior	Shoot strikes	Fruit infection
Abound	azoxystrobin	systemic	fair*	fair to good
Bravo	chlorothalonil	protectant	fair	poor
Cabrio	pyraclostrobin	systemic	poor to fair	fair
Captan	captan	protectant	poor	poor to fair
Captevate	fenhexamid + captan	systemic + protectant	fair	fair
Elevate	fenhexamid	systemic	poor	poor
Indar	fenbuconazole	systemic	good to excellent	good to excellent
Orbit	propiconazole	systemic	good to excellent	good
Pristine	pyraclostrobin + boscalid	systemic + systemic	fair to good	good
Serenade	*Bacillus subtilis*	protectant	fair to good**	fair
Sulforix/lime sulfur	calcium polysulfide	protectant	fair	poor
Switch	cyprodinil + fludioxonil	systemic + protectant	poor	fair
Ziram	ziram	protectant	fair	poor to fair

* Abound works better against shoot strikes in the southeastern United States than in Michigan. This difference may be due to differences in springtime temperatures.

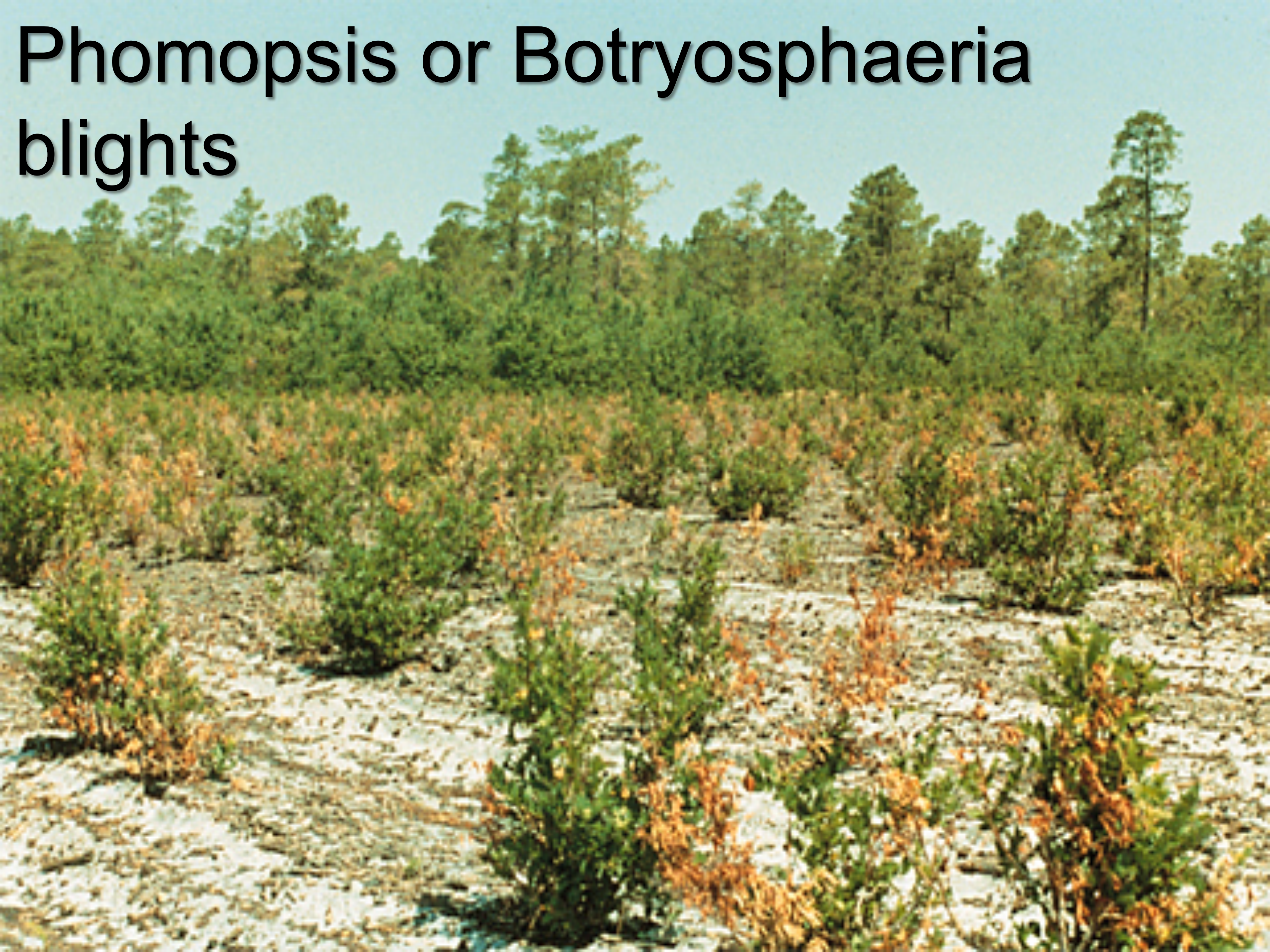
** Efficacy of Serenade can be improved by adding the adjuvant Nufilm-17.

	Mummy Berry Sprays			
	Green Tip (or early bloom)	Bloom Sprays (10-20% bloom)	Bloom Sprays (full bloom)	Late bloom
1	NO FUNGICIDE			
2	Indar 75WSP @ 2.0 oz/A	Indar 75 WSP @ 2.0 oz/A	Indar 75 WSP @ 2.0 oz/A	Indar 75 WSP @ 2.0 oz/A
3	Regalia @ 4 quarts/A	Regalia @ 4 quarts/A	Regalia @ 4 quarts/A	Regalia @ 4 quarts/A
4	Quilt Xcel @ 21 fl.oz./A	Quilt Xcel @ 21 fl.oz./A	Quilt Xcel @ 21 fl.oz./A	Quilt Xcel @ 21 fl.oz./A
5	Quash 50WDG @ 2.5 oz/A	Quash 50WDG @ 2.5 oz/A	Quash 50WDG @ 2.5 oz/A	Quash 50WDG @ 2.5 oz/A
6	Indar 75WSP @ 2.0 oz/A	Optiva @ 16 oz/A	Indar 75WSP @ 2.0 oz/A	Optiva @ 16 oz/A
7	Indar 75WSP @ 2.0 oz/A	NO FUNGICIDE	Indar 75WSP @ 2.0 oz/A	NO FUNGICIDE
8	Abound drench (0.035 oz a.i./ plant)*	NO FUNGICIDE	NO FUNGICIDE	NO FUNGICIDE

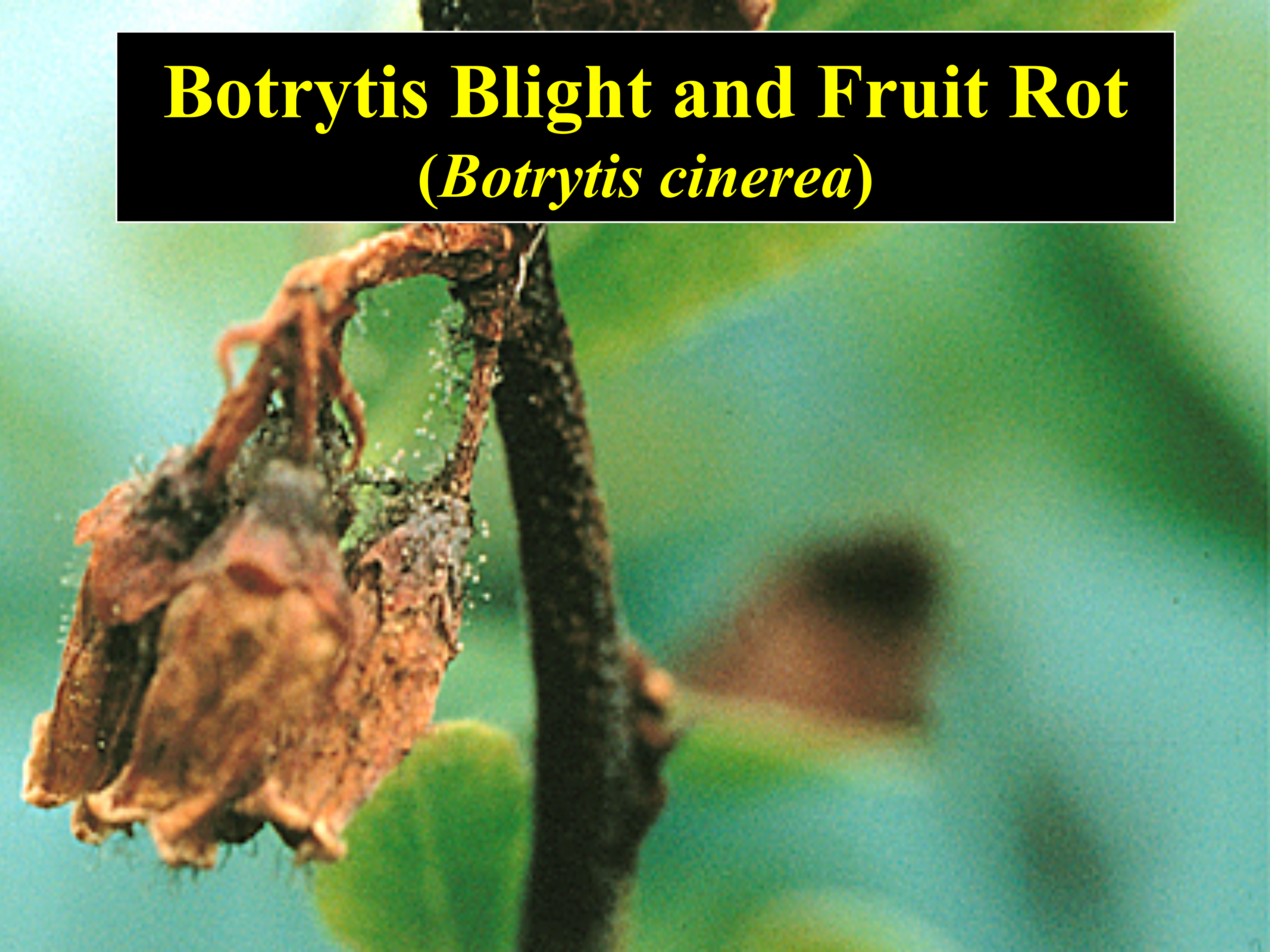
Treatment and rate/A	Treatment date[z]	Mummy incidence (%)
Untreated control		74.5 a[y]
Indar 75WSP 2 oz	1-4	19.6 c
Regalia 4.0 qt	1-4	74.0 a
Quilt Xcel 21 fl oz	1-4	19.2 c
Quash 50WDG 2.5 oz	1-4	25.1 c
Indar 75WSP 2 oz	1,3	
Optiva 16 oz	2,4	47.1 b
Indar 75WSP 2 oz	1,3	62.4 ab
Abound[x]	1	65.4 ab
LSD ($\alpha = 0.05$)		19.5

