Caneberry and blueberry disease management

Jonathan E. Oliver
Fruit Pathologist and Extension Specialist
Plant Pathology Department
University of Georgia

March 21st, 2019
Blueberry Diseases Issues
Seasonal Disease Issues

- Exobasidium
  - Mummy Berry
  - Twig Blight
- Leaf Spots
  - Botryosphaeria
- Fruit Rots
  - Botrytis

Seasonal Disease Issues

- Late Dormant
- Green Tip
- Bloom
- Petal Fall
- Cover Sprays
- Preharvest
- Hedging
- After Harvest
Exobasidium Leaf and Fruit Spot

- Disease caused by the fungus *Exobasidium maculosum*
- Causes spots on leaves, fruit, and stems

- Can cause significant losses due to fruit drop in the field and also to making fruit unmarketable
- Overwinters as yeast-like spores on the surface of buds and previous year’s shoot growth
Symptoms

• Typically first appear in early to mid-March following leaf emergence and full bloom
• By end of June almost all disease symptoms have turned necrotic and the disease is no longer active in the field.
Management

• Most effectively controlled by a single lime sulfur or calcium polysulfide spray during the late-dormant period (1-2 weeks before leaf and/or flower buds begin to break)

• Captan & Indar are effective when applied in-season in multiple sprays from bloom through early cover sprays
Mummy Berry

- Disease caused by the fungus *Monilinia vaccinii-corymbosi*
- Symptoms include shoot blight, flower cluster blight, and fruit mummification

- On GA rabbiteye, fruit mummification can cause significant yield losses
- SHB often escape due to earlier bud break and bloom
Mummy Berry Disease Cycle

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

**LATE SPRING**
- Conidia are dispersed to flowers by insects, wind or rain
- Conidia form on blighted tissue

**SUMMER**
- Bee delivering conidia to stigma
- Conidia infect flower ovaries through stigma
- Infected fruit turn pink or tan, shrivel and drop prematurely

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

**WINTER**
- Mummies overwinter on the ground

Childers et al., MSU
Management

- **Cultural controls** include sanitation practices such as burying (>1”) mummies to reduce initial inoculum
  - This alone is not sufficient for control

- **Chemical controls** are very effective.
  - Fungicide applications from green tip through bloom
  - Pristine and DMI fungicides (Indar, Tilt, Bumper, Propimax, Quash, or Proline) are recommended
    - Captan should be tank mixed with DMI fungicides
Fruit rotting pathogens can infect blueberries at diverse stages of berry development – including post-harvest – but eventually lead to a rot of ripe fruit.

Field infections often remain latent until the berry ripens (these can be difficult to detect until it is too late).

The most devastating fruit rot pathogens are those that can be readily transferred to healthy berries in packing lines or within clamshells to induce rot.

“One bad apple blueberry can spoil the whole barrel-clamshell”
Fruit Rot Diseases

- Anthracnose Rot
- Epicoccum Rot
- Yeast Rot
- Rhizopus Rot
- Hainesia Rot
- Aspergillus Rot
- White Mold
- Phomopsis Rot
- Anthracnose Rot
- Alternaria Rot
- Gray Mold

Wharton and Schilder 2003
Fruit Rot Pathogens

- Important fruit rotting pathogens of blueberry include:
  - *Phomopsis vaccinii* - Phomopsis Twig Blight and Fruit Rot
  - *Colletotrichum* spp. - Anthracnose Rot (aka “Ripe Rot”)
  - *Alternaria tenuissima* - Alternaria Leaf Spot & Fruit Rot
  - *Botrytis cinerea* – Botrytis Flower Blight and Fruit Rot (aka “Gray Mold”)

*Phomopsis vaccinii*  *Colletotrichum* spp.  *Alternaria tenuissima*  *Botrytis cinerea*

Phomopsis Rot  Anthracnose Rot  Alternaria Rot  Gray Mold
Phomopsis Twig Blight & Fruit Rot

- Caused by the fungus *Phomopsis vaccinii*
- Commonly found in southeastern US blueberry plantings
- Symptoms include a blight of fruiting twigs (resulting in reduced fruit production), leaf spots, and a ripe fruit rot

- Symptoms can be difficult to distinguish from cold injury and twig blights caused by other pathogens
Disease Cycle and Epidemiology

- Overwinters on infected twigs
- Spores are released during rain events
- Initial symptoms appear at bud break: individual flower buds turn brown & die
- Blossoms are most susceptible, but infection of fruit-bearing twigs & fruit can occur at all developmental stages
Management

- **Cultural Controls** include removal of infected twigs by pruning prior to spore release in the spring. Mowing bushes after harvest also reduces overwintering inoculum.

- **Chemical Controls** include regular fungicide applications from bud break through bloom. Recommended fungicides include Pristine and Indar.
Anthracnose Fruit Rot (Ripe Rot)

- Anthracnose fruit rot is caused by two different fungi: *Colletotrichum gloeosporioides* and *C. acutatum*.
- These pathogens can also cause leaf spots after harvest.
- Ripe rot symptoms include shriveling of the berries on the bush and orange masses of spores on berries.
- Ripe rot is often less severe on Rabbiteye vs. SHB.
Disease Cycle and Epidemiology

• Fruit infections begin during bloom, but remain latent until fruit ripen.
  • Can be major issue postharvest
• Warm, wet weather during bloom and just before harvest favors disease development.

