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 florican 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.
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:** ‘Caroline’ and ‘Heritage’, are mowed to prune (job’s done!); floricanes 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 floricanes) 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-yr-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 …
  Fruit feeders

Berry Pest Management
• Cranberry Fruitworm, Acrobasis vaccinii Riley

Berry Pest Management
• Cherry Fruitworm, Grapholita packardii Zeller

Berry Pest Management
Blueberry Maggot, Rhagoletis mendax Curran
NCSU, USDA
Grape Berry Moth, *Paralobesia viteana*

- Formerly *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%)

Rufus Isaacs, MSU

GBM injury

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

Berry Pest Management

- The Traditional Players …
- Fruit feeders
- Foliar feeders

Pests Causing Direct Injury to Caneberries


Pests Causing Indirect Injury to Grape


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)

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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)
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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

- Male
- Female
- Overwinters as Adults
- Pupa: 3-15 days
- 3-13 days as larva
- 12-72 hours

Optimal Temp: 68-80 F

Infesting Both Red and White Varieties

SWD Oviposition in Grape

Viognier
**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

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**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 drosophilids 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 *Pachyceropoideus vindemiae* (Pteromalidae) reared in lower numbers

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*: with 1.2 g/liter sucrose reduced the larval infestation of blueberries by 95–100%, relative to the untreated control; without sucrose infestation was reduced by 46–91%.

Cowles et al. (2015)
### SWD Chemical Control

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>IRAC</th>
<th>Rate/A</th>
<th>Grape PHI</th>
<th>Seasonal Max</th>
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<tr>
<td>Sevin</td>
<td>1a</td>
<td>1-2 qt</td>
<td>7d</td>
<td>5 applics</td>
</tr>
<tr>
<td>Malathion</td>
<td>1b</td>
<td>1.88 pt</td>
<td>3d</td>
<td>2 applics</td>
</tr>
<tr>
<td>Imidan</td>
<td>1b</td>
<td>1.3-2 lb</td>
<td>7-14d</td>
<td>6.5 lb</td>
</tr>
<tr>
<td>Brigade</td>
<td>3</td>
<td>8-16 oz</td>
<td>20d</td>
<td>16 oz</td>
</tr>
<tr>
<td>Danitol</td>
<td>3</td>
<td>10.6-21 fl oz</td>
<td>21d</td>
<td>2 applics</td>
</tr>
<tr>
<td>Mustang Max</td>
<td>3</td>
<td>2-4 fl oz</td>
<td>1d</td>
<td>24 fl oz</td>
</tr>
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<td>Tombstone</td>
<td>3</td>
<td>2-3.2 fl oz</td>
<td>3d</td>
<td>12 fl oz</td>
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<tr>
<td>Pyranic</td>
<td>3</td>
<td>4.5-16.8 fl oz</td>
<td>3d</td>
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<tr>
<td>Delegate</td>
<td>5</td>
<td>3.5 oz</td>
<td>7d</td>
<td>5 applics</td>
</tr>
<tr>
<td>Entrust</td>
<td>5</td>
<td>1.25-2.5 oz</td>
<td>7d</td>
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<td>Grandevo</td>
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<td>0d</td>
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<tr>
<td>Surround</td>
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<td>25-50 lb</td>
<td>0d</td>
<td>n/a</td>
</tr>
</tbody>
</table>

### 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

[Image of a spotted lanternfly]

### SLF Penn Counties - 2014

[Map of Pennsylvania counties with spotted lanternfly distribution]

### SLF Penn Counties - 2017

[Map of Pennsylvania counties with spotted lanternfly distribution]

### U.S. SLF invasion - 2017

- Also in 2017 – movement into two new states!
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

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

<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>Common name</th>
<th>Stage (if reported)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aesculaceae</td>
<td><em>Acer palmatum</em></td>
<td>Japanese maple</td>
<td>Eggs</td>
</tr>
<tr>
<td></td>
<td><em>Acer rubrum</em></td>
<td>Red maple</td>
<td>Eggs</td>
</tr>
<tr>
<td></td>
<td><em>Acer saccharum</em></td>
<td>Sugar maple</td>
<td>Eggs</td>
</tr>
<tr>
<td>Ailanthus clavata</td>
<td><em>Ailanthus chinensis</em></td>
<td>Chinese sumac</td>
<td>Nymph</td>
</tr>
<tr>
<td>Maackiaceae</td>
<td><em>Maackia amurensis</em></td>
<td>Amur maackia</td>
<td>Nymph</td>
</tr>
<tr>
<td>Rubiaceae</td>
<td><em>Rhus chinensis</em></td>
<td>Chinese sumac</td>
<td>Nymph</td>
</tr>
<tr>
<td><em>Toxicodendron vernicifluum</em></td>
<td><em>Japanese lacquer</em></td>
<td>Nymph</td>
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<td>Japanese angelica</td>
<td>Nymph</td>
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<tr>
<td></td>
<td><em>Aralia cordata</em></td>
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<td>Asclepiadaceae</td>
<td><em>Metaplexis japonica</em></td>
<td>Rough potato</td>
<td>Nymph</td>
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<td>Betulaceae</td>
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<td>Grey alder</td>
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<td><em>Betula platyphylla</em></td>
<td><em>Chinese white birch</em></td>
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<td>Caprifoliaceae</td>
<td><em>Amur kawakusa</em></td>
<td>Greater burdock</td>
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<td>Fabaceae</td>
<td><em>Robinia pseudoacacia</em></td>
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<tr>
<td>Fagaceae</td>
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<td><em>Liriodendron tulipifera</em></td>
<td><em>Tuliptree</em></td>
<td>Eggs</td>
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</table>

