Winter 1-30-2020


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Optimizing Current Cultural Practices & Evaluation of novel fungicides for fruit rot management

Leela Saisree Uppala
UMass Cranberry Station
January 30, 2020
Fruit Rot

- Botryosphaeria vaccinii
- Botrytis spp.
- Allantophomopsis cystisporea
- Allantophomopsis lycopodina
- Coleophoma empetri
- Colletotrichum acutatum
- Colletotrichum gloeosporioides
- Fusicoccum puterefaciens
- Phomopsis vaccinii
- Phyllosticta vaccinii
- Physalospora vaccinii

Field Rot

- Fungal populations known to vary from season to season & from region to region
Factors affecting cranberry fruit rot incidence & management

Plant or Bog factors
- Canopy density
- Air circulation
- Vine health
- Level of resistance

Pathogen related/Fruit Rot Inoculum
- Fungal pathogen inoculum

Cultural/Management practices
- Fertilizer rates
- Implementation of Late water, pruning, sanding & mowing
- Timing of fungicides
- Selection of fungicides
- Fungicide coverage
- Harvest practices
Integrated Disease Management –

a cost effective, sustainable fruit rot management

At present no research literature available

- Reducing inoculum levels
- Canopy management tools
- Resistant Varieties

Fungicides

- Cultural Control
- Biological Control
- Chemical Control

Fruit Rot Management
Cultural Control

- Canopy management –
  - pruning
  - sanding
  - improved air circulation
  - rapid drying
- sanitation
- minimize plant stress or lush growth
- minimize mechanical injury to fruit during dry harvesting
Cultural Control

**Late Water** –

- Mid April to Mid May.
- Once in three years.
- **Bloom will be compressed** into a shorter time period.
- Fungicides may be eliminated on processed-fruit beds if keeping quality is forecast to be good.
- Use **reduced recommended rate and less number of applications** during the late water year and the following year.
  - If one application to be made- apply at 50% bloom.
  - If two applications are to be made- at 10% bloom and two weeks later.
Second year after LW has been held:

No. of fungicide applications and rates should be increased to a normal schedule

Late Water in Newly Planted Beds: (one or two year old bogs)

- will help prevent inoculum buildup
- help the vines spread over the surface of the soil
  - slow down weed growth
Select Resistant Varieties

For Field Rot
- Stevens
- Early Black
- Howes
- Beckwith
- Black Veil
- Foxboro Howes
- Holliston
- Paradise Meadow
- Randall
- Shaw’s Success
- Stankovich
- Wilcox

For Storage Rot
- Stevens
- Early Black
- Howes
- Bergman
- Black Veil
- Foxboro Howes
- Matthews
- Paradise Meadow
- Perry Red
- Randall
- Shaw’s Success
- Stankovich
- Vose’s Pride
- Wilcox
Chemical Control

Fungicides

Group 11
Abound

Group 3
Indar
Proline

Group M5
Chlorothalonils

Group M3
Mancozebs

Group M1
Coppers

Group 19
Polyoxin-D-Zinc Salt

Azoxystrobin

Azoxystrobin & Difenconazole

Group 3 & 11
Quadris Top
<table>
<thead>
<tr>
<th>High efficacy</th>
<th>Fungicide</th>
<th>Trade Names</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chlorothalonil</td>
<td>Bravo, Echo, Equus, etc.</td>
<td>Check with handler for market restrictions.</td>
</tr>
<tr>
<td></td>
<td>Mancozeb</td>
<td>Dithane, Manzate, Penncozeb, etc.</td>
<td>May delay fruit color. Efficacy comparable to chlorothalonil. Low risk of resistance. Should be used as a resistance management tool if using ‘newer’ fungicides (see resistance management section). Restricted by some handlers.</td>
</tr>
<tr>
<td></td>
<td>Prothioconazole</td>
<td>Proline</td>
<td>Moderate risk of resistance. No more than 2 applications recommended. For best results and resistance management, use during bloom and combine with azoxystrrobin.</td>
</tr>
<tr>
<td></td>
<td>Fenbuconazole</td>
<td>Indar</td>
<td>High risk of resistance. No more than 2 applications. For best results combine with prothioconazole or fenbuconazole.</td>
</tr>
<tr>
<td></td>
<td>Azoxystrrobin</td>
<td>Abound, Satori</td>
<td>High risk of resistance. No more than 2 applications. For best results combine with prothioconazole or fenbuconazole.</td>
</tr>
<tr>
<td></td>
<td>Polyoxin-D zinc salt</td>
<td>Oso and Ph-D</td>
<td>Moderate risk of resistance. Maximum of 3 Oso applications or 6 Ph-D applications. Limited research on efficacy of polyoxin-D fungicides in MA. For best results alternate or incorporate into a program with other fungicides for fruit rot.</td>
</tr>
<tr>
<td>Low efficacy</td>
<td>Ferbam, Coppers, SDHI, plant extracts</td>
<td>Champ, Kocide, Kenja, Regalia, etc.</td>
<td>Limited research on efficacy of Kenja and Regalia in MA. These products were not effective against rot in 2016 trials. It is possible that better results could be obtained if alternated with other fungicide products with higher efficacy ratings.</td>
</tr>
</tbody>
</table>
Success of a chemical control program depends on:
- Choice of fungicide options
- Number of fungicide applications
- Application Timings
- Uniform coverage
- Resistance management
In a typical commercial setting, 3 to 5 fungicide applications are made during the growing season—resultant field rot levels range from <1-15%.