ANTHRACNOSE FRUIT ROT

Overwintering infections produce spores
Berries become infected, rot, and sporulate

Spore masses on infected berry

Wharton and Schilder 2003
Miles and Schilder 2008
Miles and Schilder 2008
Miles and Schilder 2008
Alternaria Leaf Spot & Fruit Rot

• Caused by *Alternaria tenuissima*
• Symptoms develop when fruit ripen: infected fruit become leaky and may be covered in grey-green fungal mycelium
• This fungus can also cause a (minor) leaf spot on blueberry
• Cool, wet conditions favor disease development and infection of berries in the field
Botrytis Flower Blight and Fruit Rot

• Disease caused by the fungus *Botrytis cinerea*
• Symptoms include blights of blossoms, twigs, and young leaves as well as a rot of fruit (aka “Gray Mold”)
  • Blossom blight causes the most losses

• Particularly problematic when wet weather occurs near bloom or when freeze-damaged tissues are present
Management

• For fruit rots, fungicides should be applied during bloom and cover sprays.

• For Anthracnose and Alternaria, recommended fungicides include: Abound, Pristine, Switch, Captan, Omega, Quilt Xcel.
  • Indar alone will actually increase rots like anthracnose (ripe rot), and application of captan (Indar + captan tank mix) is required during bloom to alleviate this problem.

• For serious Botrytis issues, recommended fungicides include: Pristine, Switch, Elevate, and CaptEvate.
  • Botrytis can rapidly develop fungicide resistance. Captan or Ziram are recommended for resistance management.
## Chemical Control of Fruit Rot Diseases

Recommendations below are based on the 2019 SE Regional Blueberry Integrated Management Guide

<table>
<thead>
<tr>
<th>Trade Name</th>
<th>Active Ingredient</th>
<th>FRAC MoA</th>
<th>Phomopsis Twig Blight</th>
<th>Anthracnose Ripe Rot</th>
<th>Alternaria Rot</th>
<th>Botrytis Gray Mold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indar*</td>
<td>fenbuconazole</td>
<td>3</td>
<td>++++</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Omega</td>
<td>fluazinam</td>
<td>29</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>Quilt Xcel</td>
<td>propiconazole</td>
<td>3</td>
<td>++++</td>
<td>++++</td>
<td>++++</td>
<td></td>
</tr>
<tr>
<td></td>
<td>azoxystrobin</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abound</td>
<td>azoxystrobin</td>
<td>11</td>
<td>+++</td>
<td>++++</td>
<td>++++</td>
<td></td>
</tr>
<tr>
<td>Pristine</td>
<td>pyraclostrobin</td>
<td>11</td>
<td>++++</td>
<td>++++</td>
<td>++++</td>
<td></td>
</tr>
<tr>
<td></td>
<td>boscalid</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switch</td>
<td>cyprodinil</td>
<td>9</td>
<td>+++</td>
<td>++++</td>
<td>++++</td>
<td></td>
</tr>
<tr>
<td></td>
<td>fludioxonil</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elevate</td>
<td>fenhexamid</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td>++++</td>
</tr>
<tr>
<td>CaptEvate</td>
<td>captan</td>
<td>M4</td>
<td>+++</td>
<td>+++</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td></td>
<td>fenhexamid</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Captan</td>
<td>captan</td>
<td>M4</td>
<td>++</td>
<td>+++</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>Ziram</td>
<td>ziram</td>
<td>M3</td>
<td>+++</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
</tbody>
</table>

*Indar alone will increase anthracnose fruit rot; a tank mix of Indar+Captan during bloom is recommended.*
Fungicide Resistance

• Several important fruit rot pathogens are known to rapidly develop fungicide resistance.

• Resistance to important fungicides has been documented:
  • In SE US strawberries, Botrytis resistance to fenhexamid (Elevate) and pyraclostrobin+boscalid (Pristine)
  • In FL blueberries, Anthracnose resistance to azoxystrobin (Abound) and pyraclostrobin+boscalid (Pristine)
    • GA isolates tested in 2016 were not resistant

• To prevent resistance from developing, we must be good stewards of the fungicide modes of actions we have by practicing good fungicide resistance management
Leaf Spot Diseases

- Leaf spots reduce photosynthesis, thereby resulting in less energy production and storage for a healthy plant.
- Foliar diseases can directly impact yield due to early defoliation & reduction in return bloom the following year.

[Graphs showing the relationship between leaf spot severity and assimilation rate, and between maximum number of spots per shoot and fruit weight.]
Leaf Spot Diseases

- Leaf spots reduce photosynthesis, thereby resulting in less energy production and storage for a healthy plant.
- Foliar diseases can directly impact yield due to early defoliation & reduction in return bloom the following year.