[z]Treatment dates: 1 = 29 Mar (green tip); 2 = 9 Apr (10-20% bloom); 3 = 15 Apr (full bloom); 4 = 20 May (late bloom)
[y]Means within columns followed by the same letters are not significantly different according to Fisher's protected LSD test ($P \leq 0.05$).
[x]Abound was applied as a concentrated drench at 0.035 oz a.i. per plant.

Phomopsis or Botryosphaeria blights



Botrytis Blight and Fruit Rot
(*Botrytis cinerea*)



Botrytis blight and fruit rot

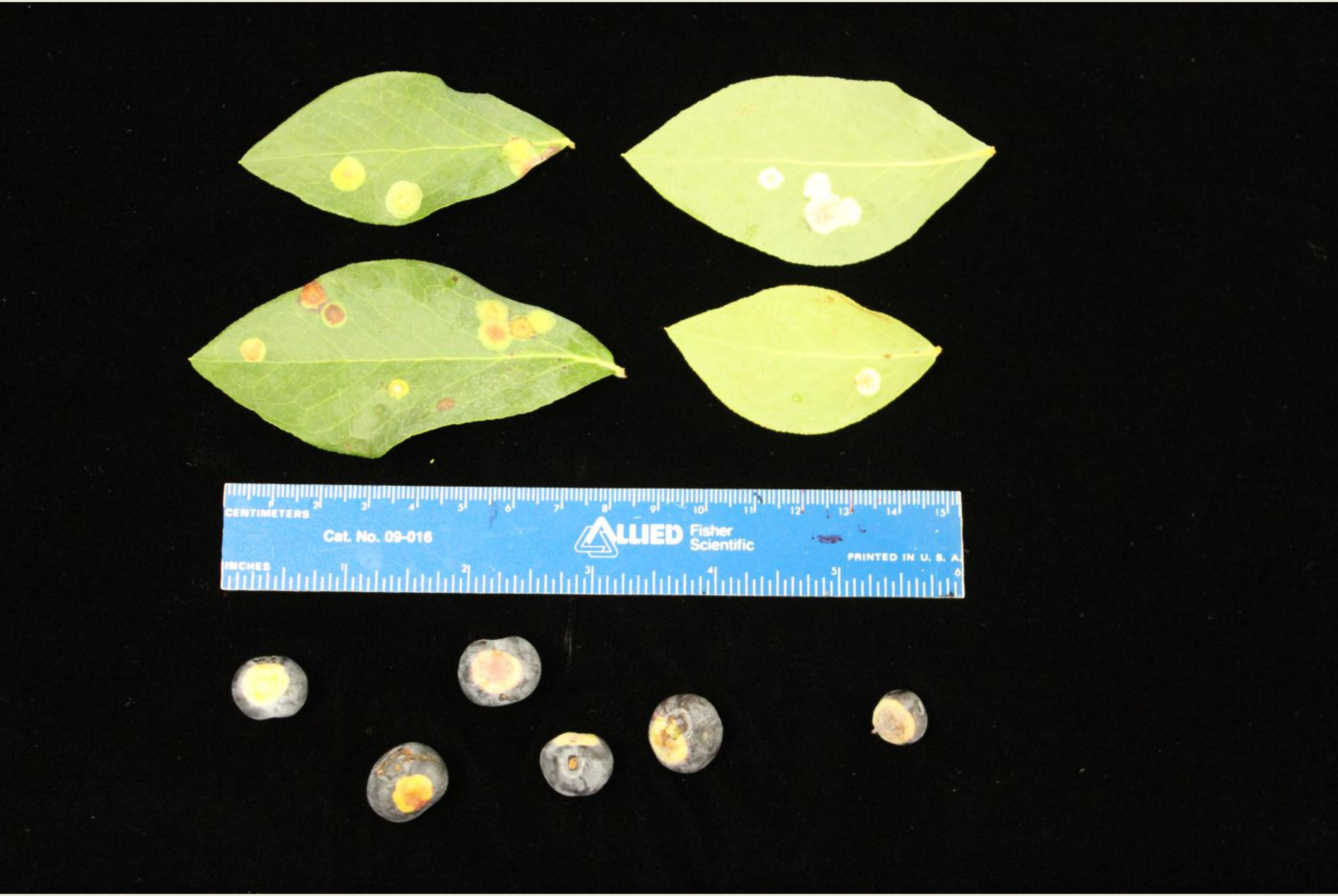

Developing berries can become
infected, but the symptoms do not
show up till after harvest.

Captan and Ziram are not likely to develop resistance. They are therefore important components of a resistance management program. Without them, we may not actually have Botrytis management, since most of the fungicides we apply during bloom or early cover sprays may not have activity at this point.


Exobasidium leaf spot


Exobasidium fruit spot

Exobasidium on rabbiteye blueberry in April/ May



Economic importance stems from fruit infection

Application Timing
Premier, 2013

Fungicide application timing against Exobasidium leaf and fruit spot at the Alma test site, 2013 (cultivar Premier).

Application	Date	Growth stage	Application block	
1	5 Feb.	Delayed dormant	Delayed dormant	
2	14 Feb.	Early green tip	Early block (pre-bloom and bloom)	Full block
3	28 Feb.	Green tip , 4% bloom	Early block (pre-bloom and bloom)	Full block
4	14 Mar.	32% bloom	Early block (pre-bloom and bloom)	Full block
5	21 Mar.	58% bloom	Early block (pre-bloom and bloom)	Full block
6	28 Mar.	84% bloom	Early block (pre-bloom and bloom)	Full block
7	1 April	Petal fall	Mid-season block (cover sprays)	Full block
8	12 April	First cover	Mid-season block (cover sprays)	Full block
9	19 April	Second cover	Mid-season block (cover sprays)	Full block

Treatment and rate/A	Application timing[z]	Leaf spot incidence (%)[y]	Leaf spot severity (spots/leaf)[y]	Fruit spot incidence (%)[x]
1. Untreated control........	----	48.0 a	2.9 a	32.4 a
2. Lime Sulfur 5 gal	1	5.7 cd	0.1 c	2.8 de
3. Captan 4L 2.5 qt..........	2-6	8.3 cd	0.2 c	4.4 cde
4. Indar 2F 6fl oz............	2-6	23.1 b	0.5 c	12.3 bc
5. Pristine 22 oz..............	2-6	24.0 b	0.5 c	10.3 bcd
6. Captan 4L 2.5 qt..........	7-9	6.7 cd	0.1 c	12.2 bc
7. Indar 2F 6fl oz............	7-9	15.5 bc	0.3 c	16.6 b
8. Pristine 22 oz..............	7-9	39.2 a	1.8 b	31.0 a
9. Captan 4L 2.5 qt..........	2-9	1.3 d	0.0 c	1.0 e
10. Indar 2F 6fl oz............	2-9	4.4 cd	0.1 c	4.0 cde
11. Pristine 22 oz..............	2-9	25.0 b	0.7 c	14.4 b

[z]Treatment dates and corresponding plant phenologies: 1 = 5 Feb (delayed dormant); 2 = 14 Feb (early green tip); 3 = 28 Feb (green tip, 4% bloom); 4 = 14 Mar (32% bloom); 5 = 21 Mar (58% bloom); 6 = 28 Mar (84% bloom); 7 = 1 Apr (petal fall); 8 = 12 Apr (first cover); 9 = 19 Apr (second cover).