Risk

<table>
<thead>
<tr>
<th>High-Moderate</th>
<th>Moderate</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 to 5 applications</td>
<td>3 applications</td>
<td>0 to 2 applications</td>
</tr>
<tr>
<td>- High prior fruit rot incidence.</td>
<td>- Moderate fruit rot incidence.</td>
<td>- Low fruit rot incidence.</td>
</tr>
<tr>
<td>- Susceptible Varieties.</td>
<td>- Resistant varieties.</td>
<td>- Resistant varieties.</td>
</tr>
<tr>
<td>- Newly established bed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
How to preserve the effectiveness and durability of registered fungicides

- Repeated and infective use leads to resistance.
- Follow all label instructions.
- **Alternate or mix fungicides** with different modes of action.

**Efforts to expand our tool box:**

- Group 2, Group 7, Group 9 and Group 12
1) Multi-state evaluation of Bravo alternative fungicide regimes for their effect on fruit rot, firmness, fruit color, fruit size, and yield.

2) Evaluate the effects of mancozeb fungicide application timings on fruit color, size and firmness.

3) Evaluation novel fungicides for fruit rot management

4) Studying Overwintering Sources of Pathogen Inoculum

5) Preliminary studies on the role of late water

6) Preliminary studies on the role of pruning, mowing and sanding on fruit rot incidence.

7) Determination of optimum fertilizer rates for various cultivars and their effects on fruit rot
1) Multi-state evaluation of Bravo (Chlorothalonil) alternative fungicide regimes for their effect on fruit rot, firmness, fruit color, fruit size, and yield.

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<table>
<thead>
<tr>
<th>Treatment</th>
<th>Early-Bloom</th>
<th>Mid-Bloom</th>
<th>Late-Bloom</th>
<th>10 days after Late-Bloom application</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>ManzateMax</td>
<td>Indar/Abound</td>
<td>Indar/Abound</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ManzateMax</td>
<td>Proline</td>
<td>Proline</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>ManzateMax</td>
<td>QuadrisTop</td>
<td>QuadrisTop</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Indar/Abound</td>
<td>ManzateMax</td>
<td>Indar/Abound</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Proline</td>
<td>ManzateMax</td>
<td>Proline</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>QuadrisTop</td>
<td>ManzateMax</td>
<td>QuadrisTop</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Indar/Abound</td>
<td>Indar/Abound</td>
<td>ManzateMax</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Proline</td>
<td>Proline</td>
<td>ManzateMax</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>QuadrisTop</td>
<td>QuadrisTop</td>
<td>ManzateMax</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>ManzateMax</td>
<td>ManzateMax</td>
<td>QuadrisTop</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>QuadrisTop</td>
<td>ManzateMax</td>
<td>ManzateMax</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>QuadrisTop</td>
<td>QuadrisTop</td>
<td>ManzateMax</td>
<td>ManzateMax</td>
</tr>
<tr>
<td>13</td>
<td>QuadrisTop</td>
<td>QuadrisTop</td>
<td>Bravo</td>
<td>Bravo Weather Stik</td>
</tr>
<tr>
<td>`14</td>
<td>ManzateMax</td>
<td>ManzateMax</td>
<td>ManzateMax</td>
<td></td>
</tr>
<tr>
<td>15. Positive Control</td>
<td>Bravo</td>
<td>Bravo Weather Stik</td>
<td>Bravo Weather Stik</td>
<td></td>
</tr>
<tr>
<td>16. Non-Sprayed Control</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Conducted in collaboration with

- Dr. Erika Saalau Rojas and Dr. Lindsay Wells-Hansen (Ocean Spray).
- Dr. Peter Oudemans (Rutgers University)
Figure 1: Effect of various fungicide regimes on % fruit rot incidence
Conclusions

• Among the three-spray fungicide regimes, late bloom application of ManzateMax is not ideal for fruit rot management.