Leaf spots diseases include:
- Anthracnose, Septoria, and Leaf Rust.
Septoria Leaf Spot

- Caused by the fungus *Septoria albopunctata*
- One of the most prevalent and severe foliar diseases in GA
- Infectious spores originate from overwintering plant debris
- Wet weather is conducive to disease spread since spores are spread by rain splash
- Causes very serious damage in rooting beds

Leaf spot lesion

Lesion showing pycnidia w/cirrhi

Conidia
Symptoms

- Infections occur on immature leaves and spots first appear in mid-April to late June, then increase until late September
- Small spots; white/tan center & purple border
- In addition to leaf spots, can also cause stem cankers
- Severe infection can cause premature defoliation
- Generally most severe on older leaves, close to the ground
Blueberry Leaf Rust

- Disease caused by the fungus *Pucciniastrum vaccinii*
- Infectious spores originate from overwintering plant debris
- Rust can prematurely defoliate plants by late August

Necrotic spots on upper leaf surface  Orange uredinia on leaf underside  Urediniospores
Management

• **Cultural Controls**, such as removal of infectious plant debris, do not provide sufficient control of leaf spots.

• **Chemical Controls** are necessary throughout the season
  • For **Septoria**: 2-4 fungicide applications are required.
    • Phosphonates (Aliette, ProPhyt, etc.) are best utilized after harvest, since they are not as efficacious against fruit rots, & serve as a resistance management tool
  • For **Anthracnose**: fungicides that control ripe rot are effective with phosphonates utilized after harvest.
  • For **Leaf Rust**: Strobilurins and DMIs sprayed for other leaf spots also have activity against rust
### Chemical Control of Leaf Spot Diseases

Recommendations below are based on the 2019 SE Regional Blueberry Integrated Management Guide

<table>
<thead>
<tr>
<th>Trade Name</th>
<th>Active Ingredient</th>
<th>FRAC MoA</th>
<th>Septoria</th>
<th>Anthracnose Leaf Spot</th>
<th>Leaf Rust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pristine</td>
<td>boscalid, pyraclostrobin</td>
<td>7, 11</td>
<td>++++</td>
<td>++++</td>
<td>++</td>
</tr>
<tr>
<td>Abound</td>
<td>azoxystrobin</td>
<td>11</td>
<td>++++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Quilt Xcel</td>
<td>azoxystrobin, propiconazole</td>
<td>11, 3</td>
<td>++++</td>
<td>++++</td>
<td>++++</td>
</tr>
<tr>
<td>Indar</td>
<td>fenbuconazole</td>
<td>3</td>
<td>++++</td>
<td>++++</td>
<td>+++</td>
</tr>
<tr>
<td>Quash</td>
<td>metconazole</td>
<td>3</td>
<td>++++</td>
<td>++++</td>
<td>+++</td>
</tr>
<tr>
<td>Tilt, Bumper</td>
<td>propiconazole</td>
<td>3</td>
<td>++++</td>
<td>NA</td>
<td>+++</td>
</tr>
<tr>
<td>Proline</td>
<td>prothioconazole</td>
<td>3</td>
<td>++++</td>
<td>NA</td>
<td>++++</td>
</tr>
<tr>
<td>Bravo*</td>
<td>chlorothalonil</td>
<td>M5</td>
<td>++++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Captan</td>
<td>captan</td>
<td>M4</td>
<td>++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>Switch</td>
<td>cyprodinil, fludioxonil</td>
<td>9, 12</td>
<td>+++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>ProPhyt</td>
<td>potassium phosphite</td>
<td>33</td>
<td>++++</td>
<td>+++</td>
<td></td>
</tr>
</tbody>
</table>

*Bravo should not be used prior to harvest because of potential to damage fruit*
Botryosphaeria Stem Blight

- Caused by the fungus *Botryosphaeria dothidea*
- Symptoms appear as dying of the leaves on one or more stem, often occurring after drought or heat stress
- Infects via wounds caused by mechanical damage, herbicide contact, insect damage, or cold injury
  - Crown infections can result in rapid plant death
Management

• Take steps to prevent infection:
  • Avoid wounding injuries and nutrient & water stress
  • Avoid overfertilization in the fall to reduce chances of cold injury

• After symptoms are observed:
  • Cut out and destroy any symptomatic canes to a point 12 inches below the last dead wood,
    • Sterilize shears between cuts with 10% bleach
    • Spray a broad spectrum fungicide, such as Pristine, after each day of pruning to help protect new wounded tissue
Example Seasonal Spray Schedule
*assuming Exobasidium and Fungicide-Resistant Anthracnose Tip Green

**SEASONAL SPRAY SCHEDULE**

Always follow all label rates & instructions.

