Post-infection Management of Shoot Blight Stage with Apogee and Other Fire Blight Efficacy Trials

Srdjan G. Acimovic, Christopher L. Meredith, Ricardo D. Santander
Fire Blight Basics – *Erwinia amylovora*
- Risk of Production -
Know Your Enemy
- Oozing Cankers -

http://www.omafra.gov.on.ca
Blossom Blight
- Ooze -
Ooze on Tissue Before Blight Occurs!
- Spreader -
Shoot Blight - Too Late Then!
Rootstock Blight – Major Issue
- Epidemic in NY 2016 -

Photo by Anna Wallis
High Density Planting = No FB Tolerance  
- Dwarf trees, Susceptible Rootstocks -

- Spindle systems  
  (~1000 - 2000 /A)

- Susceptible cultivars:  
  Mutsu, Fuji, Gala,  
  Gingergold, Pink Lady,  
  Idared, Jonathan,  
  Monroe, Paulared, Rome,  
  SweeTango, NY-1, NY-2

- Susceptible rootstocks:  
  M.9, M.26

- Trees < 6-8 yr old.
FB Infection Requirements

1. Open/ing flowers
2. Accumulate enough heat units in bloom for inoculum to reach threshold
3. Wetting event after this point to wash bacteria flower down in flower
4. Average temperature above 60F.

- MaryBlyt EIP (Epiphytic Infection Potential) - index for infection risk for enough heat (degree hours >65 F) for infection
- Threshold for infection is EIP ≥ 100 (heat is there)
NEWA’s Maryblyt - EIP
Fire Blight in New York 2018
- Why and When to Spray? -

RIMpro-Erwinia location

Hudson8 - 2018

Indicated potential infection events only relevant for trees in bloom.

Visual symptoms appear

Infection threshold

Critical level

Epiphytic population - CFU

Incidence endophytic population - CFU

May 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72

Cornell University

Hudson Valley Research Laboratory
Management - Pruning & Sprays
- Late Spring & Early Summer -

If model predicted infection: Scout 3 times per week for symptoms

**Low number of clusters/ strikes (5-15):**
- Prune out rapidly, sanitize tools?
- 18-24” below visible symptom edge
- Or to older wood (12”)
- Prevent further spread
- Drop cuttings in the middle, let it dry, chop with flail-mower, or remove
- Spray copper, Apogee
- If done early – effective
- Scout and cut on a cool dry day

**High number of clusters/ strikes (25-30):**
- Spray Apogee high rate, copper with 1-3lbs/A of hydrated lime
- Slow migration of bacteria to the larger limbs
- Prevent further spread
- Severe pruning on a cool dry day
- Every day/hour delay in spray allows FB spread
- Pruning promotes shoot growth – more infections
- Scout every week and cut
Management Strategy – Prevent Secondary Infections  
- Mid Summer -

**Fact:** Bacteria inside flowers, shoots, wood, fruit

**Goal:** Prevent/ Reduce inoculum spread

- Copper before/ after pruning – lower doses, cultivar dependent
  - Limit spread to shoots
  - CAUTION: Russeting

- Apogee: 6-12 oz/100 gal; 3-6 oz for trees <5 years
  - 1-3 inch shoot growth (late bloom)
  - 14-21 days later
  - Stunt growth
  - Stop new growth
  - Limit new infections
  - Bridge to terminal bud set
Management Strategy – Continue Pruning and Sprays
- Late Summer -

• Scout once every week and cut
• Terminal bud set is variable
• Pruning can promote new shoot growth
• Apply copper before/after pruning
• New shoot growth needs to be covered
• 7-10 day interval – use low doses until terminal bud set (!)
• Avoid slow drying (fruit russet)
• Hand thin on a cool dry day, then apply copper
Hail
- Spring / Summer -

- No wounds on leaves - cause enough fruit injury for infection
- Blight is in the region
- Copper does not penetrate in tissue
- Any hail, gusts, or T-storm (up to 24h):
  You must spray STREPTOMYCIN: FireWall 50WP (10 oz) of 17 (24 oz) + Regulaid
Management Strategy
- Young Trees and Suckers -

