Managing Apple and Peach Diseases with Notes on the Strengths and Weaknesses of Sulfur

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Common Apple Diseases in Illinois

Spring Diseases
- Scab
- Fire Blight (bacterial)
- Powdery Mildew
- Rusts
- Phytophthora Root Rot

Summer Diseases
- Sooty Blotch/Flyspeck
- Fruit Rots
  - Black Rot
  - Bitter Rot
  - White Rot
Common Peach Diseases in Illinois

- Peach Leaf Curl
- Brown Rot
- Powdery Mildew
- Scab
- Bacterial Spot
Managing Apple and Peach Diseases with Notes on the Strengths and Weaknesses of Sulfur
Brief History of Sulfur

- 1000 BC: pest-averting sulfur
- 1850: dusting sulfur for disease control
- 1852: lime-sulfur for grape mildew
- 1884: Bordeaux mixture + sulfur for grape
- 1923: wettable sulfur for plant diseases
- 1970: flowable sulfur for pests
- 1990s: micronized sulfur (less toxic)
Extraction of sulfur in Indonesia
Sulfur for Tree Fruit Diseases

- Sulfur is a powdery mildew fungicide
- Sulfur is a protectant fungicide
- Sulfur is not prone to resistance development in fungi
- Sulfur is available for both organic and conventional crop production
Sulfur fungicides:

- Elemental sulfur: powdery mildews
- Wettable sulfur: foliar diseases
- Flowable sulfur: foliar diseases
- Lime-sulfur: eradicant

Mechanism of action: hydrogen sulfide

Sulfur is phytotoxic above 88°F
### Efficacy of Sulfur Compounds for Apple Diseases

<table>
<thead>
<tr>
<th>Disease</th>
<th>Fire Blight</th>
<th>Scab</th>
<th>Powdery Mildew</th>
<th>Rusts</th>
<th>Bitter Rot</th>
<th>Black Rot</th>
<th>White Rot</th>
<th>Sooty Blotch / Flyspeck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Blight</td>
<td>P</td>
<td>F</td>
<td>G</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
</tr>
</tbody>
</table>

- = unknown; P = poor; F = fare; G = good

### Efficacy of Sulfur Compounds for Peach Diseases

<table>
<thead>
<tr>
<th>Disease</th>
<th>Leaf Curl</th>
<th>Brown Rot</th>
<th>Brown Rot</th>
<th>Powdery Mildew</th>
<th>Scab</th>
<th>Bacterial Spot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf Curl</td>
<td>_</td>
<td>F</td>
<td>P</td>
<td>G</td>
<td>G</td>
<td>P</td>
</tr>
</tbody>
</table>

- = unknown; P = poor; F = fare; G = good

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Major Apple and Peach Diseases in Illinois in the Past three Years

**Apples**
- Scab
- Fire Blight
- Fruit Rots
  - Bitter Rot
  - White Rot

**Peaches**
- Brown Rot
- Bacterial Spot
## Efficacy of Compounds for Apple Scab

<table>
<thead>
<tr>
<th>Fungicide</th>
<th>FRAC Code</th>
<th>Scab</th>
<th>Fungicide</th>
<th>FRAC Code</th>
<th>Scab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bayleton</td>
<td>3</td>
<td>P</td>
<td>Rally</td>
<td>3</td>
<td>E</td>
</tr>
<tr>
<td>Captan</td>
<td>M</td>
<td>G</td>
<td>Rubigan</td>
<td>3</td>
<td>E</td>
</tr>
<tr>
<td>Flint</td>
<td>11</td>
<td>E</td>
<td>Scala</td>
<td>9</td>
<td>G</td>
</tr>
<tr>
<td>Indar</td>
<td>3</td>
<td>E</td>
<td>Sovran</td>
<td>11</td>
<td>E</td>
</tr>
<tr>
<td>Inspire Super</td>
<td>3</td>
<td>E</td>
<td>Sulfur</td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>Mancozeb</td>
<td>M</td>
<td>G</td>
<td>Syllit</td>
<td>M</td>
<td>E</td>
</tr>
<tr>
<td>Polyram</td>
<td>M</td>
<td>G</td>
<td>Topsin-M</td>
<td>1</td>
<td>E</td>
</tr>
<tr>
<td>Pristine</td>
<td>11+7</td>
<td>E</td>
<td>Vangard</td>
<td>9</td>
<td>G</td>
</tr>
<tr>
<td>Procure</td>
<td>3</td>
<td>E</td>
<td>Ziram</td>
<td>M</td>
<td>F</td>
</tr>
</tbody>
</table>
Apple fire blight in Illinois
Apple fire blight in Illinois
Apple fire blight in Illinois
Control of Fire Blight of Apple

- Copper application at silver-tip
- Streptomycin application after hail damage
- Streptomycin application at bloom
  Streptomycin application as predicted by MARYBLIT or Cougar Blight
Streptomycin for Fire Blight of Apple

- 1950s: Streptomycin use began
- 1971: Streptomycin-resistance in California
- By 2010: Streptomycin-resistance in western US, Michigan, New York, Canada, Israel
Apple Fire Blight in Illinois