### SLF Host Range

<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>Common Name</th>
<th>Stage (if reported)</th>
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<tbody>
<tr>
<td><strong>Meliaceae</strong></td>
<td>Cedrela fissilis</td>
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<td><strong>Oleaceae</strong></td>
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<td></td>
<td>Vitis amurensis</td>
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<td>Vitis vinifera</td>
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</tr>
<tr>
<td></td>
<td>Vitis spp.</td>
<td>Wild grape</td>
<td>Nymph</td>
</tr>
</tbody>
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**Spotted lanternfly, Lycorma delicatula**

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

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**Spotted lanternfly, Lycorma delicatula**

- **Winter eggs from January 2018**

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**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.

- 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


---

**Prospects for Biological Control**
Biocontrol for SLF?

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


---

**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


---

**Anastatus orientalis**

- Evidence for parasitization
- Parasitoid emergence
- SLF emergence


---

**Anastatus orientalis**

- Evidence for parasitization
- Parasitoid emergence
- SLF emergence


---

**Anastatus orientalis**

- Evidence for parasitization
- Parasitoid emergence
- SLF emergence


---

**Biocontrol for SLF?**

- **Anastatus ovipositional behavior**
- Host feeding increases mortality

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


Biocontrol for SLF?

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


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

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


### 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."


- **Spotted Lanternfly control:**
  
  - Brown sticky traps may be useful for nymphs and adults


- **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)
- Web site for reporting finds or suspected finds of SLF!

Sampling?

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

Reporting

- If found in Virginia, please notify:
  - Doug Pfeiffer, Dept. of Entomology
dgpfieff@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

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

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)

**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
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)

Disease Incidence (%) Disease Severity (%)
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.
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.

No cluster downy mildew development

The lack of treatment difference was probably due to low level of disease development.
Grape disease management tips
Disease Triangle Matters!

- Variety selection
- Canopy management
- Site selection
- Host (grape)
- Environment (esp. Rain & Temp)
- Pathogen
- Fungicide application
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 = mode of action (MOA) = how the pesticide kills or inactivates the target pathogen, which is listed as FRAC code
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 requires darkness and high humidity for spore production.

It only takes 90 min for infection under optimal conditions.

Dispersal of spores to flowers (and young berries)

Dispersal of spores to new leaves

Symptom development = production of spores

Rain

2° cycle

Late season DM

Winter survival
- With infected leaf tissues
- Formation of Oospores

Rain
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.
Winter survival
- In infected clusters

Dispersal of spores to and young berries

Dispersal of spores to new leaves

Symptom development = production of spores

Rain

2nd cycle

Rain
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
Winter survival
- On bark, leaf, berries

Dispersal of spores to new leaves

Dispersal of spores to and young berries

Symptom development = production of spores

2° cycle
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. However, rachis tissue does not become resistant. 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), **DMI** (Sterol-inhibitor, Rally, Mettle, etc, 3), **Quintec** (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
Winter survival
- With infected berry tissues

Dispersal of spores to new leaves (Spore production?)

Dispersal of spores to flowers

Dispersal of spores to young berries

Latent infection (Asymptomatic)

Dispersal of spores to mature berries

Development of berry symptoms = production of spores

To break latency, wounding event is required

Rain
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

Winter survival
- With infected berry tissues
- In woody tissues

Dispersal of spores (in Spring?)
to new leaves (Asymptomatic infection)

Dispersal of spores to flowers

Dispersal of spores to young berries

Latent infection (Asymptomatic)

Development of berry symptoms = production of spores

Dispersal of spores to mature berries

2° cycle
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.

<table>
<thead>
<tr>
<th>Moderate level of reduction</th>
<th>Low level of reduction</th>
<th>No or limited effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Aprovia <em>(Benzovindiflupyr, FRAC= 7)</em></td>
<td>• Elevate *(fenhexamid (7)) alt. w/ Rovral (iprodione (2))</td>
<td>• Endura *(Boscalid (7))</td>
</tr>
<tr>
<td>• Cueva *(Copper (M1))</td>
<td>• PhD *(polyoxin-D (19))</td>
<td>• Oso *(polyoxin-D (19))</td>
</tr>
<tr>
<td>• Intuity *(mandestrobin, (11))</td>
<td>• Switch *(cyprodinil (9) + fludioxonil (12))</td>
<td>• Rally *(myclobutanil (3))</td>
</tr>
<tr>
<td>• Luna Experience *(Fluopyram (7) + tebuconazole (3))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Viathon *(Phos acid (33) + tebuconazole (3))</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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
Southeastern Regional IPM guide

- 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

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Mizuho Nita (Virginia Tech)

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Pathology; Mizuho Nita (Virginia Tech)
Entomology; Hannah Barrack (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
Basics of Blackberry Disease Management

Phillip M. Brannen
Plant Pathology Department
University of Georgia
2015 Southeast Regional Caneberries Integrated Management Guide

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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 Pseudocercospora
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