• Later bloom
• Prone to lingering bloom
• Prune ASAP and if possible on a cool dry day
• No pruning in rain
• If 12” is into leader – remove & replant
• If early control effective - suckers should not be infected
• Avoid M.26 and M.9
• Avoid nitrogen
• Minimize irrigation
• Sanitize tools when removing suckers
• Apogee effect on suckers – no data?
Management Strategy – Scout, Prune, Spray
- Dormancy 2018/2019 -

• **Scout, prune cankers & strikes, no tool sterilization**
  • Reduce inoculum sources (flail mow, pile burn)
  • Difficult to find
  • 1 – 4 /2.5 Acres

• **Late dormant copper: silver to green tip/ QIG/ HIG**
  • Kills bacteria on the bark in ooze

• **FB is there!**
  • Warm weather boosts bacteria numbers in cankers

• **Use prediction models - time bloom sprays**
  • Bloom: streptomycin (0.5 lb/100 gal) 50 DPI

• **Organic: Cueva + Double Nickel, Badge X2 + hydrated lime**
  • Serenade Optimum, or Blossom Protect (alternate with strep)
Spray Antibiotics in Bloom 2019
- Considerations -

- Use NEWA/RIMpro to time strep sprays and avoid control failures
- Precise timing = high efficiency
- Bacteria grow fast in flowers at warm weather (> 65 F)
- Antibiotic protects only blossoms that are open at the spray time
- After drying, antibiotic will not redistribute
- Spray just before wetting (all open flowers protected during infection)
- LOOK NEWA EIP = need for additional treatment
- Reapplication protects newly opened flowers before the next rain
Conditions Favoring Infections 2016
- NY -

• Late cv-s: still in bloom
• Early cv-s: rat-tail flowers; young shoots
• Extremely conducive conditions in NE:
  • Bloom (still)
  • No terminal bud set
  • Shoot growth
  • Hot: high 80’s
  • Several short rain or dew events
  • Storms with hail
  • Fire blight history (nursery, old cankers) 0.5 miles
• May 27, thinning meeting: predicted extreme risks – rain on 29 & 30
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**NEWA Fire Blight Model 2016 - Summary**

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### Fire Blight Risk Predictions for Peru

Blossom blight predictions using the Cougarblight model begin at first blossom open.

**First blossom open date:** 5/7/2016

- **Orchard Blight History:** Fire blight occurred in your neighborhood last year.

The orchard blight history above is the NEWA default. Select the actual blight history for your orchard and the model will recalculate recommendations.

#### Blossom Blight Summary - Cougarblight

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**Wetness Events**

- **Wetness Amount:** Rain
  - **Rain Prob (%) Night/Day:** Yes
- **Dew:** No
- **Leaf Wetness (hours):** 9

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### Fire Blight Risk Predictions for Chazy

Blossom blight predictions using the Cougarblight model begin at first blossom open.

**First blossom open date:** 5/10/2016

- **Orchard Blight History:** Fire blight occurred in your neighborhood last year.

The orchard blight history above is the NEWA default. Select the actual blight history for your orchard and the model will recalculate recommendations.

#### Blossom Blight Summary - Cougarblight

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**Wetness Events**

- **Wetness Amount:** Rain
  - **Rain Prob (%) Night/Day:** Yes
- **Dew:** No
- **Leaf Wetness (hours):** 11

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**Cornell University**

**Hudson Valley Research Laboratory**
Research on Fire Blight Management
- Cankers as Infection Sources -

http://www.omafra.gov.on.ca
## Inoculum Reduction - Removal of Cankers
- Acimovic et al. 2014 -

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*Brooks 1926, Tullis 1929
I. 2017 & 2018 Post-Infection Fire Bight Management
- PGR, SAR, Surfactant Programs -

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<td>3 x Apogee 2-1-2</td>
<td>2 oz, 1 oz, 2 oz</td>
<td>1-3-inch shoots, 14 days, 14 days</td>
</tr>
<tr>
<td>7</td>
<td>1 x Apogee + Actigard 50WG</td>
<td>6 oz + 2 oz/A</td>
<td>1-3-inch shoots</td>
</tr>
<tr>
<td>8</td>
<td>2 x Apogee + Actigard 50WG</td>
<td>6 oz + 2 oz/A</td>
<td>1-3-inch shoots, 14 days</td>
</tr>
<tr>
<td>9</td>
<td>2 x Apogee + Actigard 50WG + Regulaid</td>
<td>6 oz + 2 oz/A + 32 fl oz</td>
<td>1-3-inch shoots, 14 days</td>
</tr>
<tr>
<td>10</td>
<td>3 x Apogee + Actigard 50WG</td>
<td>6 oz + 2 oz/A</td>
<td>1-3-inch shoots, 14 days, 14 days</td>
</tr>
<tr>
<td>13</td>
<td>Inoculated control</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>14</td>
<td>Uninoculated control</td>
<td>/</td>
<td>/</td>
</tr>
</tbody>
</table>
2017 & 2018 Post-Infection Fire Bight Mgmt.