• Four-spray fungicide regimes applied at Earlybloom-Midbloom-Latebloom-10 days after late bloom stages did not result in any further statistical reduction of fruit rot compared to the effective three-spray fungicide regimes.
Conclusions

• **Yield** data did not differ significantly among various fungicide regimes.

• **Weight per berry** data did not differ significantly among various fungicide regimes.

• **Total Anthocyanin Content** data did not differ among the fungicide regimes.

• **Berry firmness values** did not differ among the fungicide regimes.
1) Multi-state evaluation of Bravo alternative fungicide regimes for their effect on fruit rot, firmness, fruit color, fruit size, and yield.

2) Evaluate the effects of mancozeb fungicide application timings on fruit color, size and firmness.

3) Evaluation novel fungicides for fruit rot management

4) Studying Overwintering Sources of Pathogen Inoculum

5) Preliminary studies on the role of late water

6) Preliminary studies on the role of pruning, mowing and sanding on fruit rot incidence.

7) Determination of optimum fertilizer rates for various cultivars and their effects on fruit rot
Evaluation novel fungicides for fruit rot management

- **Group 2**
- **Group 3 & 7**
- **Group 3 & 11**
- **Group 7 & 12**
- **Group M1 Coppers**

- Rovral
- Aprovia Top
- Miravis Top
- Propulse
- Inspire Super
- Quadris Top
- Topguard
- Aprovia
- Miravis Prime
- Swich
- Bravo Weatherstik
- Kocide 3000
- MasterCop
- Non-Sprayed Control
Evaluation novel fungicides for fruit rot management

- Except MiravisTop, Propulse, TopGuard and Aprovia, all other fungicide treatments consistently resulted in lower fruit rot compared to the non-sprayed control.
- **Yield** data did not differ significantly among the fungicides evaluated.
- **Weight per berry** data did not differ significantly among the fungicides evaluated.
- **Berry firmness values** did not differ among the fungicides evaluated.
1) Multi-state evaluation of Bravo alternative fungicide regimes for their effect on fruit rot, firmness, fruit color, fruit size, and yield.

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At present, there is no research literature on the sources of overwintering for fruit rot inoculum.

We hypothesized that fungal pathogens survive in detached host structures (leaves, stems, rotted berries) or debris left near the bogs after harvest (called trash piles), and then serve as inoculum for fruit rot.

Debris (fruits, uprights and leaves) from 9 different bogs left on the bog and within 100 ft from the bog (from trash piles) were studied for fruit rot fungi.
Studying Overwintering Sources of Pathogen Inoculum

Where are the pathogens hiding?

- **(Current-year leaves)**
  - Phyllosticta vaccinii
  - Phyllosticta elongata
  - Physalospora vaccinii

- **(Flowers)**
  - Fusigoctum putrefaciens

- **(Green fruit)**
  - Phyllosticta vaccinii

- **(Stems)**
  - Colletotrichum gloeosporioides

- **(1- and 2-year leaves)**
  - Phyllosticta vaccinii
  - Phyllosticta elongata
  - Physalospora vaccinii
  - Fusigoctum putrefaciens

- **(1-year pedicel)**
  - Fusigoctum putrefaciens
  - Phomopsis vaccinii

- **(Current-year pedicel)**
  - Fusigoctum putrefaciens
  - Phomopsis vaccinii

- **(Rotten fruit)**
  - Physalospora vaccinii
  - Coleophoma empetri

- **(Duff--leaves)**
  - Coleophoma empetri

- **(Duff--fruit)**
  - Coleophoma empetri

- **(Duff--fruit)**
  - Physalospora vaccinii
  - Colletotrichum gloeosporioides

- **water**

- **Phyllosticta elongata**
  - Coleophoma empetri
  - Colletotrichum acutatum

- **Phyllosticta elongata**
  - Coleophoma empetri
  - Colletotrichum acutatum
Conidia of Cranberry Fruit Rot Fungi