Exobasidium
Mummy Berry
Twig Blight
Fruit Rots
Botrytis

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

• Guides put together annually by the Southern Region Small Fruit Consortium (SRSFC)
• Includes disease and insect management recommendations based upon the latest research and efficacy data

Southeast Regional IPM Guides

http://www.smallfruits.org/ipm-guides.html
Blueberry IPM Guide

IPM/Production Guides

Blueberries
- Southeast Regional Blueberry Integrated Management Guide
- Southeast Regional Blueberry Horticulture and Growth Regulator Guide
- Southeast Regional Organic Blueberry Pest Management Guide

Bunch Grapes
- Southeast Regional Bunch Grape Integrated Management Guide

Caneberries
- Southeast Regional Caneberries Integrated Management Guide
- Southeast Regional Caneberry Production Guide (PDF)
- Southeast Regional Caneberry Production Guide (Online Version)

Muscadines
- Southeast Regional Muscadine Grape Integrated Management Guide

Strawberries
- Southeast Regional Strawberry Integrated Pest Management Guide
- Southeast Regional Strawberry Plasticulture Production Guide
- Fungicide Selection for Botrytis and Anthracnose Fruit Rot Management 2017

Welcome to the Blueberry IPM Guide!
**Seasonal ‘at a glance’ fungicidal spray schedule options for blueberry**

<table>
<thead>
<tr>
<th>Disease Controlled (Fungicides)</th>
<th>Developmental Stage</th>
<th>Late Dormant</th>
<th>Green tip</th>
<th>Bloom (2-3 applications)</th>
<th>Petal Fall</th>
<th>10-14 Days after Petal Fall</th>
<th>20-24 Days after Petal Fall</th>
<th>Pre-Harvest</th>
<th>After Harvest Foliage Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>If Exobasidium has been a problem, add Captan [M4]</td>
<td>For serious Botrytis problems, add (CaptEvate [17+M4] or Elevate [17] or Pristine [11+7] or Switch [9+12])</td>
<td>If Alternaria and Ripe Rot have been a problem, add (Abound [11] or Pristine [11+7] or Switch [9+12] or Omega [29])°</td>
<td>If Exobasidium has been a problem, add Captan [M4]</td>
<td>If Exobasidium has been a problem, add Captan [M4]</td>
<td>If Exobasidium has been a problem, add Captan [M4]</td>
<td>If Exobasidium has been a problem, add Captan [M4]</td>
<td>If Exobasidium has been a problem, add Captan [M4]</td>
<td>Anthracnose (AgriFos or Aliette or ProPhyt [P07] or Pristine [11+7] or Quilt Xcel [11+3] or Quash [3])</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rust (Bravo [M5] or Tilt or Bumper or PropiMax [3] or Pristine [11+7] or Indar or Quash [3] or Proline [3])°</td>
</tr>
</tbody>
</table>

°Exobasidium is not specifically on the label. However, when applied for other diseases, suppression of Exobasidium has been observed.

°Bloom times vary, due to varietal differences and the environment. Bloom sprays should provide protection against the primary pathogens of blooms for the entire bloom period. The number of applications required for bloom may vary from 1-3, depending on the season and the variety.

°When using Indar during bloom, always tank-mix with Captan. Captan provides additional control of mummy berry, and it has some activity against twig blight, Botrytis and fruit rots. However, it is mainly of value to prevent increased rots with the use of Indar, as well as providing resistance management.

°Many of the fungicides which are registered for rot control may also have activity against twig dieback organisms, such as Phomopsis species.

°In wet years, pre-harvest and post-harvest rots may be a potential problem. Under these conditions, 1-2 applications of a pre-harvest material may be necessary for rot control.

°Septoria leaf spot is generally controlled with 2-4 fungicide applications. This disease is more problematic on highbush blueberry varieties, but some rabbiteye varieties may experience premature defoliation from Septoria as well. For leaf spot, Aliette and other phosphites (ProPhyt, AgriFos, etc.) are best utilized after harvest, since they are not as efficacious against the fruit rots, and they serve as a resistance management tool.

°Rust is problematic on some blueberry varieties, especially in far southern areas such as south Georgia, and it can result in complete, premature defoliation on susceptible varieties. Scout for rust in mid to late July. Applications of fungicides (2-3) from August to mid-September will generally result in good rust management. Some varieties may require yearly rust control.
Blackberry Disease Issues
Example Seasonal Spray Schedule

<table>
<thead>
<tr>
<th>Delayed Dormant</th>
<th>Shoots 6” long</th>
<th>Bloom</th>
<th>Petal Fall</th>
<th>Cover Sprays</th>
<th>Preharvest</th>
<th>Harvest</th>
<th>After harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Anthracnose & Spur Blight**

**Cane Blight**

**Leaf Spots**

**Rusts & Powdery Mildew**

**Botrytis & Rosette**

**Orange Cane Blotch**
Cane Blight

- Caused by the fungus *Leptosphaeria coniothyrium*
- Fungal spores (conidia) are spread by rainsplash and infect canes through wounds.
- Lesions appear on primocanes in summer, fall, and winter.
- Cane death results when lesions girdle the vascular tissue.