- Dates -

- Inoculation *E. amylovora* 9 May 2017 (1-2” shoot size)
- Applications:
  - 29 April: PK Apogee 6 oz (Trt 1)
  - 10 May @ 1-3” shoot size
  - 24 May
  - 9 June

- Inoculations: 15 May 2018 (1-2” shoot size) & 14 June 2018
- Applications:
  - 5 May: PK Apogee 6 oz (Trt 1)
  - 17 May @ 1-3” shoot size
  - 31 May
  - 15 June
2017 Apogee Post-Infection Fire Bight Management

Control:
- 50%
- 54.7%
- 58.5%
- 65.3%

Shoot blight severity (%)

- 3 x Apogee 2-1-2 oz (1-3", 14 days, 14 days)
- 1 x Apogee 6 oz (PK bud)
- 3 x Apogee 1-2-1 oz (1-3", 14 days, 14 days)
- 2 x Apogee 6 oz + Regulaid 32 fl oz (1-3", 14 days)
- 1 x Apogee 12 oz (1-3")
- Inoculated control
- 2 x Apogee 12 oz (1-3", 14 days)
- Uninoculated control

- 8. 2 x Apogee 6 oz + Actigard 2 oz/A (1-3", 14 days)
- 9. 2 x Apogee 6 oz + Actigard 2 oz/A + Regulaid 32 fl oz (1-3", 14 days)
- 10. 3 x Apogee 6 oz + Actigard 2 oz/A (1-3", 14 days, 14 days)
- 7. 1 x Apogee 6 oz + Actigard 2 oz/A (1-3")
2018 Apogee Post-Infection Fire Bight Management

Inoculated control
- 1 x Apogee 6 oz (PK bud)
- 3 x Apogee 1-2-1 oz (1-3”, 14 days, 14 days)
- 1 x Apogee 6 oz + Actigard 2 oz/A (1-3”)
- 2 x Apogee 6 oz + Actigard 2 oz/A (1-3”, 14 days)
- 3 x Apogee 2-1-2 oz (1-3”, 14 days, 14 days)
- 2 x Apogee 6 oz + Regulaid 32 fl oz (1-3”, 14 days)
- 2 x Apogee 6 oz + Actigard 2 oz/A + Regulaid 32 fl oz (1-3”, 14 days)
- 3 x Apogee 6 oz + Actigard 2 oz/A (1-3”, 14 days)
- 2 x Apogee 12 oz (1-3”, 14 days)
- 1 x Apogee 12 oz (1-3”)
- Uninoculated control

Shoot Blight Severity (%)

Control %:
- 6.2
- 10.3
- 13.9
- 16.6
- 26.7
- 38.5
- 37.1
- 50.8
- 62.6
- 72.0
- 78.8
- 89.5
2017 Apogee Prevents Canker Formation

1. 1 x Apogee 6 oz (Pink bud)
2. 2 x Apogee 6 oz + Regulaid 32 fl oz (1-3", 14 days)
3. 1 x Apogee 12 oz (1-3")
4. 2 x Apogee 12 oz (1-3", 14 days)
5. 3 x Apogee 1-2-1 oz (1-3", 14 days, 14 days)
6. 3 x Apogee 2-1-2 oz (1-3", 14 days, 14 days)
7. 1 x Apogee 6 oz + Actigard 2 oz/A (1-3")
8. 2 x Apogee 6 oz + Actigard 2 oz/A (1-3", 14 days)
9. 2 x Apogee 6 oz + Actigard 2 oz/A + Regulaid 32 fl oz (1-3", 14 days)
10. 3 x Apogee 6 oz + Actigard 2 oz/A (1-3", 14 days, 14 days)
11. Inoculated control
12. Uninoculated control
13. Inoculated control
14. Uninoculated control