<table>
<thead>
<tr>
<th>Developmental Stage</th>
<th>Delayed Dormant</th>
<th>Shoots 6” long till Pre-Bloom</th>
<th>Early bloom (5-10%)</th>
<th>Full Bloom*</th>
<th>Petal Fall</th>
<th>Cover Sprays</th>
<th>Pre-Harvest</th>
<th>Harvest</th>
<th>After Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthracnose, Spur Blight, Cane Blight (Lime Sulfur or Copper)</td>
<td>Anthracnose, Cane Blight, Spur Blight, and Leaf Spots (Copper, Cabrio, Abound, Pristine, and Captan)</td>
<td>Botrytis (Rovral, Nevada, Iprodione, Elevate, Switch, Pristine)</td>
<td>Rosette (Switch, Abound, Pristine)</td>
<td>Powdery Mildew (Rally, Cabrio, Abound, Pristine)</td>
<td>Rusts (Rally, Abound, Cabrio, Pristine, Orbit, Tilt)</td>
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<td>Phytophthora Root Rot (Ridomil, phosphorous acid-based products)</td>
</tr>
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<td>Cane Blight (see notes)</td>
</tr>
</tbody>
</table>

* 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

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

Buckley and Waters; 2002
## Resistant Cultivars

<table>
<thead>
<tr>
<th>Cultivar and breeding selection</th>
<th>Rosette incidence (%)</th>
<th>Rosette severity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shawnee</td>
<td>100</td>
<td>52</td>
</tr>
<tr>
<td>Kiowa</td>
<td>100</td>
<td>19</td>
</tr>
<tr>
<td>Chickasaw</td>
<td>99</td>
<td>24</td>
</tr>
<tr>
<td>Apache</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Navaho</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Buckley and Waters; 2002
<table>
<thead>
<tr>
<th>Highly Susceptible</th>
<th>Susceptible</th>
<th>High Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chickasaw (thorned)</td>
<td>Kiowa (thorned)</td>
<td>Navaho (thornless)</td>
</tr>
<tr>
<td>Shawnee (thorned)</td>
<td>Arapaho ??? (thornless)</td>
<td>Apache (thornless)</td>
</tr>
<tr>
<td>Black Satin</td>
<td>Rosborough (thorned)</td>
<td>Humble</td>
</tr>
<tr>
<td>Choctaw (thorned)</td>
<td>Hull (thornless)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chester (thornless)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Loch Ness</td>
<td></td>
</tr>
</tbody>
</table>
Orange Rust
(*Arthuriomyces peckianus* and *Gymnocoenia 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.
Temperatures above 77ºF greatly reduce aeciospore germination. Above 86ºF, infection does not occur. Infections in southeastern summers should be minimal.

Low temperatures and high humidity favor infections.

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

<table>
<thead>
<tr>
<th>Variety</th>
<th>Resistance comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apache</td>
<td>No orange rust observed</td>
</tr>
<tr>
<td>Arapaho</td>
<td>No orange rust observed</td>
</tr>
<tr>
<td>Chickasaw</td>
<td>No orange rust observed</td>
</tr>
<tr>
<td>Choctaw</td>
<td>Orange rust resistant</td>
</tr>
<tr>
<td>Kiowa</td>
<td>No orange rust observed</td>
</tr>
<tr>
<td>Natchez</td>
<td>No orange rust observed</td>
</tr>
<tr>
<td>Navaho</td>
<td>Susceptible</td>
</tr>
<tr>
<td>Osage</td>
<td>No orange rust observed</td>
</tr>
<tr>
<td>Ouachita</td>
<td>No orange rust observed</td>
</tr>
<tr>
<td>Shawnee</td>
<td>Orange rust resistant</td>
</tr>
</tbody>
</table>
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.
<table>
<thead>
<tr>
<th>Trade Name</th>
<th>Active Ingredient</th>
<th>Chemical Class</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Orbit, etc.</td>
<td>Propiconazole</td>
<td>DMI</td>
<td>Syngenta/Various</td>
</tr>
<tr>
<td>2. Abound</td>
<td>Azoxystrobin</td>
<td>Strobilurin</td>
<td>Syngenta</td>
</tr>
<tr>
<td>3. Rally, etc.</td>
<td>Myclobutanil</td>
<td>DMI</td>
<td>Dow/Various</td>
</tr>
<tr>
<td>4. Pristine</td>
<td>Pyraclostrobin + Boscalid</td>
<td>Strobilurin + SDHI</td>
<td>BASF</td>
</tr>
<tr>
<td>5. Quilt Xcel</td>
<td>Azoxystrobin + Propiconazole</td>
<td>Strobilurin + DMI</td>
<td>Syngenta</td>
</tr>
<tr>
<td>6. Cabrio (suppression)</td>
<td>Pyraclostrobin</td>
<td>Strobilurin</td>
<td>BASF</td>
</tr>
</tbody>
</table>
Leaf and Cane Rust \textit{(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

<table>
<thead>
<tr>
<th>Treatments</th>
<th>% Botrytis Fruit Rot (6 DAH)</th>
<th>% Botrytis Fruit Rot (9 DAH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UTC</td>
<td>64.7 a</td>
<td>100.0 a</td>
</tr>
<tr>
<td>Switch</td>
<td>0 b</td>
<td>60.7 d</td>
</tr>
<tr>
<td>Pristine</td>
<td>0 b</td>
<td>69.8 c</td>
</tr>
<tr>
<td>Elevate</td>
<td>0 b</td>
<td>79.7 bc</td>
</tr>
<tr>
<td>Rovral</td>
<td>0 b</td>
<td>81.5 bc</td>
</tr>
<tr>
<td>CaptEvate</td>
<td>0 b</td>
<td>89.5 ab</td>
</tr>
</tbody>
</table>