Blighted canes often appear to be grey/silver

Fungal pycnidia on cane surface
Cane Blight

Management

• **Cultural control** recommendations include:
  • Avoid wounding of primocanes whenever possible
  • Pinch-off/tip primocanes once at desired height (3-4 ft)
  • Remove infected canes and old floricanes after harvest
  • Promote quick drying of the canopy via weed free strip
  • Avoid nutrition and water stress to plants

• **Chemical controls** recommendations include:
  • Apply fungicides such as Rally or Pristine after each day of pruning to protect wound site from fungal entry
  • Whenever possible, avoid pruning prior to rainfall events
Botrytis Fruit Rot and Blossom Blight

- Caused by the fungus *Botrytis cinerea*
- Fungal spores (conidia) readily infect blossoms & ripe fruit
- Since conidia are dispersed by wind & rainsplash, persistent rain during bloom can result in significant infections
- Can cause devastating preharvest and postharvest fruit rot
Management

- **Cultural controls** include:
  - Practices that create an open canopy to improve air circulation and speed drying of plant surfaces

- **Chemical controls** include:
  - Fungicide applications at early bloom, full bloom, and pre-harvest to protect flowers and ripening fruit (post bloom and pre-harvest sprays generally not required unless weather is cool and wet).
  - Fungicides include Rovral, Nevado, Iprodione, Elevate, Switch, Pristine, Luna Tranquility, Ph-D and Captan.
  - *Fungicide resistance is common with botrytis*
Rosette (Double Blossom)

- Caused by the fungus *Cercospora rubi*
- More colorful, distorted petals produced (double blossoms)
- Leafy shoots are produced from infected vegetative buds
- Infected flowers on floricanes produce conidia which can infect primocanes in the late spring/summer
- Primocanes don’t show symptoms until the next spring.
Management

• **Cultural controls** include:
  • Removal of infected rosettes before they open to prevent fungal dispersal
  • Planting disease-free nursery stock away from wild blackberries
  • Removal of old floricanes immediately after harvest

• **Chemical controls** include:
  • Applications of fungicides including Switch, Abound, Pristine, and Quilt Xcel from first bloom until harvest.
Rust Diseases on Blackberry

- Two major rust diseases of blackberry
  - Orange Rust
  - Cane and Leaf Rust

- Appear superficially similar, but require different management practices due to fungal biology
Orange Rust

- Caused by *Arthuriomyces peckianus* and *Gymnoconia nitens*
- These fungi infect **systemically** and cause dramatic reductions in vegetative growth and fruit production
- Shoots appear spindly and unfolding leaves initially appear stunted, distorted, and pale green in color
- Infected floricanes produce no blossoms

*Distorted leaf margins*  
*Bright orange blisterlike aecia*  
*Spindly shoots*
Management

• **Cultural controls** are critical for managing orange rust
  
  **At initial establishment:**
  1. Ensure plants are free of orange rust
  2. Eradicate wild blackberries within 0.25 mi of planting

  **On established plantings:**
  1. Thoroughly inspect when new canes are 12-18”
  2. Promptly **remove and destroy** infected plants

• **Chemical controls** are **not effective** once plants are systemically infected
  
  • Strobilurin and DMI type fungicides are recommended to help reduce the number of new infections
Cane and Leaf Rust

- Caused by fungus *Kuehneola uredinis*
- This fungus **does not** infect systemically like the Orange Rust fungi
- Severe infection can cause premature defoliation and increase winter injury
- Results in significant economic losses in blackberry production
- This fungus produces pustules on **both** canes and leaves
Management

- **Cultural controls** include the immediate removal of floricanes after harvest to limit primocane infection.

- **Chemical controls** can provide satisfactory control:
  - Strobilurin and DMI type fungicides are recommended.
  - Apply at green tip and prior to bloom, then resume after harvest until floricanes are removed. After floricane removal, delay sprays until scouting indicates new infections of primocanes.
<table>
<thead>
<tr>
<th>Cane and Leaf Rust</th>
<th>Orange Rust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant blackberry disease</td>
<td>Significant blackberry disease</td>
</tr>
<tr>
<td>Nonsystemic fungal disease</td>
<td>Systemic fungal disease</td>
</tr>
<tr>
<td>Lemon yellow pustules on both canes and leaves</td>
<td>Bright orange pustules on leaves only</td>
</tr>
<tr>
<td>Leaf pustules don’t distort leaf margins</td>
<td>Leaf pustules distort leaf margins</td>
</tr>
<tr>
<td>Floricane removal after harvest is recommended</td>
<td>Complete destruction of infected plant is necessary</td>
</tr>
<tr>
<td>Sanitation and fungicide sprays can provide satisfactory control</td>
<td>Fungicides will reduce new infections, but infected plants must be destroyed</td>
</tr>
</tbody>
</table>
Leaf Spots

- Septoria Leaf Spot, Pseudocercospora Leaf Spot, and Cercospora Leaf Spot are important leaf spot diseases that can lead to significant defoliation of blackberries under warm humid conditions.
- Heavily infected plants may produce less fruit and lack vitality, making them more susceptible to cold injury.

Septoria Leaf Spot caused by the fungus *Mycosphaerella rubi*

Pseudocercospora rubi
Management

- **Cultural controls** include:
  - Increasing air circulation within the planting to promote faster drying of the foliage
  - Removal of dead or damaged canes as soon as possible after harvest

- **Chemical controls** include:
  - Application of fungicides such as Tilt, Abound, Cabrio, Quilt Xcel, and Pristine
## Chemical Control of Blackberry Diseases

Recommendations below are based on the 2019 SE Regional Caneberry Integrated Management Guide.