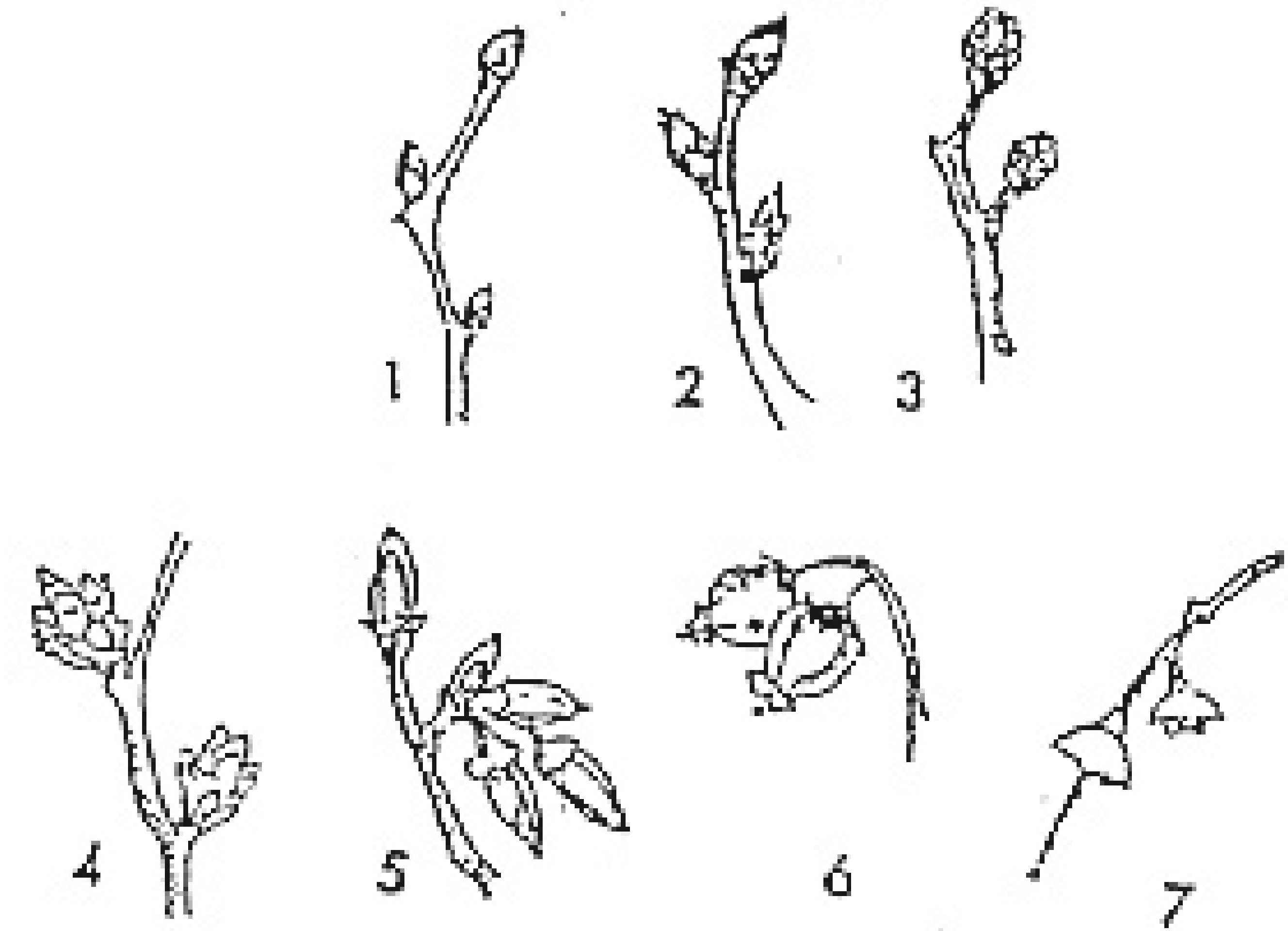
[y]Recorded for 20 shoots per plot with ~7 leaves per shoot on average. Means followed by the same letter are not significantly different when using Tukey's test ($P = 0.05$).

[x]Recorded for ~300 fruit per plot on average. Means followed by the same letter are not significantly different when using Tukey's test ($P = 0.05$).

Treatment and Rate/A	Leaf Symptoms: % leaves with one or more spots		Leaf Symptoms: Average no. of spots per leaf		Fruit Symptoms at first pick on 20 Jun: Total yield (g)		Market-able yield (g)		Weight per berry (g)		Number of good berries per 100 (%)	
Untreated check	89.8	a*	7.81	a	81	a	33	a	1.4	a	39	a
Indar 2F 6 fl oz.	3.8	b	.03	b	158	b	147	c	1.7	b	90	b
Pristine 23 oz.	5.2	b	.06	b	142	b	129	bc	1.8	b	88	b
Captan 80WDG 3.12 lb	1.8	b	.01	b	142	b	134	bc	1.6	ab	92	b
Elevate 50WDG 1.5 lb	4.0	b	.04	b	108	ab	91	b	1.7	b	80	b

*Means within a column followed by the same letter are not significantly different, LSD, (α=0.05).

Bill Cline, NCSU 2013

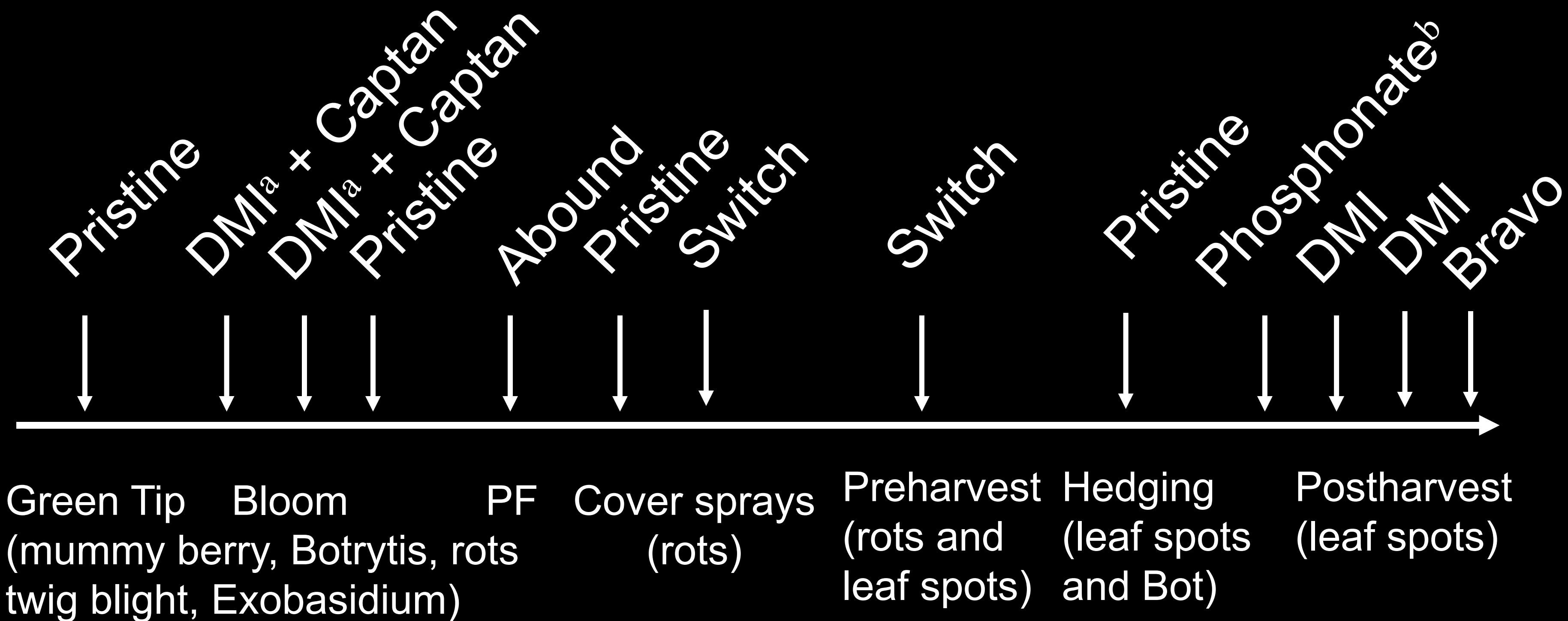


1 = no visible swelling, bud scales completely enclose the flowers;
2 = visible swelling of bud, scales separating, flowers still completely enclosed;
3 = bud scales separated, apices of flowers visible;
4 = individual flowers distinguishable, bud scales abscised;
5 = individual flowers distinctly separated, corollas elongated but closed;
6 = corollas completely expanded and open;
7 = corollas dropped.
Adapted from J. M. Spiers, 1978, J. Amer. Soc. Hort. Sci. 103 (4): 452-454.