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)

Echols County

Switch
Topsin M
Rally
Pristine
Untreated

Justin Shealey
Incidence of Cane Blight (2014)

Echols County

- Quadris Top
- Proline
- Quilt Xcel
- Inspire XT
- Prophyt + Captan
- Captan
- Switch
- Topsin M
- Rally
- Pristine
- Untreated

Justin Shealey
Incidence of Cane Blight (2014)

Lanier County

- Quadris Top
- Proline
- Quilt Xcel
- Inspire XT
- Prophyt + Captan
- Captan
- Switch
- Topsin M
- Rally
- Pristine
- Untreated

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

*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.
Septoria Leaf and Cane Spot

J.W. Pscheidt, OSU
<table>
<thead>
<tr>
<th>Treatment, product rate/A</th>
<th>Time of Application</th>
<th>Incidence (^y) (%)</th>
<th>Severity (^x)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanos, 10 oz</td>
<td>A, B, C</td>
<td>65.0 c(^w)</td>
<td>5.0 bc(^w)</td>
</tr>
<tr>
<td>Tanos, 10 oz + Kocide 3000, 12 oz</td>
<td>A, B, C</td>
<td>60.0 c</td>
<td>3.25 ab</td>
</tr>
<tr>
<td>Abound, 10.8 fl oz</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kocide 3000, 12 oz</td>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pristine, 20.75 oz</td>
<td>C</td>
<td>21.25 ab</td>
<td>1.5 a</td>
</tr>
<tr>
<td>Tanos, 10 oz</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kocide 3000, 12 oz</td>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pristine, 20.75 oz</td>
<td>C</td>
<td>8.75 a</td>
<td>1.5 a</td>
</tr>
<tr>
<td>Aim 40EW, 6.4 fl oz</td>
<td>A, B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pristine, 20.75 oz</td>
<td>C</td>
<td>35.0 b</td>
<td>2.0 a</td>
</tr>
<tr>
<td>Untreated check</td>
<td>Not applicable</td>
<td>92.5 d</td>
<td>5.75 c</td>
</tr>
</tbody>
</table>

\(^z\) 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 \((P \leq 0.05)\)
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 Spray 1**
Pristine @ 23 oz
ProPhyt @ 4 pt

**Cover Spray 2**
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.

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

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

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.

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
- 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
<table>
<thead>
<tr>
<th>Time of Application</th>
<th>Material</th>
<th>Rate Per Acre</th>
<th>Pest Controlled</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>When green tips on vegetative buds first show</td>
<td>Benlate 50WP</td>
<td>1 lb.</td>
<td>Twig Blight</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Funginex 1.6EC</td>
<td>24 ozs.</td>
<td>Mummy Berry</td>
<td></td>
</tr>
<tr>
<td>Pre-bloom (apply every 7-10 days)</td>
<td>Benlate 50WP</td>
<td>1 lb.</td>
<td>Twig Blight</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Funginex 1.6EC</td>
<td>24 ozs.</td>
<td>Mummy Berry</td>
<td></td>
</tr>
<tr>
<td>10 to 20 percent Bloom</td>
<td>Benlate 50WP</td>
<td>1 lb.</td>
<td>Flower Blight</td>
<td>If mummy berry disease becomes established in your field, Funginex is essential in the pre-bloom sprays.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mummy Berry</td>
<td></td>
</tr>
<tr>
<td>Full Bloom</td>
<td>Benlate 50WP</td>
<td>1 lb.</td>
<td>Flower Blight</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mummy Berry</td>
<td></td>
</tr>
<tr>
<td>Immediately after bloom</td>
<td>Difolatan 4F</td>
<td>2 qts.</td>
<td>Anthracnose</td>
<td>This spray and the following spray is very important for insect control.</td>
</tr>
<tr>
<td>or Parathion 15WP</td>
<td>or Sevin 50WP</td>
<td>3 lbs.</td>
<td></td>
<td>Do not use Parathion within 14 days of harvest; Guthion within 3 days; Malathion within 1 day of harvest.</td>
</tr>
<tr>
<td>or Guthion 50WP</td>
<td>or Malathion 25WP</td>
<td>1 lb.</td>
<td>Plum Curculio Fruit Worms Leaf Rollers</td>
<td></td>
</tr>
<tr>
<td>10 to 14 days after above spray</td>
<td>Difolatan 4F plus Benlate 50WP plus One of the Insecticides above</td>
<td>2 qts. 1 lb.</td>
<td>Anthracnose Leaf Spots Plum Curculio Fruit Worms</td>
<td>Do not use Berlate or Difolatan within 21 days of harvest. Note: Additional sprays may be required for late-season generation of the cranberry fruitworm.</td>
</tr>
</tbody>
</table>

*Guthion and Parathion are highly toxic materials for use only by trained applicators.*
2013 Southeast Regional Blueberry Integrated Management Guide

Commodity Editor
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Contributions were also made by Matt Jackson (University of Georgia), John Meyer (University of North Carolina), and Phil Harms (University of Georgia). Phil

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 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

2. ISSUES AND DISEASES ASSOCIATED WITH SITE OR CULTURE

3. PERENNIAL DISEASES

4. ANNUAL DISEASES
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

Sexual stage: *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
Red ringspot virus is transmitted through propagation.
Botryosphaeria diseases are also readily transmitted through propagation.
1. TRANSPLANT DISEASES

2. ISSUES AND DISEASES ASSOCIATED WITH SITE OR CULTURE

3. PERENNIAL DISEASES

4. ANNUAL DISEASES
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
Cold damage
Botryosphaeria can result from cold injury.
Brown wedge or pie-shaped lesions are generally indicative of Botryosphaeria diseases.
Phytophthora Root Rot
(*Phytophthora cinnamomii*)

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

CABI Compendia
Oogonium of *Pythium irregulare* with irregular wall projection 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.
Georgia's Blueberry Industry

Located throughout the state, but highly concentrated in south Georgia. Fresh and frozen market. Rabbiteye and Southern Highbush varieties.