Fire Blight Canker Percent (%)

Dates:
- 8/13/2017
- 7/9/2017
- 6/8/2017
2018 Apogee Reduces Canker Formation

Dates:
- 9/17/2018
- 7/11/2018
- 6/18/2018

1. 1 x Apogee 6 oz (Pink bud)
2. 2 x Apogee 6 oz + Regulaid 32 fl oz (1-3", 14 days)
3. 1 x Apogee 12 oz (1-3")
4. 2 x Apogee 12 oz (1-3", 14 days)
5. 3 x Apogee 1-2-1 oz (1-3", 14 days, 14 days)
6. 3 x Apogee 2-1-2 oz (1-3", 14 days, 14 days)
7. 1 x Apogee 6 oz + Actigard 2 oz/A (1-3")
8. 2 x Apogee 6 oz + Actigard 2 oz/A (1-3", 14 days)
9. 2 x Apogee 6 oz + Actigard 2 oz/A + Regulaid 32 fl oz (1-3", 14 days)
10. 3 x Apogee 6 oz + Actigard 2 oz/A (1-3", 14 days, 14 days)
11. 2 x Apogee 6 oz + Actigard 2 oz/A + Regulaid 32 fl oz (1-3", 14 days, 14 days)
12. 3 x Apogee 6 oz + Actigard 2 oz/A (1-3", 14 days, 14 days)
13. Inoculated control
14. Uninoculated control

Fire Blight Canker Percent (%)

0 5 10 15 20 25 30
## 2017 Low-rate Coppers for Fire Blight - Low Russet -

<table>
<thead>
<tr>
<th>No.</th>
<th>Product</th>
<th>Number of applications / Amount per acre</th>
<th>Metallic copper / unit product</th>
<th>Metallic copper equivalent sprayed in lb/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Copper Sulfate Crystals</td>
<td>2 x 0.784 lb/A</td>
<td>0.25 lb/ lb</td>
<td>2 x 0.196 lb/A</td>
</tr>
<tr>
<td>2</td>
<td>Bordeaux Mixture</td>
<td>2 x 0.784-0.784-50 (0.784 lb copper sulfate + 0.784 lb lime + 50 gal water/A)</td>
<td>0.25 lb/ lb</td>
<td>2 x 0.196 lb/A</td>
</tr>
<tr>
<td>3</td>
<td>Camelot O</td>
<td>2 x 1.225 gal /A</td>
<td>0.16 lb/ gal</td>
<td>2 x 0.196 lb/A</td>
</tr>
<tr>
<td>4</td>
<td>Camelot O</td>
<td>2 x 2.45 gal/A</td>
<td>0.16 lb/ gal</td>
<td>2 x 0.392 lb/A</td>
</tr>
<tr>
<td>5</td>
<td>Champ WG</td>
<td>2 x 0.392 lb/A</td>
<td>0.50 lb/ lb</td>
<td>2 x 0.196 lb/A</td>
</tr>
<tr>
<td>6</td>
<td>COC DF + ZnS</td>
<td>2 x 0.392 lb/A + 0.073 oz zinc sulfide/A</td>
<td>0.50 lb/ lb</td>
<td>2 x 0.196 lb/A</td>
</tr>
<tr>
<td>7</td>
<td>CS 2005</td>
<td>2 x 0.469 gal/A</td>
<td>0.418 lb/gal</td>
<td>2 x 0.196 lb/A</td>
</tr>
<tr>
<td>8</td>
<td>Cuprofix Ultra 40 Disperss</td>
<td>2 x 0.49 lb/A</td>
<td>0.40 lb/ lb</td>
<td>2 x 0.196 lb/A</td>
</tr>
<tr>
<td>9</td>
<td>Nordox 75 WG</td>
<td>2 x 0.261 lb/A</td>
<td>0.75 lb / lb</td>
<td>2 x 0.196 lb/A</td>
</tr>
<tr>
<td>10</td>
<td>Badge X2</td>
<td>2 x 0.695 lb/A</td>
<td>0.282 lb/ lb</td>
<td>2 x 0.196 lb/A</td>
</tr>
<tr>
<td>11</td>
<td>C-O-C-S WDG</td>
<td>2 x 0.382 lb/A</td>
<td>0.5125 lb/ lb</td>
<td>2 x 0.196 lb/A</td>
</tr>
<tr>
<td>12</td>
<td>Copper Count N</td>
<td>2 x 1 qt/A</td>
<td>0.773 lb/ gal</td>
<td>2 x 0.196 lb/A</td>
</tr>
<tr>
<td>13</td>
<td>Basic Copper 53</td>
<td>2 x 0.37 lb/A</td>
<td>0.53 lb/ lb</td>
<td>2 x 0.196 lb/A</td>
</tr>
<tr>
<td>14</td>
<td>CS2005 + Regalia</td>
<td>2 x 16 fl oz/A + 32 fl oz/A</td>
<td>0.418 lb/gal</td>
<td>2 x 0.052 lb/A</td>
</tr>
<tr>
<td>15</td>
<td>CS2005 + Regalia</td>
<td>1 x 47.7 fl oz/A + 95.4 fl oz/A (150 gal/A)</td>
<td>0.418 lb/gal</td>
<td>1 x 0.160 lb/A</td>
</tr>
<tr>
<td>16</td>
<td>Fireline 17 WP</td>
<td>2 x 1 lb/A (100 gal/A)</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>17</td>
<td>Harbour + Regulaid</td>
<td>2 x 1.5 lb/A + 3 pts/ 100 gal/A</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>18</td>
<td>Untreated Control</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
</tbody>
</table>
Application & Inoculation - Honeycrisp -