- Allantophomopsis spp.
- Coleophoma empetri
- Colletotrichum spp.
- Epicoccum spp.
- Fusicoccum putrescens
- Pestalotia vaccinii
- Physalospora vaccinii
- Phyllosticta vaccinii
- Phomopsis vaccinii
- Botryosphaeria vaccinii & Phyllosticta elongata
Results

- Prevalence and distribution of fruit rot pathogens differed among the bogs and tissue samples.
- Except for *Epicoccum* spp. and *Phyllosticta vaccinii* all other pathogens were more prevalent in Berries followed by uprights. Percent positive samples were low among leaf samples.
- *Phyllosticta vaccinii* is more prevalent in uprights followed by berries then in leaves.
- Very few samples presented *Epicoccum* spores.
- Results indicate the importance of post-harvest cleaning of the debris from cranberry bogs and surrounding areas as they could serve as over wintering sources for fruit rot inoculum.
Reduce Overwintering sources of fruit rot inoculum –

Trash Removal

• Remove trash from water harvested beds during harvest or as soon after as possible
• If beds are dry harvested – remove trash with a post-harvest flood in the fall or from the winter flood before it is withdrawn
• Trash piles should not be left next to the bed – should be moved at least a quarter mile away.
1) Multi-state evaluation of Bravo alternative fungicide regimes for their effect on fruit rot, firmness, fruit color, fruit size, and yield.

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5) Preliminary studies on the role of late water

6) Preliminary studies on the role of pruning, mowing and sanding on fruit rot incidence.

7) Determination of optimum fertilizer rates for various cultivars and their effects on fruit rot
2019 late water studies

• 6 late water held, grower bogs were monitored from bloom to harvest.
• Late water beds were treated the same as control beds except for one month flood from mid April-mid May.
• In all late water held beds, bloom got synchronized.
• Fruit rot results were variable.
• Yield reductions were observed at three sites.
• Application of full rate fertilizers might have contributed to excess vegetative growth and yield reductions.
• Planning on including more sites and controlled studies in the upcoming growing seasons.
• Pursuing funding sources to develop a late water decision making model that could predict ideal cropping seasons or conditions for holding late water.
2019 Research Studies

1) Multi-state evaluation of Bravo alternative fungicide regimes for their effect on fruit rot, firmness, fruit color, fruit size, and yield.

2) Evaluate the effects of mancozeb fungicide application timings on fruit color, size and firmness.

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4) Studying Overwintering Sources of Pathogen Inoculum

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6) Preliminary studies on the role of pruning, mowing and sanding on fruit rot incidence.

7) Determination of optimum fertilizer rates for various cultivars and their effects on fruit rot
6. Canopy management studies- Effect of pruning, mowing and sanding on fruit rot in cranberry

PI: Dr. Giverson Mupambi.
Conclusions

• Fruit rot incidence was not affected by canopy management treatments.
• Yield got reduced- due to reduced flowering uprights.
• Fruit quality parameters got improved.
• Planning to conduct these studies at multiple locations in the coming cropping seasons.
2019 Research Studies

1) Multi-state evaluation of Bravo alternative fungicide regimes for their effect on fruit rot, firmness, fruit color, fruit size, and yield.

2) Evaluate the effects of mancozeb fungicide application timings on fruit color, size and firmness.

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7) Determination of optimum fertilizer rates for various cultivars and their effects on fruit rot
Fruit Rot incidence in different cultivars

- Crimson Queen: a
- Demoranville: bc
- Mullica Queen: bc
- Howes: c
- Stevens: ab
1 & 2. Among the various Bravo (Chlorothalonil) alternative fungicide regimes evaluated, late bloom application of ManzateMax is not ideal for fruit rot management.

Four-spray fungicide regimes did not result in any further statistical reduction of fruit rot compared to the effective three-spray fungicide regimes.

Yield, fruit color, firmness and fruit size did not differ among the various fungicide regimes evaluated.

3. Among the 11 new (9 unregistered and 2 coppers) fungicides evaluated for fruit rot management, 7 (5 unregistered and 2 coppers) consistently showed efficacy in reducing fruit rot compared to non-sprayed control.

4. Results of the fruit rot overwintering sources investigation indicate the importance of post-harvest cleaning of the debris from cranberry bogs and surrounding areas as they could serve as over wintering sources for fruit rot inoculum.
5 & 6. Preliminary studies on late water and canopy management gave variable results. They will be pursued further in multiple locations for better understanding of their role in fruit rot management and fruit quality improvement.

- Possibility of developing a Late Water decision making model is being pursued.

7. Increased N-fertilizer rates correlated with increased fruit rot incidence.
Thank You