Estimated production value of $102 million on 16,346 acres (2009 Georgia Farm Gate Value Report).
Table 1. Survey of frequency and abundance of plant-parasitic nematodes on blueberry in southeast Georgia on two dates.

<table>
<thead>
<tr>
<th>Nematode genera</th>
<th>Percent frequency</th>
<th>April–May 2010</th>
<th>October–November 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Abundance</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>Mesocriconema</td>
<td>55</td>
<td>251</td>
<td>590</td>
</tr>
<tr>
<td>Hoplolaimus</td>
<td>11</td>
<td>77</td>
<td>183</td>
</tr>
<tr>
<td>Tylenchorhynchus</td>
<td>10</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>Hemicycliophora</td>
<td>7</td>
<td>40</td>
<td>42</td>
</tr>
<tr>
<td>Paratrichodorus</td>
<td>7</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>Helicotylenchus</td>
<td>5</td>
<td>24</td>
<td>17</td>
</tr>
<tr>
<td>Belonolaimus</td>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Dolichodorus</td>
<td>2</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>Xiphinema</td>
<td>2</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>Tylenchus</td>
<td>1</td>
<td>115</td>
<td>116</td>
</tr>
</tbody>
</table>

* 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.

* Sum of nematode densities per 100-cm³ soil divided by the total number of samples in which the nematode genus was detected on either survey date.

* Maximum nematode density detected per 100-cm³ soil.
<table>
<thead>
<tr>
<th>County</th>
<th>N</th>
<th>Percent frequency</th>
<th>April–May 2010</th>
<th>November 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Abundance</td>
<td>Abundance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Standard deviation</td>
<td>Standard deviation</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Maximum density</td>
<td>Maximum density</td>
</tr>
<tr>
<td>Appling</td>
<td>32</td>
<td>50</td>
<td>216</td>
<td>229</td>
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<tr>
<td>Atkinson</td>
<td>25</td>
<td>36</td>
<td>102</td>
<td>64</td>
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<tr>
<td>Bacon</td>
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<td>70</td>
<td>782</td>
<td>517</td>
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<tr>
<td>Berrien</td>
<td>29</td>
<td>59</td>
<td>281</td>
<td>321</td>
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<tr>
<td>Brantley</td>
<td>43</td>
<td>53</td>
<td>81</td>
<td>176</td>
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<tr>
<td>Clinch</td>
<td>28</td>
<td>68</td>
<td>446</td>
<td>701</td>
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<tr>
<td>Coffee</td>
<td>27</td>
<td>59</td>
<td>35</td>
<td>89</td>
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<tr>
<td>Jeff Davis</td>
<td>16</td>
<td>38</td>
<td>96</td>
<td>64</td>
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<tr>
<td>Lanier</td>
<td>8</td>
<td>63</td>
<td>14</td>
<td>140</td>
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<tr>
<td>Pierce</td>
<td>28</td>
<td>71</td>
<td>175</td>
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<td>Ware</td>
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<td>3</td>
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<tr>
<td>Wayne</td>
<td>8</td>
<td>100</td>
<td>342</td>
<td>1,212</td>
</tr>
</tbody>
</table>

\(^a\) 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-cm³ 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-cm³ soil.
Ring nematodes per 100 cubic cm soil

Cultivars

Legacy, Rebel, Farthing, Emerald, Star, Vernon, Brightwell, Premier, Ochlocknee, Powderblue

Legend:
- NHB
- SHB
- RBE

Note: Cultivars with the same letter are not significantly different.
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

Yield in ounces/plant

- **Control**: 10
- **MeBr/Chl**: 45

Ring nematodes/100 cc soil

- **Control**: 800
- **MeBr/Chl**: 61% decrease
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

2. ISSUES AND DISEASES ASSOCIATED WITH SITE OR CULTURE

3. PERENNIAL DISEASES

4. ANNUAL DISEASES
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**

Temecula isolate (WT)

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.

\begin{align*}
\text{Homalodisca insolita} & \quad 0.25\% \\
\text{Paraulacizes irrorata} & \quad 0.77\% \\
\text{Oncometopia nigricans} & \quad 0.25\% \\
\text{Graphocephala versuta} & \quad 0.51\% \\
\end{align*}

\text{M. Tertuliano}
Stunt
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.
### 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

<table>
<thead>
<tr>
<th></th>
<th>7/23/12</th>
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<tr>
<td></td>
<td>100</td>
<td>101</td>
<td>102</td>
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</tbody>
</table>

Field aggregation: Enigma, GA 2011
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.
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

Green Tip Bloom PF Cover sprays Preharvest (rots and leaf spots) Hedging (leaf spots and Bot) Postharvest (leaf spots)

Pristine DMI\textsuperscript{a} + Captan DMI\textsuperscript{a} + Captan Abound Pristine Switch

Pristine Switch Pristine Phosphonate\textsuperscript{b} DMI DMI Bravo

\textsuperscript{a}DMIs include Indar, Orbit/Tilt/generics and Quash. Elevate can be added for additional Botrytis management.