• Explosive bloom – **PK** 26 Apr, **KBL** 63% on 27 Apr
• **Sprays:** 29 Apr
• **65-70% bloom (vs. 20, 50%)**
• **Inject:** HFG 16 Apr, PK 24 Apr, PF 7 May, FC 17 May
• 50 gal/A
• **Inoculation:** 30 Apr
• 80% King bloom
• 3 × 10⁶ CFU/ml *E. amylovora*
• Low temp 52.7ºF
Copper
- Shoot blight -

Shoot blight incidence (%)

0.0 10.0 20.0 30.0 40.0 50.0 60.0 70.0 80.0 90.0 100.0

- Copper Sulfate Crystals 0.784 lb
- 2 x Bordeaux Mix 0.784-0.784-50
- 2 x Camelo O @ 1.225 gal
- 2 x Champ WG 0.392 lb
- 2 x CS 200S @ 0.075 oz
- 2 x Nordox 75 @ 0.469 gal
- 2 x Badge X2 @ 0.261 lb
- 2 x Copper Count N 1 qt
- 2 x Basic Copper 53 @ 0.37 lb
- 2 x CS 200S 16 fl oz + Regalia 32 fl oz
- 2 x Harbour 1.5 lb + Regalard 3 pts
- Untreated control
## Fire Blight: Biologicals, Regalia - Treatments -