<table>
<thead>
<tr>
<th>Trade Name</th>
<th>Active Ingredient</th>
<th>FRAC MoA</th>
<th>Cane Blight</th>
<th>Botrytis</th>
<th>Rosette</th>
<th>Rusts</th>
<th>Leaf Spots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pristine</td>
<td>pyraclostrobin</td>
<td>11</td>
<td>++++</td>
<td>+++</td>
<td>++++</td>
<td>++++</td>
<td>+++</td>
</tr>
<tr>
<td></td>
<td>bosalid</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quilt Xcel</td>
<td>azoxystrobin</td>
<td>11</td>
<td>++++</td>
<td></td>
<td>++++</td>
<td>++++</td>
<td>++++</td>
</tr>
<tr>
<td></td>
<td>propiconazole</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abound</td>
<td>azoxystrobin</td>
<td>11</td>
<td>++++</td>
<td></td>
<td>++++</td>
<td>++++</td>
<td>+++</td>
</tr>
<tr>
<td>Cabrio</td>
<td>pyraclostrobin</td>
<td>11</td>
<td>++++</td>
<td></td>
<td></td>
<td>++++</td>
<td>+++</td>
</tr>
<tr>
<td>Tilt</td>
<td>propiconazole</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rally</td>
<td>myclobutanil</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switch</td>
<td>cyprodinil</td>
<td>9</td>
<td>++++</td>
<td>++++</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>fludioxonil</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elevate</td>
<td>fenhexamid</td>
<td>17</td>
<td>++++</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luna Tranquility</td>
<td>fluopyram</td>
<td>7</td>
<td>++++</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>pyrimethanil</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iprodione</td>
<td>iprodione</td>
<td>2</td>
<td>+++</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ph-D</td>
<td>polyoxin D zinc salt</td>
<td>19</td>
<td>++</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Captan</td>
<td>captan</td>
<td>M4</td>
<td>++</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Example Seasonal Spray Schedule

- **Shoots 6” long**
- **Bloom**
- **Petal Fall**
- **Cover Sprays**
- **Preharvest**
- **Harvest**
- **After harvest**

**Anthracnose & Spur Blight**
- Delayed Dormant
- Rally + Captan
- Switch + Captan + Rally
- Pristine
- Switch + Captan + Rally
- Pristine

**Cane Blight**
- ProPhyt

**Leaf Spots**
- Pristine
- Switch + Captan + Rally
- Pristine
- ProPhyt

**Rusts & Powdery Mildew**
- ProPhyt

**Botrytis & Rosette**
- Always follow all label rates & instructions.

*Apply after each pruning IF applications remain.*
IPM/Production Guides

Blueberries
Southeast Regional Blueberry Integrated Management Guide
Southeast Regional Blueberry Horticulture and Growth Regulator Guide
Southeast Regional Organic Blueberry Pest Management Guide

Bunch Grapes
Southeast Regional Bunch Grape Integrated Management Guide

Caneberries
Southeast Regional Caneberries Integrated Management Guide
Southeast Regional Caneberry Production Guide (PDF)
Southeast Regional Caneberry Production Guide (Online Version)

Muscadines
Southeast Regional Muscadine Grape Integrated Management Guide

Strawberries
Southeast Regional Strawberry Integrated Pest Management Guide
Southeast Regional Strawberry Plasticulture Production Guide
Fungicide Selection for Botrytis and Anthracnose Fruit Rot Management 2017
Understanding Pathogen Biology & Diversity for Novel Control of Plant Diseases

**OUTLINE**

- Caneberry 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 cultivar.