\textsuperscript{b}Phosponates include materials such as ProPhyt, K-phite, etc.
**Mummy Berry Disease Cycle**

**SPRING**
- Ascospores dispersed by wind
- Ascospores infect developing leaves

**EARLY SPRING**
- Mummies germinate and develop apothecia in the spring
- Mummies overwinter on the ground

**WINTER**
- Infected fruit turn pink or tan, shrivel and drop prematurely

**LATE SPRING**
- Conidia are dispersed to flowers by insects, wind or rain
- Conidia form on blighted tissue
- Conidia infect flower ovaries through stigma

**SUMMER**
- Bee delivering conidia to stigma

**LATE SPRING**
- Young shoots and occasionally flower clusters become blighted

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.

<table>
<thead>
<tr>
<th>Fungicide</th>
<th>Active Ingredient</th>
<th>Behavior</th>
<th>Shoot strikes</th>
<th>Fruit infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abound</td>
<td>azoxystrobin</td>
<td>systemic</td>
<td>fair*</td>
<td>fair to good</td>
</tr>
<tr>
<td>Bravo</td>
<td>chlorothalonil</td>
<td>protectant</td>
<td>fair</td>
<td>poor</td>
</tr>
<tr>
<td>Cabrio</td>
<td>pyraclostrobin</td>
<td>systemic</td>
<td>poor to fair</td>
<td>fair</td>
</tr>
<tr>
<td>Captan</td>
<td>captan</td>
<td>protectant</td>
<td>poor</td>
<td>poor to fair</td>
</tr>
<tr>
<td>Captevate</td>
<td>fenhexamid + captan</td>
<td>systemic + protectant</td>
<td>fair</td>
<td>poor</td>
</tr>
<tr>
<td>Elevate</td>
<td>fenhexamid</td>
<td>systemic</td>
<td>poor</td>
<td>poor</td>
</tr>
<tr>
<td>Indar</td>
<td>fenbuconazole</td>
<td>systemic</td>
<td>good to excellent</td>
<td>good to excellent</td>
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<tr>
<td>Orbit</td>
<td>propiconazole</td>
<td>systemic</td>
<td>good to excellent</td>
<td>good</td>
</tr>
<tr>
<td>Pristine</td>
<td>pyraclostrobin + bosalid</td>
<td>systemic + systemic</td>
<td>fair to good</td>
<td>good</td>
</tr>
<tr>
<td>Serenade</td>
<td><em>Bacillus subtilis</em></td>
<td>protectant</td>
<td>fair to good**</td>
<td>fair</td>
</tr>
<tr>
<td>Sulforix/lime sulfur</td>
<td>calcium polysulfide</td>
<td>protectant</td>
<td>fair</td>
<td>poor</td>
</tr>
<tr>
<td>Switch</td>
<td>cyprodinil + fludioxonil</td>
<td>systemic + protectant</td>
<td>poor</td>
<td>fair</td>
</tr>
<tr>
<td>Ziram</td>
<td>ziram</td>
<td>protectant</td>
<td>fair</td>
<td>poor to fair</td>
</tr>
</tbody>
</table>

* 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.
<table>
<thead>
<tr>
<th>Treatment and rate/A</th>
<th>Treatment date</th>
<th>Mummy incidence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated control</td>
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<td>74.5 a</td>
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<tr>
<td>Indar 75WSP 2 oz</td>
<td>1-4</td>
<td>19.6 c</td>
</tr>
<tr>
<td>Regalia 4.0 qt</td>
<td>1-4</td>
<td>74.0 a</td>
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<tr>
<td>Quilt Xcel 21 fl oz</td>
<td>1-4</td>
<td>19.2 c</td>
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<tr>
<td>Quash 50WDG 2.5 oz</td>
<td>1-4</td>
<td>25.1 c</td>
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<tr>
<td>Indar 75WSP 2 oz</td>
<td>1,3</td>
<td></td>
</tr>
<tr>
<td>Optiva 16 oz</td>
<td>2,4</td>
<td>47.1 b</td>
</tr>
<tr>
<td>Indar 75WSP 2 oz</td>
<td>1,3</td>
<td>62.4 ab</td>
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<tr>
<td>Abound x</td>
<td>1</td>
<td>65.4 ab</td>
</tr>
</tbody>
</table>

LSD (α = 0.05) 19.5

*Treatment dates: 1 = 29 Mar (green tip); 2 = 9 Apr (10-20% bloom); 3 = 15 Apr (full bloom); 4 = 20 May (late bloom)

Means within columns followed by the same letters are not significantly different according to Fisher’s protected LSD test (P<0.05).