<table>
<thead>
<tr>
<th>No.</th>
<th>Product</th>
<th>Active ingredient</th>
<th>Amount per acre</th>
<th>Metallic copper per amount of product</th>
<th>Metallic copper equivalent in lb/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Prestop WG</td>
<td><em>Gliocladium catenulatum</em> Strain J1446</td>
<td>2 x 35 oz / A</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>2</td>
<td>Prestop WG</td>
<td><em>Gliocladium catenulatum</em> Strain J1446</td>
<td>2 x 70 oz A</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>3</td>
<td>CS2005 + Regalia</td>
<td>19.8% copper sulfate pentahydrate + 5% extract of plant <em>R. sachalinensis</em></td>
<td>2 x 16 fl oz/A + 32 fl oz/A</td>
<td>0.418 lb/gal</td>
<td>2 x 0.052 lb/A</td>
</tr>
<tr>
<td>4</td>
<td>CS2005 + Regalia</td>
<td>19.8% copper sulfate pentahydrate + 5% extract of plant <em>R. sachalinensis</em></td>
<td>1 x 47.7 fl oz/A + 95.4 fl oz/A</td>
<td>0.418 lb/gal</td>
<td>1 x 0.160 lb/A</td>
</tr>
<tr>
<td>5</td>
<td>Regalia</td>
<td>5% extract of plant <em>R. sachalinensis</em></td>
<td>2 x 64 fl oz / A</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>6</td>
<td>Regalia</td>
<td>5% extract of plant <em>R. sachalinensis</em></td>
<td>3 x 64 fl oz / A</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>7</td>
<td>MBI-10612</td>
<td>12% extract of plant <em>R. sachalinensis</em></td>
<td>2 x 32 fl oz /A</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>8</td>
<td>MBI-110AF5</td>
<td>B. amyloliquefaciens strain F727</td>
<td>2 x 64 fl oz / A</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>9</td>
<td>MBI-10612 – Trunk-injection</td>
<td>12% extract of plant <em>R. sachalinensis</em></td>
<td>2 x 32 fl oz / A</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>10</td>
<td>Regalia – Trunk-injection</td>
<td>5% extract of plant <em>R. sachalinensis</em></td>
<td>2 x 76.8 fl oz /A</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>11</td>
<td>MBI-10612 – Trunk-injection</td>
<td>12% extract of plant <em>R. sachalinensis</em></td>
<td>4 x 32 fl oz /A</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>12</td>
<td>Harbour + Regulaid</td>
<td>17% streptomycin + 90.6% 2-butoxyethanol-ol, poloxalene, monopropylene glycol</td>
<td>2 x 1.5 lb/A + 3 pts</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>13</td>
<td>Fireline 17 WP</td>
<td>17% oxytetracycline</td>
<td>2 x 1 lb/A</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>14</td>
<td>Untreated Control</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
</tbody>
</table>
Biologicals & Regalia
- Blossom blight -

Blossom blight incidence (%)
Biologicales & Regalia
- Shoot blight -

Shoot blight incidence (%)

- 2 x Prestop 35 oz
- 2 x Prestop 70 oz
- 2 x CS2005 16 fl oz + Regalia 32 fl oz
- 1 x CS2005 47.7 fl oz + Regalia 95.4 fl oz
- 2 x Regalia PK, 65.70% @ 64 fl oz
- 2 x MBI-10612 32 fl oz/A (Ba F727)
- 2 x MBI-110AF5@ 64 fl oz/A
- 2 x Regalia injection 76.8 fl oz/A
- 4 x MBI-10612 injection 32 fl oz/A
- 2 x Harbour 1.5 lb + Regulaid 3 pts
- 2 x Fireline 17 @ 1 lb
- Untreated control
Evaluation of dormant copper sprays with bark penetrating surfactants in reduction of *Erwinia amylovora* in cankers and of low-rate copper sprays in blossom blight control

Srdjan G. Aćimović, Christopher L. Meredith
Section of Plant Pathology and Plant Microbe Biology, School of Integrative Plant Science, Cornell University, New York State Agricultural Experiment Station, Highland and Geneva, NY

This research was supported by the New York Apple Research and Development Program

In 2016, fire blight caused severe losses in some New York (NY) apple orchards. Financial damage included apple yield reduction, tree death, and costs of removal of infected trees and wood, and of orchard re-planting. Estimated crop losses ranged between $10,000 and $75,000 per farm. Between 150 and 2500 trees per farm were removed in the NY Champaign Valley apple growing region due to infections of susceptible M9 rootstock. Tree removal continued into spring of 2017, increasing financial losses as latent fire blight infections on rootstock were expressed as tree collapse with ensuing warmer weather. Approximately 20-40% of productive bud wood per farm was lost due to fire blight. Summer-long labor costs for fire blight removal ranged between $27,000 and $75,000 per farm. Cost of bactericides applied after infection was estimated at $25,000 to $55,000 per farm, with repeated applications increasing the potential risk of streptomycin resistance in *Erwinia amylovora* populations.

Varieties that growers plant to fulfill this demand. Second, high demand for fire blight-resistant rootstocks of the Geneva series (G.11, G.16, G.30, G.41, G.202, G.210, G.214, G.890, G.935), coupled with the slow pace and low capacity of their production in nurseries, pushes growers to order new trees from nurseries on the more immediately available but fire blight-susceptible rootstocks such as M.9, M.9-237, M.9-Ne, and LMA 26. Third, since new apple orchards are constantly planted in NY, higher susceptibility of young trees in comparison to mature trees puts apple production at a much higher risk from frequent and destructive fire blight epidemics that can kill many trees in one season, because infections in the young orchards can provide inoculum that spreads over an entire farm or region. Finally, in high-density plantings with spindle-shaped training systems, internal fire blight infections spread faster into the tree trunks because fruiting limbs are much shorter and thinner in comparison to thick, old limbs of classic training systems. Resulting cankers on small diameter trunks, and visible or latent fire blight infections of rootstock, lead to rapid tree death.