Tentative Management Conclusions

- Lime sulfur delayed-dormant surprisingly effective
  – Suggests epiphytic pathogen overwintering
- Among in-season fungicides tested, Captan is best, followed by Indar; Pristine not as effective as hoped
- Both bloom and early cover applications contribute to disease control; bloom may be slightly more effective
- Late applications during fruit maturation ineffective (2012 conclusion)
  – Suggests that fruit infections occur early, perhaps simultaneously with leaf infections during bloom

Blueberry Disease Management Strategy



[a]DMIs include Indar, Orbit/Tilt/generics and Quash. Elevate can be added for additional Botrytis management.

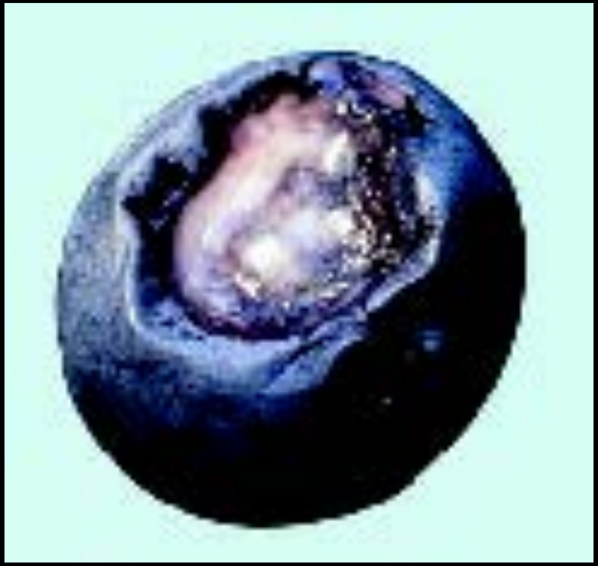
[b]Phosponates include materials such as ProPhyt, K-phite, etc.

Alternaria tenuissima

Colletotrichum spp.

Phomopsis vaccinii

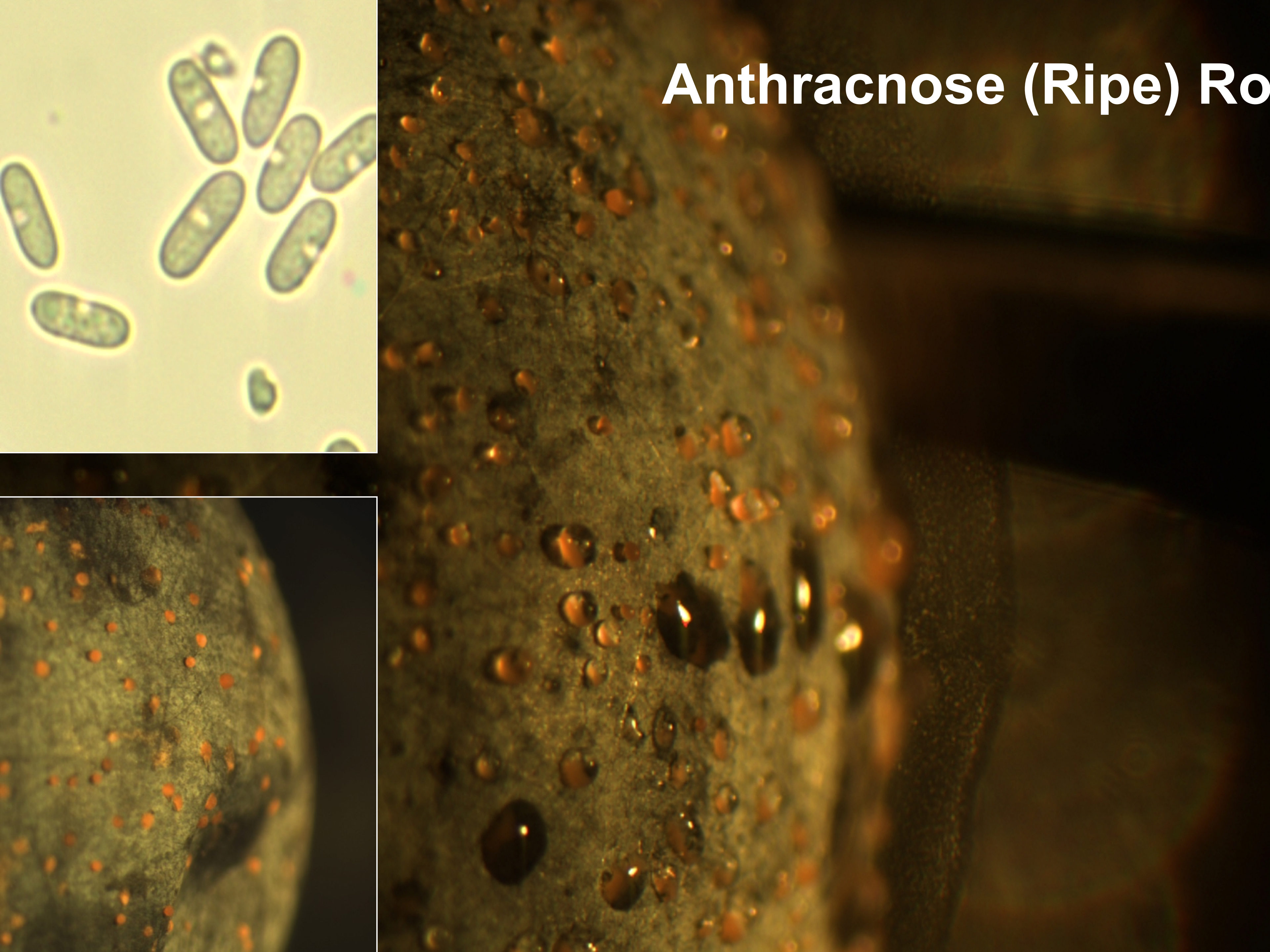
Botrytis cinerea



Aureobasidium pullulans

Anthracnose (Ripe) Rot

The fungus survives the winter in blighted twigs. Spores are released from blighted twigs throughout the growing season during rainy periods to initiate latent infections on immature green fruit. These fruit remain symptomless until maturity. At harvest or soon after, the infected fruit rapidly decay and exude masses of orange spores capable of starting new infections.


Anthracnose (Ripe) Ro

Alternaria Fruit Rot

"*Alternaria* spp., fungi. Although not as common as ripe rot, this disease has caused severe losses in some Oregon fields. Infections can occur any time between late bloom through fruit maturity. Infections remain quiescent (latent) until fruit ripens. The disease often is not seen in the field but develops in storage or in transit to market."

Oregon State University

Alternaria Fruit Rot

"In post-harvest experiments, 96% of alternaria rot infections occurred through the stem scar of the berry. This indicates that most Alternaria infections are not initiated until after fruit is harvested, because the stem scar is only exposed when berries are detached."