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

<table>
<thead>
<tr>
<th>Application</th>
<th>Date</th>
<th>Growth stage</th>
<th>Application block</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>5 Feb.</td>
<td>Delayed dormant</td>
<td>Delayed dormant</td>
</tr>
<tr>
<td>2</td>
<td>14 Feb.</td>
<td>Early green tip</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>28 Feb.</td>
<td>Green tip, 4% bloom</td>
<td>Early block (pre-bloom and bloom)</td>
</tr>
<tr>
<td>4</td>
<td>14 Mar.</td>
<td>32% bloom</td>
<td></td>
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<tr>
<td>5</td>
<td>21 Mar.</td>
<td>58% bloom</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>28 Mar.</td>
<td>84% bloom</td>
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</tr>
<tr>
<td>7</td>
<td>1 April</td>
<td>Petal fall</td>
<td>Mid-season block (cover sprays)</td>
</tr>
<tr>
<td>8</td>
<td>12 April</td>
<td>First cover</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>19 April</td>
<td>Second cover</td>
<td></td>
</tr>
<tr>
<td>Treatment and rate/A</td>
<td>Application timing</td>
<td>Leaf spot incidence (%)&lt;sup&gt;y&lt;/sup&gt;</td>
<td>Leaf spot severity (spots/leaf)&lt;sup&gt;y&lt;/sup&gt;</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------</td>
<td>---------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>1. Untreated control</td>
<td>----</td>
<td>48.0 a</td>
<td>2.9 a</td>
</tr>
<tr>
<td>2. Lime Sulfur 5 gal</td>
<td>1</td>
<td>5.7 cd</td>
<td>0.1 c</td>
</tr>
<tr>
<td>3. Captan 4L 2.5 qt</td>
<td>2-6</td>
<td>8.3 cd</td>
<td>0.2 c</td>
</tr>
<tr>
<td>4. Indar 2F 6fl oz</td>
<td>2-6</td>
<td>23.1 b</td>
<td>0.5 c</td>
</tr>
<tr>
<td>5. Pristine 22 oz</td>
<td>2-6</td>
<td>24.0 b</td>
<td>0.5 c</td>
</tr>
<tr>
<td>6. Captan 4L 2.5 qt</td>
<td>7-9</td>
<td>6.7 cd</td>
<td>0.1 c</td>
</tr>
<tr>
<td>7. Indar 2F 6fl oz</td>
<td>7-9</td>
<td>15.5 bc</td>
<td>0.3 c</td>
</tr>
<tr>
<td>8. Pristine 22 oz</td>
<td>7-9</td>
<td>39.2 a</td>
<td>1.8 b</td>
</tr>
<tr>
<td>9. Captan 4L 2.5 qt</td>
<td>2-9</td>
<td>1.3 d</td>
<td>0.0 c</td>
</tr>
<tr>
<td>10. Indar 2F 6fl oz</td>
<td>2-9</td>
<td>4.4 cd</td>
<td>0.1 c</td>
</tr>
<tr>
<td>11. Pristine 22 oz</td>
<td>2-9</td>
<td>25.0 b</td>
<td>0.7 c</td>
</tr>
</tbody>
</table>

<sup>x</sup>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).

<sup>y</sup>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).

<sup>x</sup>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).
<table>
<thead>
<tr>
<th>Treatment and Rate/A</th>
<th>Leaf Symptoms</th>
<th>Fruit Symptoms at first pick on 20 Jun</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% leaves with one or more spots</td>
<td>Average no. of spots per leaf</td>
</tr>
<tr>
<td>Untreated check</td>
<td>89.8 a*</td>
<td>7.81 a</td>
</tr>
<tr>
<td>Indar 2F 6 fl oz.</td>
<td>3.8 b</td>
<td>.03 b</td>
</tr>
<tr>
<td>Pristine 23 oz.</td>
<td>5.2 b</td>
<td>.06 b</td>
</tr>
<tr>
<td>Captan 80WDG 3.12 lb</td>
<td>1.8 b</td>
<td>.01 b</td>
</tr>
<tr>
<td>Elevate 50WDG 1.5 lb</td>
<td>4.0 b</td>
<td>.04 b</td>
</tr>
</tbody>
</table>

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

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

Green Tip    Bloom            PF
(mummy berry, Botrytis, rots
twig blight, Exobasidium)

Cover sprays (rots)

Preharvest (rots and leaf spots)

Hedging (leaf spots and Bot)

Postharvest (leaf spots)

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

\[^{b}\text{Phosponates include materials such as ProPhyt, K-phite, etc.}\]
Alternaria tenuissima

Botrytis cinerea

Colletotrichum spp.

Aureobasidium pullulans

Phomopsis vaccinii
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) Rot
 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
“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.
Scherm et al., 2009

![Graph showing the relationship between fruit firmness (g/mm) and fruit rot incidence (%). The graph includes data points for 'Sweetcrisp - Hand', 'Sweetcrisp - Machine', 'Scintilla - Hand', and 'Scintilla - Machine'. The x-axis represents fruit firmness (g/mm) ranging from 120 to 280, and the y-axis represents fruit rot incidence (%) ranging from 0 to 60. The graph is sourced from Scherm et al., 2009.](image-url)
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

Green Tip    Bloom            PF
(mummy berry, Botrytis, rots twig blight, Exobasidium)

Preharvest (rots and leaf spots)
Postharvest (leaf spots)

Pristine

Cover sprays (rots)

Switch

Pristine

Switch

Phosphonate

DMI

DMI

Bravo

DMI

DMI

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

DMIs include Indar, Orbit/Tilt/generics and Quash. Elevate can be added for additional Botrytis management.
Botryosphaeria
**Blueberry Disease Management Strategy**