### Seasonal ‘at a glance’ fungicide spray schedule options for caneberries

<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, Cane Blight, Spur Blight, and Leaf Spots (Copper, Cabrio, Abound, Pristine, Quilt Xcel, and Captan)</td>
<td>Anthracnose, Cane Blight, Spur Blight, and Leaf Spots (Copper, Cabrio, Abound, Pristine, Quilt Xcel, and Captan)</td>
<td>Anthracnose, Cane Blight, Spur Blight, and Leaf Spots (Cabrio, Abound, Pristine, Quilt Xcel, and Captan)</td>
<td>Anthracnose, Cane Blight, Spur Blight, and Leaf Spots (Cabrio, Abound, Pristine, Quilt Xcel, and Captan)</td>
<td>Anthracnose, Cane Blight, Spur Blight, and Leaf Spots (Cabrio, Abound, Pristine, Quilt Xcel, and Captan)</td>
<td>Anthracnose, Cane Blight, Spur Blight, and Leaf Spots (Cabrio, Abound, Pristine, Quilt Xcel, and Captan)</td>
<td>Anthracnose, Cane Blight, Spur Blight, and Leaf Spots (Cabrio, Abound, Pristine, Quilt Xcel, and Captan)</td>
<td>Anthracnose, Cane Blight, Spur Blight, and Leaf Spots (Cabrio, Abound, Pristine, and Captan)</td>
<td>Anthracnose, Cane Blight, Spur Blight, and Leaf Spots (Cabrio, Abound, Pristine, and Captan)</td>
<td>Anthracnose, Cane Blight, Spur Blight, and Leaf Spots (Cabrio, Abound, Pristine, and Captan)</td>
</tr>
<tr>
<td>Powdery Mildew (Sulfur, Rally, Cabrio, Abound, Pristine, Luna Tranquility, Quilt Xcel)</td>
<td>Powdery Mildew (Rally, Cabrio, Abound, Pristine, Luna Tranquility, Quilt Xcel)</td>
<td>Powdery Mildew (Rally, Cabrio, Abound, Pristine, Luna Tranquility, Quilt Xcel)</td>
<td>Powdery Mildew (Rally, Cabrio, Abound, Pristine, Luna Tranquility, Quilt Xcel)</td>
<td>Powdery Mildew (Rally, Cabrio, Abound, Pristine, Luna Tranquility, Quilt Xcel)</td>
<td>Powdery Mildew (Rally, Cabrio, Abound, Pristine, Luna Tranquility, Quilt Xcel)</td>
<td>Powdery Mildew (Rally, Cabrio, Abound, Pristine, Luna Tranquility, Quilt Xcel)</td>
<td>Powdery Mildew (Rally, Cabrio, Abound, Pristine, Luna Tranquility, Quilt Xcel)</td>
<td>Powdery Mildew (Rally, Cabrio, Abound, Pristine, Luna Tranquility)</td>
<td>Powdery Mildew (Rally, Cabrio, Abound, Pristine, Luna Tranquility)</td>
</tr>
<tr>
<td>Rusts (Rally, Abound, Cabrio, Pristine, Tilt, Quilt Xcel)</td>
<td>Rusts (Rally, Abound, Cabrio, Pristine, Tilt, Quilt Xcel)</td>
<td>Rusts (Rally, Abound, Cabrio, Pristine, Tilt, Quilt Xcel)</td>
<td>Rusts (Rally, Abound, Cabrio, Pristine, Tilt, Quilt Xcel)</td>
<td>Rusts (Rally, Abound, Cabrio, Pristine, Tilt, Quilt Xcel)</td>
<td>Rusts (Rally, Abound, Cabrio, Pristine, Tilt, Quilt Xcel)</td>
<td>Rusts (Rally, Abound, Cabrio, Pristine, Tilt, Quilt Xcel)</td>
<td>Rusts (Rally, Abound, Cabrio, Pristine)</td>
<td>Rusts (Rally, Abound, Cabrio, Pristine)</td>
<td>Rusts (Rally, Abound, Cabrio, Pristine)</td>
</tr>
<tr>
<td>Phytophthora Root Rot (Ridomil, phosphorous acid-based products [ProPhyt, K-phite, etc.])</td>
<td>Botrytis (Rovral, Nevada, Iprodione, Elevate, Switch, Pristine, Luna Tranquility, Ph-D and Captan)</td>
<td>Botrytis (Rovral, Nevada, Iprodione, Elevate, Switch, Pristine, Luna Tranquility, Ph-D and Captan)</td>
<td>Botrytis (Rovral, Nevada, Iprodione, Elevate, Switch, Pristine, Luna Tranquility, Ph-D and Captan)</td>
<td>Botrytis (Rovral, Nevada, Iprodione, Elevate, Switch, Pristine, Luna Tranquility, Ph-D and Captan)</td>
<td>Botrytis (Rovral, Nevada, Iprodione, Elevate, Switch, Pristine, Luna Tranquility, Ph-D and Captan)</td>
<td>Botrytis (Rovral, Nevada, Iprodione, Elevate, Switch, Pristine, Luna Tranquility, Ph-D and Captan)</td>
<td>Botrytis (Rovral, Nevada, Iprodione, Elevate, Switch, Pristine, Luna Tranquility, Ph-D and Captan)</td>
<td>Botrytis (Rovral, Nevada, Iprodione, Ph-D and Captan)</td>
<td>Botrytis (Rovral, Nevada, Iprodione, Ph-D and Captan)</td>
</tr>
<tr>
<td>Rosette (Switch, Abound, Pristine, Quilt Xcel)</td>
<td>Rosette (Switch, Abound, Pristine, Quilt Xcel)</td>
<td>Rosette (Switch, Abound, Pristine, Quilt Xcel)</td>
<td>Rosette (Switch, Abound, Pristine, Quilt Xcel)</td>
<td>Rosette (Switch, Abound, Pristine, Quilt Xcel)</td>
<td>Rosette (Switch, Abound, Pristine, Quilt Xcel)</td>
<td>Rosette (Switch, Abound, Pristine, Quilt Xcel)</td>
<td>Rosette (Switch, Abound, Pristine)</td>
<td>Rosette (Switch, Abound, Pristine)</td>
<td>Rosette (Switch, Abound, Pristine)</td>
</tr>
</tbody>
</table>

*Caneberry 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 cultivar.*
MyIPM App