Bill Cline; North Carolina State University

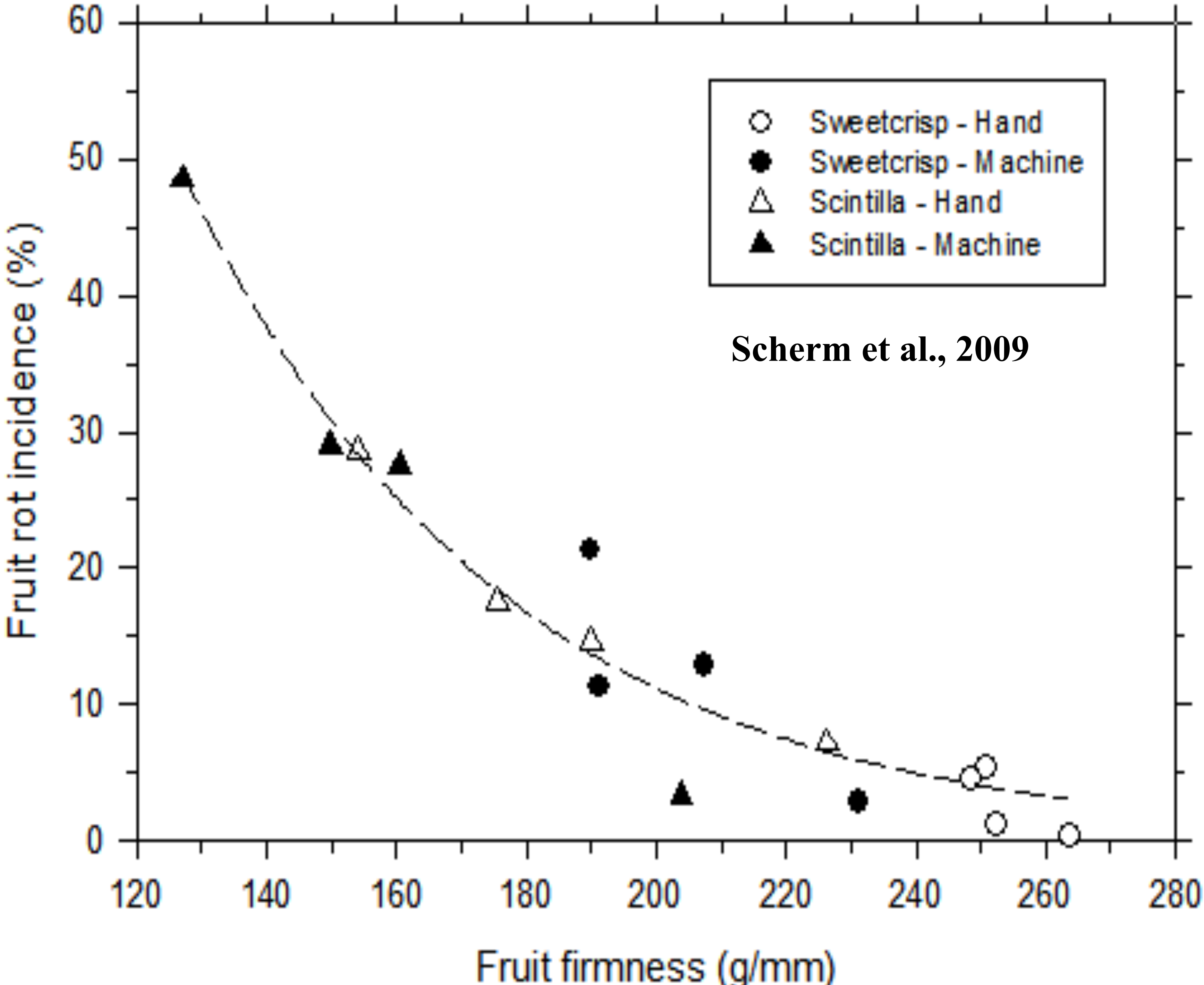
Post-Harvest Cooling and Rots

“**Postharvest Cooling** has given the most consistent control of postharvest decay. Cooling the fruit after harvest retains quality and prolongs shelf life. Cool as quickly as possible to 40° F (5° C) or lower, but not below 32°F (0° C). If cooled promptly and kept cool, quality blueberries packaged ready for retail sale can be expected to hold up well at 32° F (0° C) for 2 weeks and at 40° F (5° C) for 1 week, but only for 2 days at 70° F (21° C). Forced-air cooling is the most satisfactory method for quickly reducing the temperature of palletized blueberry fruit in consumer-ready containers.”

Bill Cline; North Carolina State University

Rot Control

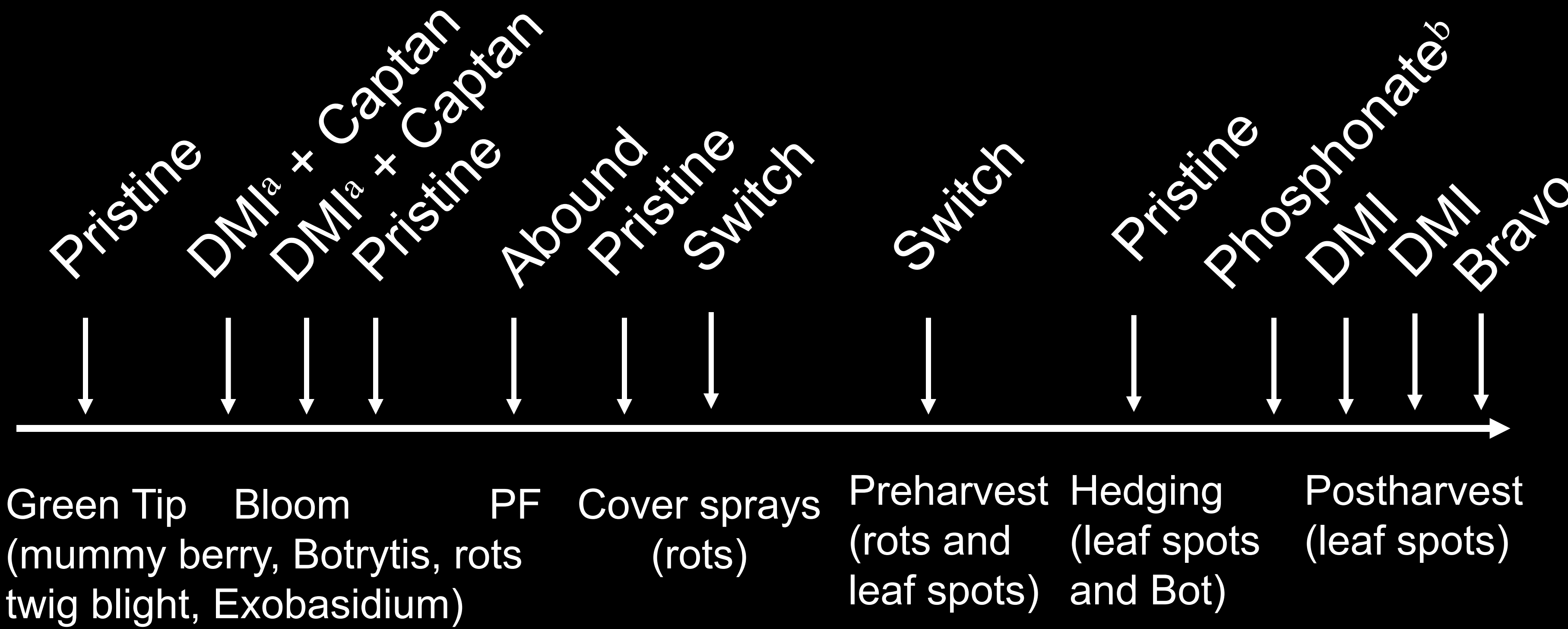
- Fungicide sprays (Switch™, Abound™, Cabrio™, Pristine ™, and Captan) and rapid cooling immediately following harvest provide for control.
- Infection can take place at any time on the fruit, but critical times appear to be bloom, post-bloom and preharvest.



Sweetcrisp - Hand
Sweetcrisp - Machine
Scintilla - Hand
Scintilla - Machine
Scherm et al., 2009
Fruit rot incidence (%)
Fruit firmness (g/mm)
0
10
20
30
40
50
60
120
140
160
180
200
220
240
260
280

Fruit rot and delayed harvest go hand in hand. Rainfall can make harvest next to impossible. Fungicides can help, but they have to be applied in a timely fashion.

Blueberry Disease Management Strategy

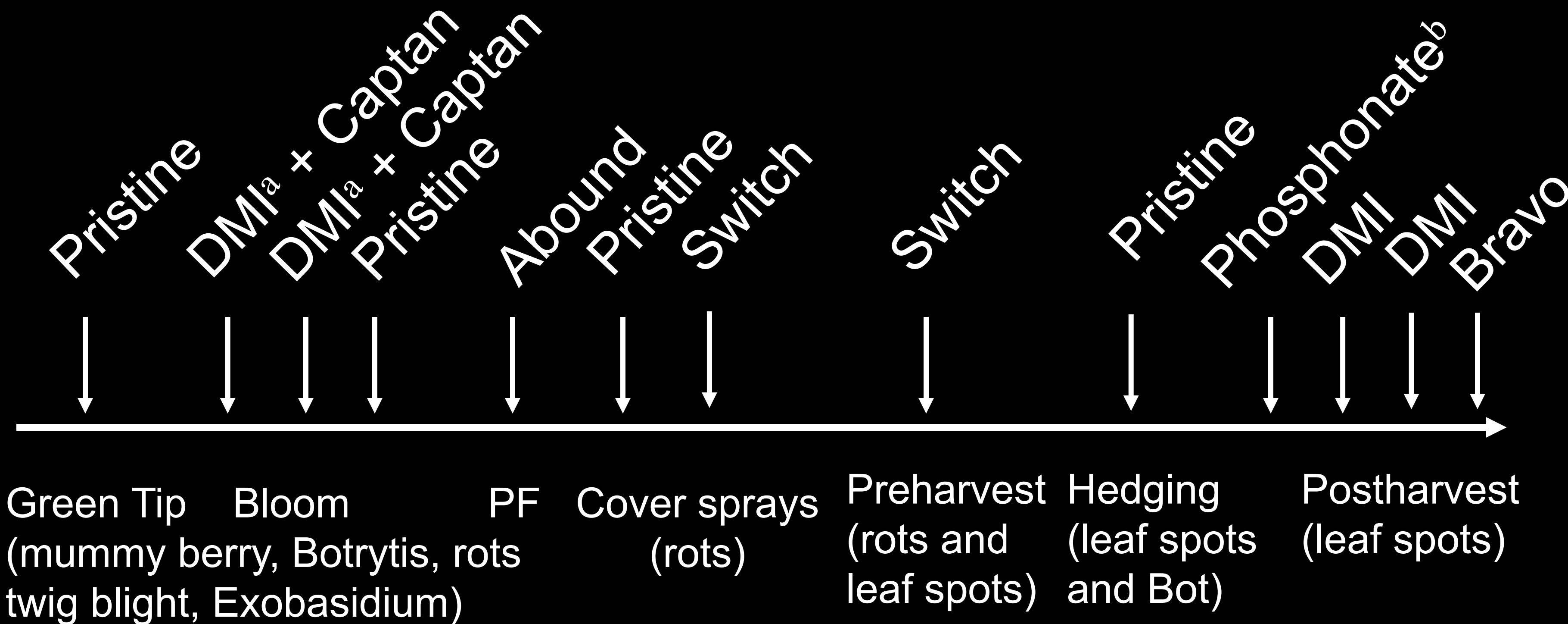


[a]DMIs include Indar, Orbit/Tilt/generics and Quash. Elevate can be added for additional Botrytis management.