- **Green Tip** (mummy berry, Botrytis, rots and twig blight, Exobasidium)
- **Bloom**
- **PF**
- **Cover sprays** (rots)
- **Preharvest** (rots and leaf spots)
- **Hedging** (leaf spots and Bot)
- **Postharvest** (leaf spots)

---

- **Pristine**
- **DMI**
- **+ Captan**
- **Switch**

---

- **Phosphonates** include materials such as ProPhyt, K-phite, etc.
- **DMI**
- **+ Captan**
- **DMIs** include Indar, Orbit/Tilt/generics and Quash. Elevate can be added for additional Botrytis management.
- **Bravo**
Primary Blueberry Leaf Spots

- Septoria Leaf Spot (*Septoria albopunctata*)
- Anthracnose Leaf Spot (*Gloeosporium minus*)
- Leaf rust (*Pucciniastrum vaccinii*)
- Pestalotia (*Pestalotia sp.*)
- Phylllosticta (*Phylllosticta sp.*)
- Powdery Mildew (*Microsphaera vaccinii*)
- Non-pathogenic or Physiological Leaf Spots
Septoria leaf spot
Anthracnose leaf spot
Rust
Pustules on underside of leaf.

Urediospores
# Southern Highbush Blueberry Defoliation Trial Results

<table>
<thead>
<tr>
<th>Defoliation Date</th>
<th>1998 Yield (Fruit Fresh Wt. [g/cm shoot])</th>
<th>1999 Yield (Fruit Fresh Wt. [g/cm shoot])</th>
</tr>
</thead>
<tbody>
<tr>
<td>September</td>
<td>0.26 b, 'Misty'</td>
<td>0.18 b, 'Sharpblue'</td>
</tr>
<tr>
<td>October</td>
<td>0.23 b, 'Misty'</td>
<td>0.24 b, 'Sharpblue'</td>
</tr>
<tr>
<td>November</td>
<td>0.75 b, 'Misty'</td>
<td>0.67 a, 'Sharpblue'</td>
</tr>
<tr>
<td>December</td>
<td>1.45 a, 'Misty'</td>
<td>0.95 a, 'Sharpblue'</td>
</tr>
<tr>
<td>Control (no mechanical defoliation)</td>
<td>1.50 a</td>
<td>0.67 a</td>
</tr>
</tbody>
</table>

*P=0.05*  
Williamson and Miller; University of Florida
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

Green Tip (mummy berry, Botrytis, rots, twig blight, Exobasidium)
Bloom
PF
Cover sprays (rots)
Preharvest (rots and leaf spots)
Hedging (leaf spots and Bot)
Postharvest (leaf spots)

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

Phosphonates include materials such as ProPhyt, K-phite, etc.
Blueberry Disease
Management Strategy with Exobasidium

**Preharvest**
- (rots and Exobasidium)
- Cover sprays (rots and Exobasidium)
- Preharvest (rots and leaf spots)
- Hedging (leaf spots and Bot)

**Postharvest**
- (leaf spots)

---

**Sulfurix**
- Pristine + Captan
- DMI + Captan
- DMI + Captan
- Abound + Captan
- Pristine + Captan
- Switch + Captan
- Switch

**Phosphonates**
- Pristine
- Phosphonate
- DMI
- DMI
- Bravo

---

**LD Green Tip**
- Bloom
- PF
- (mummy berry, Botrytis, rots twig blight, Exobasidium)

---

aDMIs include Indar, Orbit/Tilt/generics, Quash, and Proline. Elevate can be added for additional Botrytis management, if resistance is not an issue.
bPhosponates include materials such as ProPhyt, K-phite, etc.
Blueberry Disease Management Strategy with Exobasidium and Fungicide-Resistant Anthracnose

<table>
<thead>
<tr>
<th>Preharvest</th>
<th>Postharvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover sprays (rots and Exobasidium)</td>
<td>Pristine</td>
</tr>
<tr>
<td>Sulfonox</td>
<td>Pristine + Captan</td>
</tr>
<tr>
<td>Pristine + Captan</td>
<td>Pristine</td>
</tr>
<tr>
<td>DMI\textsuperscript{a} + Captan</td>
<td>DMI\textsuperscript{b}</td>
</tr>
<tr>
<td>DMI\textsuperscript{a} + Captan</td>
<td>DMI</td>
</tr>
<tr>
<td>Switch + Captan</td>
<td>Bravo</td>
</tr>
<tr>
<td>Switch + Captan</td>
<td>Bravo</td>
</tr>
<tr>
<td>Pristine + Captan</td>
<td>Bravo</td>
</tr>
<tr>
<td>Abound + Captan</td>
<td>Bravo</td>
</tr>
<tr>
<td>BP Green Tip (mummy berry, Botrytis, rots twig blight, Exobasidium)</td>
<td>Pristine + Captan</td>
</tr>
</tbody>
</table>

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

\textsuperscript{b}Phosphonates include materials such as ProPhyt, K-phite, etc.
Residues are a concern.
Blueberry Disease Management Strategy with Exobasidium and Fungicide-Resistant Anthracnose

**Blueberry Disease Management Strategy with Exobasidium and Fungicide-Resistant Anthracnose**

- **Preharvest** (rots and leaf spots)
  - Cover sprays (rots and Exobasidium)
  - Preharvest (rots and leaf spots)
  - Hedging (leaf spots and Bot)

- **Postharvest** (leaf spots)
  - Pristine + Captan
  - Phosphonate

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

**Phosponates include materials such as ProPhyt, K-phite, etc.**