Instead, fire blight was a sporadic, relatively rare problem in northeastern NY. Cool weather during bloom did not favor epidemic disease development. However, several low-incidence fire blight outbreaks during late spring or early summer were recorded on several farms over the past several decades (D. Rosenberg, personal communication). Even though fire blight rarely infected cankers were mostly removed by winter pruning at these farms, some fire blight cankers may have remained on old trees and served as primary sources for infection in 2016.

Evaluation of newer biologicals and the SAR-activator candidate Regalia in fire blight control applied by spraying or trunk injection

Srdan G. Aćimović and Christopher L. Meredith
Plant Pathology and Plant Microbe Biology Section, Cornell University, New York State Agricultural Experiment Station, Highland and Geneva, NY

This research was partially supported by the New York Apple Research and Development Program

The 2016 fire blight epidemic caused severe losses in young apple orchards in northeastern and western New York (NY). Based on studies associating global warming with changes in plant pest ranges and degree of infestations, we predict that years with very favorable weather for fire blight epidemics will become more frequent in cool climate regions of the US and the rest of the world (Parenteau et al. 2012; Bebber et al. 2011, Reimer 2015). Besides losses in yield, young trees, and costs of removal of dead trees and wood, plus orchard re-planting costs, some farms in NY applied several bactericides sprays long after the infections had become established on opened flowers at the end of bloom. Even though this practice can prevent further pathogen spread to new shoots, surface-applied bactericides are ineffective once the fire blight bacterium *Erwinia amylovora* enters the apple xylem or bark. In cases where, instead of copper, streptomycin was used after the infections became visible, repeated applications of this antibiotic might have increased the risk of streptomycin resistance.

Due to prevalent use of antibiotics in animal production and occurrence of antibiotic resistance in clinical pathogens in hospitals, antibiotics are not considered to be as acceptable for use in agriculture as they were in the past. Even though the mechanisms for transferring the resistance genes are distinct between human and plant pathogens (Sinndel 2002), fear of potential transfer of antibiotic resistance from environmental bacteria to clinical pathogens promotes scrutinized use of antibiotics in all agriculture. As of 2014, use of antibiotics is prohibited in organic apple production. In addition, effective bactericides for plant protection are becoming very rare and difficult to get approved by EPA. Finally, due to toxic effects of metallic copper on soil fauna, per-acre yearly limits on spray-use of copper products are currently being reconsidered. However, the main benefit of copper as a bactericide is that low rates can be used to prevent spread of secondary shoot blight infections during the summer. In search of alternative plant protection materials for fire blight, previous research on biologicals, plant growth regulators, and SAR-activator candidate Regalia for blossom and shoot blight management.

Due to the potential risk of streptomycin resistance, it is important to develop new treatment methods. The use of biologicals, such as bacteria and viruses, could be an effective strategy to control fire blight. Biologicals are living organisms that can inhabit soils. The strain 1446 of this fungus in Pestop was isolated from Finnish field soil and
Conclusions

• NEWA EIP use to time streptomycin
• RIMpro scab prediction a must-have
• Post-infection Apogee reduces/prevents canker development
• Low rate coppers and biologicals – poor efficacy
  – 2018 FB infection before trial set
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- Cooley Lab, UMass
- Jon Clements, UMass
- Cold Spring Orchard Research & Education Center Belchertown, MA

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- Seth, Mason & Mac Forrence
- Forrence Orchards
- Jay Toohil, Chazy Orchards
- Randy Hart, Hart Apple Farm
- Everett brothers, Everett Orchards
- Jesse Mulbury, Northern Orchard
- Kevin Bowman, Bowman Apples
- Peter Ten Eyck, Indian Ladder Farms
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- Robert & Doug Minard, W.G. Minard and Sons
- Danny Albinder, Shawn Bixby Hudson River Fruit

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**Hudson Valley Research Laboratory**

Jentsch Lab, Cornell’s HVRL
Dr. David Rosenberger
Thank You for Attention!

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Questions . . .