[b]Phosponates include materials such as ProPhyt, K-phite, etc.


Botryosphaeria

Blueberry Disease Management Strategy

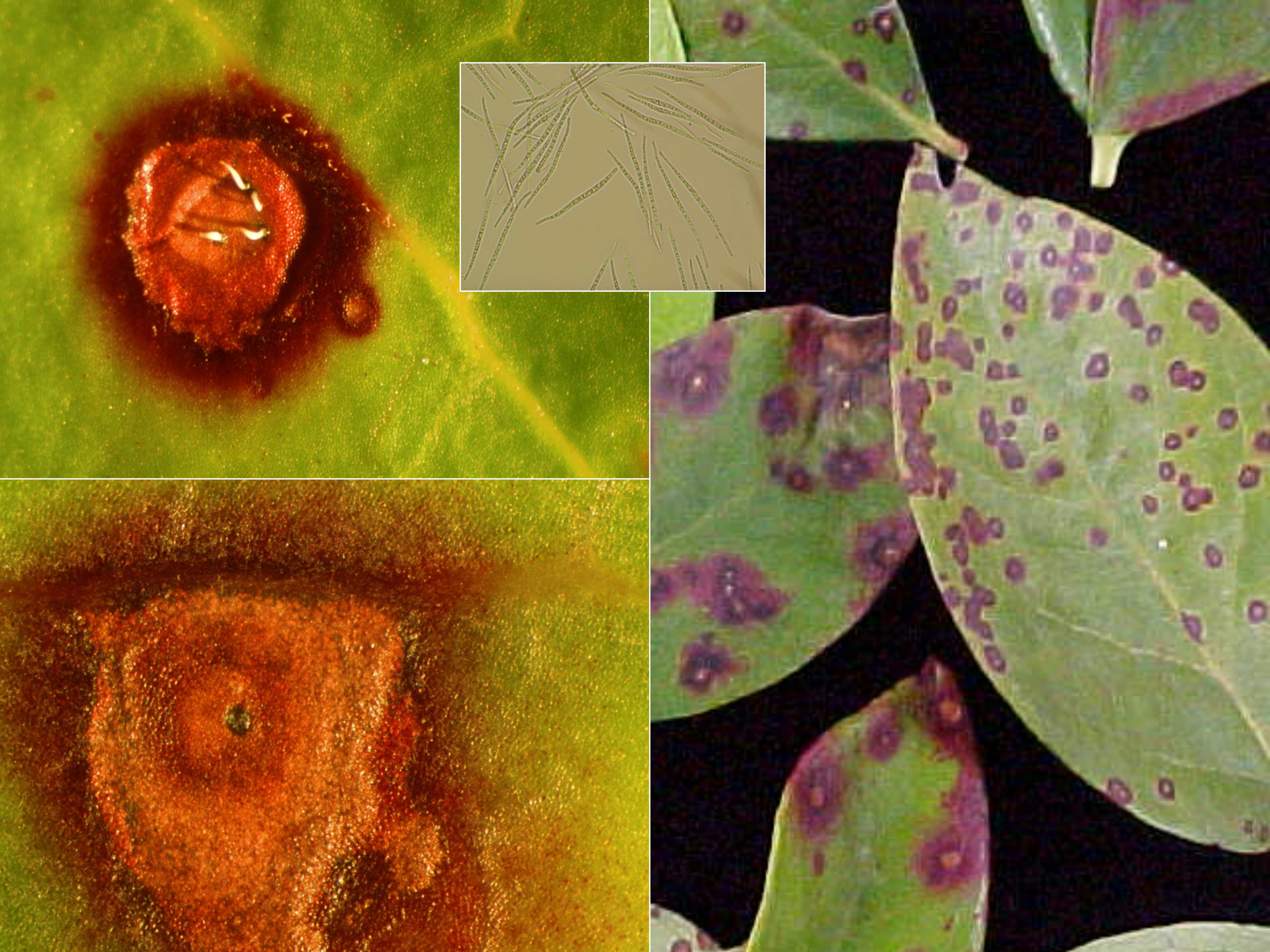


[a]DMIs include Indar, Orbit/Tilt/generics and Quash. Elevate can be added for additional Botrytis management.
[b]Phosponates include materials such as ProPhyt, K-phite, etc.

Primary Blueberry Leaf Spots

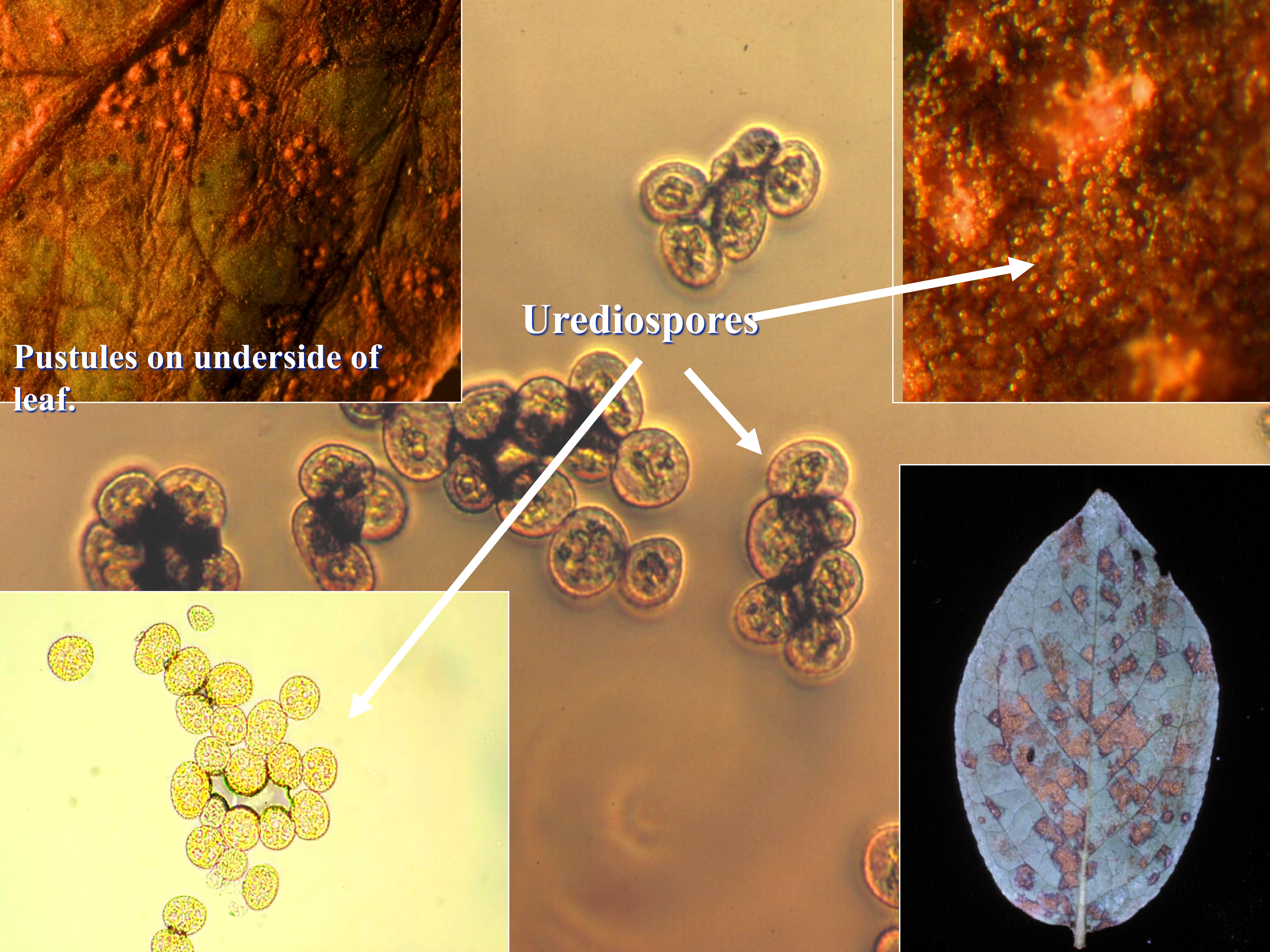
- Septoria Leaf Spot (*Septoria albopunctata*)
- Anthracnose Leaf Spot (*Gloeosporium minus*)
- Leaf rust (*Pucciniastrum vaccinii*)
- Pestalotia (*Pestalotia* sp.)
- Phyllosticta (*Phyllosticta* sp.)
- Powdery Mildew (*Microsphaera vaccinii*)
- Non-pathogenic or Physiological Leaf Spots