- Contains basic disease (and pest) info for Apple, Blackberry, Blueberry, Cherry, Cranberry, Grape, Peach, Pear, & Strawberry
- Includes management and pesticide efficacy info
- Available for free download
Thank you for your attention!
Orange Cane Blotch

- Caused by the parasitic alga species *Cephalaleuros virescens*
- Algal sporangiophores form an orange felt-like material on blackberry stems; release zoospores under wet conditions.
- Blotches on primocanes first appear in the late summer/fall
- Blotches crack canes and may provide entry for pathogens.
- Orange blotches formed on canes can be mistaken for rust.
Management

- **Cultural controls** include:
  - Removal of old floricanes immediately after harvest
  - Promoting rapid drying of the canopy through the use of weed free strips, black plastic, and drip-tape irrigation
  - Avoiding nutrient and water stresses
  - Avoiding planting in poorly drained sites

- **Chemical controls** include:
  - Applications of phosphonate fungicides (ProPhyt, K-Phite, etc.) after harvest
Propagation Diseases

• The most important diseases in propagation operations are root rots caused by *Cylindrocladium parasiticum*, *Rhizoctonia* sp., and *Phytophthora* sp.

• These cause poor rooting and/or death of cuttings.
Management

- **Cultural control** recommendations for propagation operations include good sanitary practices, avoiding the reuse of growing media, and the use of composted pine bark (versus raw pine bark).

- **Chemical control** options for blueberry propagation are limited.
  - The only fungicide materials labelled for use in blueberry propagation are Terraguard® SC (triflumizole) and Cannonball® WP (fludioxonil). A rotation of these materials is recommended.
Root Rot Diseases

- Caused by *Phytophthora cinnamomi* and *Rhizoctonia sp.*
- *P. cinnamomi* produces zoospores and spreads via water
- Disease often first seen in poorly drained areas of the field
- Damage to roots leads to stunted growth and leaf discoloration (yellow to red)

*Rhizoctonia* can be an issue in bark beds and new plantings
Management

- **Cultural controls** are critical since root rot is generally a problem of low, poorly-drained, excessively moist sites.
  - Ensure adequate drainage prior to planting via site selection and/or proper bedding
  - Avoid excessive irrigation

- **Chemical controls** for Phytophthora include phosphonates (ProPhyt, K-Phite, etc.) and mefanoxam (Ridomil Gold). For Rhizoctonia, Cannonball WP is registered. Suppression of Rhizoctonia with Abound has also been observed.

- Note that chemical control is **not effective** for reversing root rot damage on plants with severe symptoms
Replant Disease/Disorder

- Symptoms include poor plant growth, higher mortality, and premature decline, in blueberry replant sites

- High populations of ring nematodes (*Mesocriciconema ornatum*) are associated with this disorder
  - These directly destroy roots, resulting in less nutrient and water uptake, and more root diseases

- Ring nematodes are likely *not the only* pathogen involved
Management

• **Chemical control** recommendations include the utilization of a broad-spectrum fumigant ahead of planting
  • Activity against nematodes **and** other soil pathogens

Treated (left) rows vs. Untreated control (right)
Management

- **Chemical control** recommendations include the utilization of a *broad-spectrum* fumigant ahead of planting
  - Activity against nematodes *and* other soil pathogens

- **Cultural controls** include the addition of pine bark, as this has been found to slow nematode population increases

Noe et al. 2014
Bacterial Leaf Scorch

- Caused by the bacterial pathogen *Xylella fastidiosa*
- Spread from plant to plant by sharpshooter insects

- Symptoms more evident in **drought** and/or nutrient stress
- Vector control can slow, but not stop pathogen spread
- Infected plants should be promptly removed and destroyed
Blueberry red ringspot virus

- Virus systemically infects blueberry plant

- Symptoms usually more pronounced as season progresses
- Red ringspots have green centers, unlike fungal leaf spots
- No vector known, spread by propagation of infected plants
- Not believed to negatively affect yield in most cases
**Blueberry necrotic ring blotch virus**

- Virus **does not** systemically infect blueberry plant

- No vector known, but suspected to be transmitted by mites
- Necrotic blotches penetrate from top to bottom of leaf
- Blotches often have green centers, unlike fungal leaf spots
- Severe infection can cause premature leaf drop
Fungicide Modes of Action (MoA)

- Fungicides work by targeting important enzymes/processes that fungal pathogens need to survive, grow, and reproduce.
- Some fungicides target a single enzyme/process within fungal organisms.
  - These are single mode/site of action fungicides.
- Other fungicides simultaneously target multiple fungal enzymes/processes.
  - These are multiple modes/sites of action fungicides.
- Each fungicide is assigned a class # indicating its MoA by the Fungicide Resistance Action Committee (FRAC).
Fungicide Resistance Management

1. As much as possible, utilize fungicides less likely to develop resistance (those with **multiple modes of action**).

2. Alternate sprays with fungicides from different classes (**different modes of action**).

3. Tank-mixing of **different fungicides** is also an acceptable method of resistance management.

4. **Follow the label recommendations.** Many fungicides are limited to a set number of applications per year in order to improve their long-term survival.