Septoria leaf spot



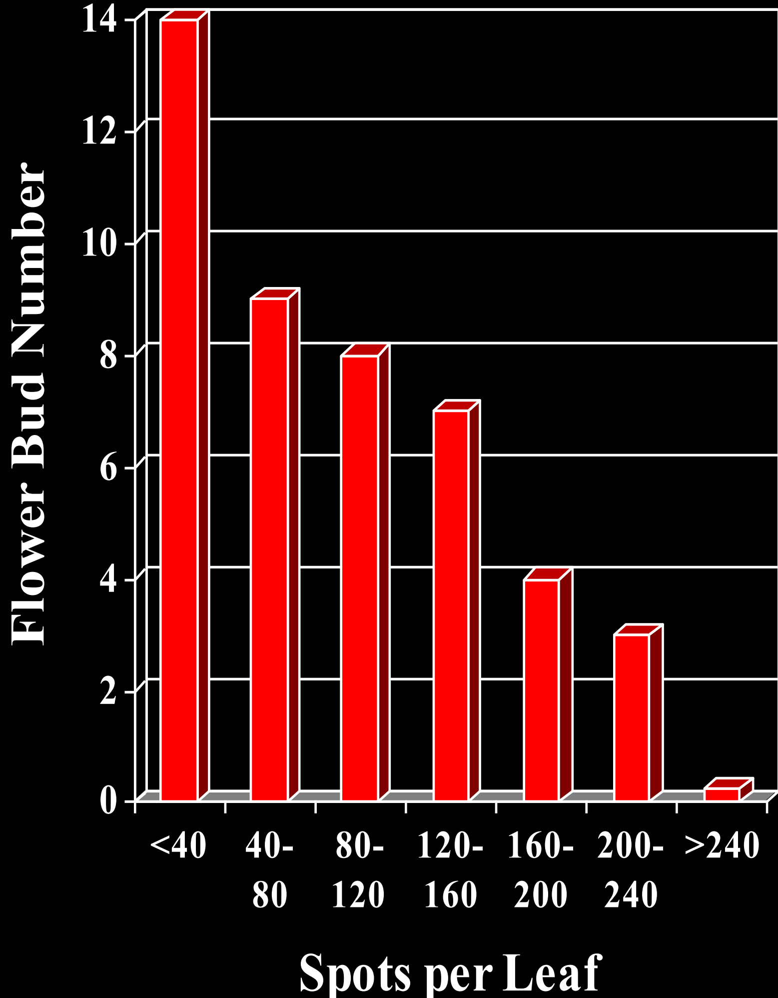

Anthracnose leaf spot


Rust

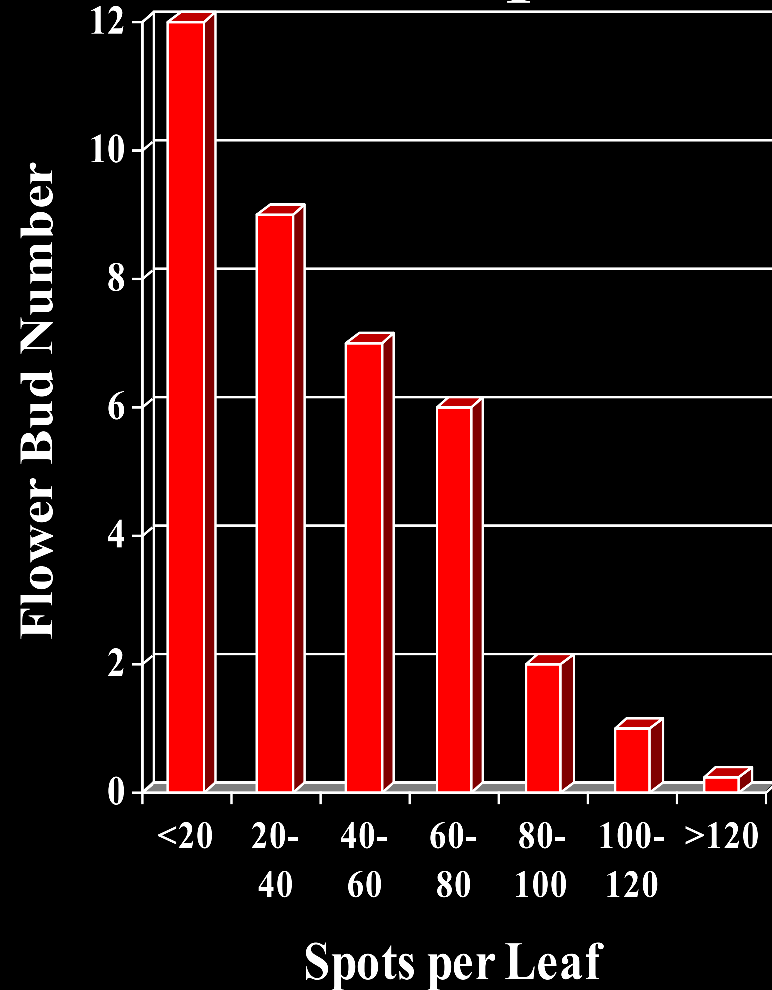

Urediospores
Pustules on underside of leaf.




Premiere Data



Bluecrisp Data



Southern Highbush Blueberry Defoliation Trial Results

	1998 Yield (Fruit Fresh Wt. [g/cm shoot])		1999 Yield (Fruit Fresh Wt. [g/cm shoot])	
Defoliation Date	'Misty'	'Sharpblue'	'Misty'	'Sharpblue'
September	0.26 b	0.18 b	0.22 d	0.11 c
October	0.23 b	0.24 b	0.87 c	0.59 b
November	0.75 b	0.67 a	1.70 b	0.81 ab
December	1.45 a	0.95 a	1.89 b	1.09 a
Control (no mechanical defoliation)	1.50 a	0.67 a	2.60 a	0.82 ab

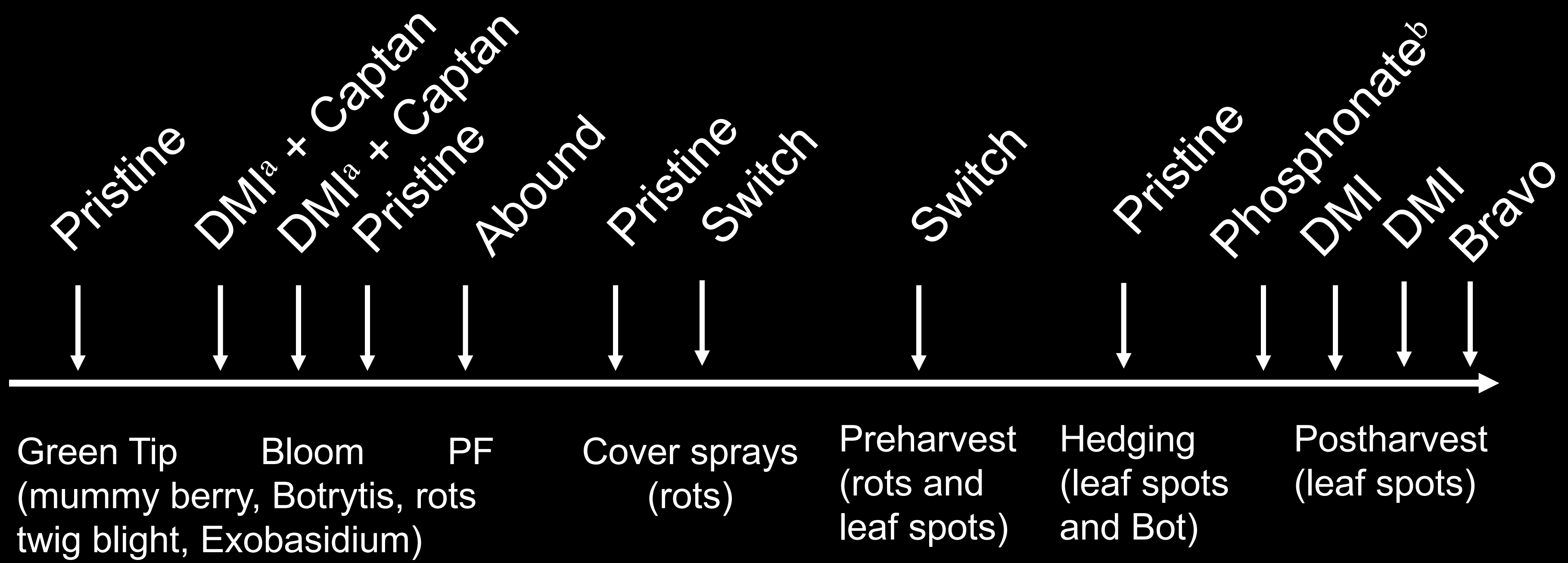
P=0.05 Williamson and Miller; University of Florida


Phytotoxicity

Principles of Resistance Management

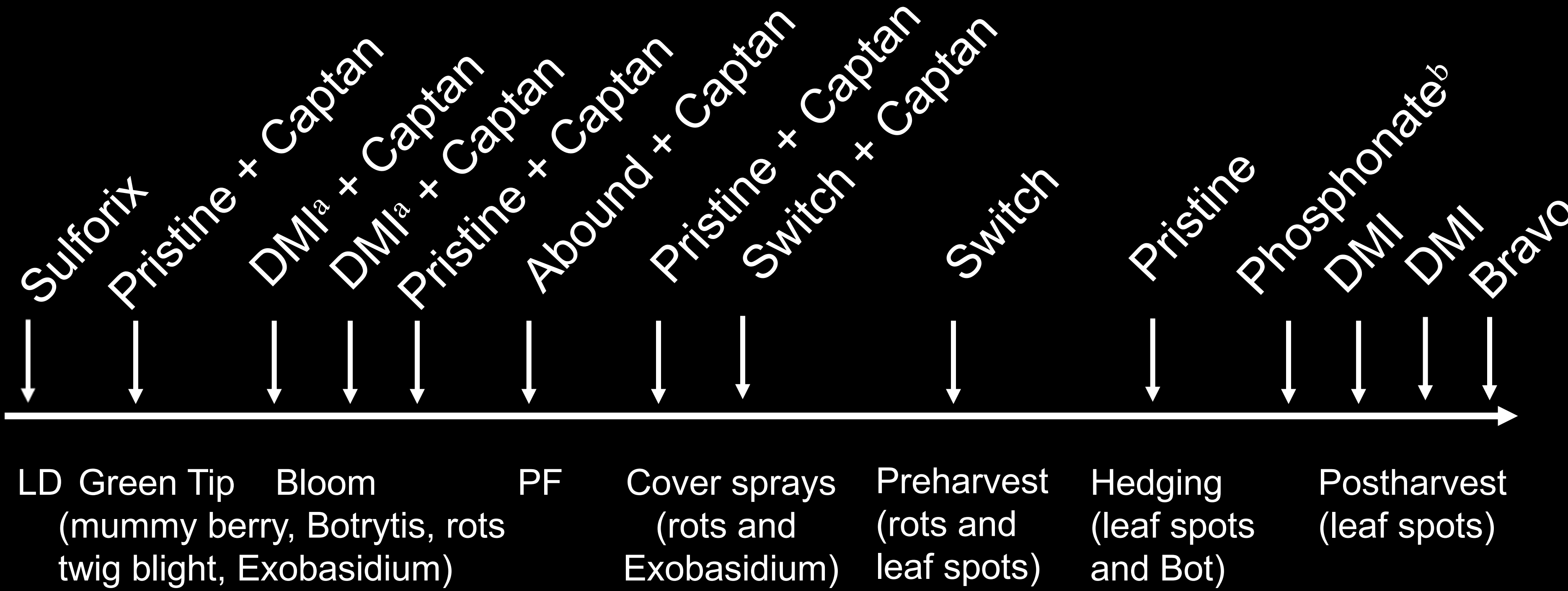
- Alternating sprays with fungicides from different classes (different modes of action) is an important means of resistance management.
- Tank-mixing of different fungicides is also an acceptable method of resistance management, and both methods are employed.
- Many fungicides are limited to a set number of applications per year in order to improve their long-term survival. Follow the label recommendations.

Blueberry Disease Management Strategy



[a]DMIs include Indar, Orbit/Tilt/generics, Quash, and Proline. Elevate can be added for additional Botrytis management, if resistance is not an issue.
[b]Phosponates include materials such as ProPhyt, K-phite, etc.

Blueberry Disease Management Strategy with Exobasidium



[a]DMIs include Indar, Orbit/Tilt/generics, Quash, and Proline. Elevate can be added for additional Botrytis management, if resistance is not an issue.
[b]Phosponates include materials such as ProPhyt, K-phite, etc.


0.01 mm

Blueberry Disease Management Strategy with Exobasidium and Fungicide-Resistant Anthracnose

Sulforix

Pristine + Captan

DMI[a] + Captan

DMI[a] + Captan

Pristine + Captan

Switch + Captan

Switch + Captan

Pristine + Captan

Abound + Captan

Pristine

Phosphonate[b]

DMI

DMI

Bravo

LD Green Tip Bloom PF Cover sprays Preharvest Hedging Postharvest

(mummy berry, Botrytis, rots twig blight, Exobasidium)

Cover sprays (rots and Exobasidium)

Preharvest (rots and leaf spots)

Hedging (leaf spots and Bot)

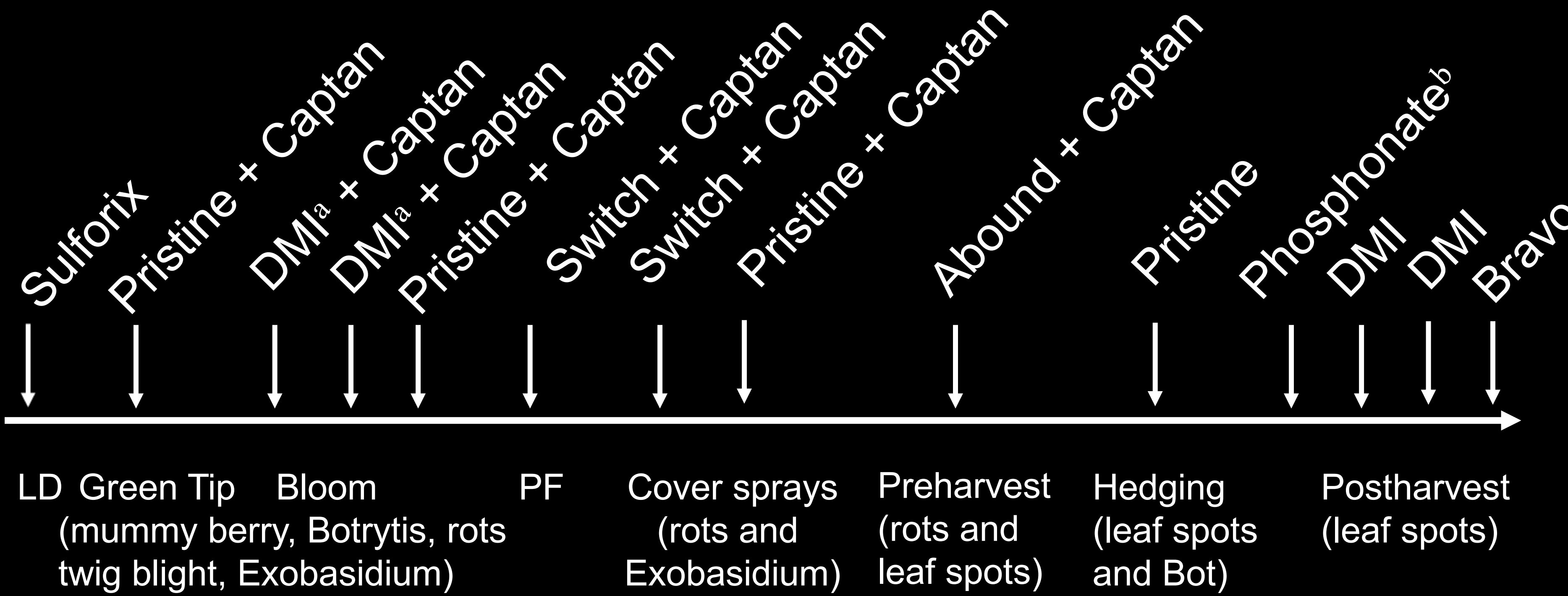
Postharvest (leaf spots)

[a]DMIs include Indar, Orbit/Tilt/generics, Quash, and Proline. Elevate can be added for additional Botrytis management, if resistance is not an issue.

[b]Phosponates include materials such as ProPhyt, K-phite, etc.

Residues are a concern.

Blueberry Disease Management Strategy with Exobasidium and Fungicide-Resistant Anthracnose



[a]DMIs include Indar, Orbit/Tilt/generics, Quash, and Proline. Elevate can be added for additional Botrytis management, if resistance is not an issue.
[b]Phosponates include materials such as ProPhyt, K-phite, etc.