- 2008: widespread and severe infection
- 2009: widespread and severe infection
- 2010: low incidence
Apple Fire Blight in Illinois

- Initiated a research to determine whether there are Streptomycin-resistant strains of the causal bacterium (*Erwinia amylovora*)
2010
Orchards Surveyed
PCR Identification:
Primers AJ 75/76; targeting plasmid pEA 29 (McManus and Jones, 1995)
## 2010 Streptomycin Resistance Status Report

<table>
<thead>
<tr>
<th>County</th>
<th>Strikes</th>
<th><em>Erwinia amylovora</em> 50ppm</th>
<th>Other Bacteria 50ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boone</td>
<td>15</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Calhoun</td>
<td>36</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Champaign</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Jersey</td>
<td>29</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Kane</td>
<td>11</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Macoupin</td>
<td>9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Madison</td>
<td>10</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Marshall</td>
<td>16</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>McHenry</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Peoria</td>
<td>11</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Putnam</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sangamon</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>St.Clair</td>
<td>42</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Winnebago</td>
<td>4</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Woodford</td>
<td>7</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Totals</td>
<td>218</td>
<td>0</td>
<td>22</td>
</tr>
</tbody>
</table>
Agri-Mycin 17

*Erwinia amylovora* isolates:

- Michigan streptomycin-resistant
- Calhoun, IL - 2010

- 25 ppm
- 50 ppm
- 100 ppm
- 0 ppm
Agri-Mycin 17

Erwinia amylovora isolates:

Michigan streptomycin-resistant

Calhoun, IL - 2010

25 ppm

0 ppm

50 ppm

100 ppm
Agri-Mycin 17

Erwinia amylovora isolates:

Michigan streptomycin-resistant

Jersey, IL - 2010

25 ppm

0 ppm

50 ppm

100 ppm

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**Agri-Mycin 17**

*Erwinia amylovora* isolates:

- Michigan streptomycin-resistant
- St. Clair, IL - 2010

Test concentrations:
- 25 ppm
- 0 ppm
- 50 ppm
- 100 ppm

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Agri-Mycin 17

*Erwinia amylovora* isolates:

Michigan streptomycin-resistant

Boon, IL - 2010

- 0 ppm
- 25 ppm
- 50 ppm
- 100 ppm
Agri-Mycin 17

*Erwinia amylovora* isolates:
Macoupin, IL - 2010

25 ppm

0 ppm

50 ppm

100 ppm

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Bitter rot or apples
## Fungicides for Summer Diseases of Apples

<table>
<thead>
<tr>
<th>Fungicide Application</th>
<th>Diseases</th>
<th>Appl. Inter. (Days)</th>
<th>Suggested Fungicides</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Cover</td>
<td>Scab, Fruit Rot</td>
<td>10-14</td>
<td>Sovran (or Pristine)+ Ziram</td>
</tr>
<tr>
<td>Second Cover</td>
<td>Scab, Fruit Rot</td>
<td>10-14</td>
<td>Topsin-M + Captan</td>
</tr>
<tr>
<td>Third Cover</td>
<td>Sooty Blotch/Flyspeck, Fruit Rot</td>
<td>10-14</td>
<td>Sovran (or Pristine)+ Ziram</td>
</tr>
<tr>
<td>Fourth Cover</td>
<td>Sooty Blotch/Flyspeck, Fruit Rot</td>
<td>10-14</td>
<td>Topsin-M + Captan</td>
</tr>
<tr>
<td>Fifth Cover</td>
<td>Sooty Blotch/Flyspeck, Fruit Rot</td>
<td>10-14</td>
<td>Sovran (or Pristine)+ Ziram</td>
</tr>
<tr>
<td>Sixth Cover</td>
<td>Sooty Blotch/Flyspeck, Fruit Rot</td>
<td>10-14</td>
<td>Topsin-M + Captan</td>
</tr>
<tr>
<td>Seventh Cover</td>
<td>Sooty Blotch/Flyspeck, Fruit Rot</td>
<td>10-14</td>
<td>Sovran (or Pristine)+ Ziram</td>
</tr>
<tr>
<td>Eighth Cover</td>
<td>Sooty Blotch/Flyspeck, Fruit Rot</td>
<td>10-14</td>
<td>Topsin-M + Captan</td>
</tr>
</tbody>
</table>
Disease-Warning System: Moisture
All Summer Diseases of Apple

- **175 h leaf wetness (4 h)**
- **Threshold: 175 h after the first cover spray**
Watchdog Leaf Wetness/Temperature Logger
175 h Leaf Wetness (4 h)- Illinois

- Tested in 22 commercial orchards
- All summer diseases: 2001-2010
  - Sooty Blotch/Flyspeck
  - Fruit rots (bitter, black, white rots)
- Spring diseases (scab, powdery mildew, rusts,...) were also evaluated
Illinois
2001-2010
<table>
<thead>
<tr>
<th>Year</th>
<th>No of Orchards</th>
<th>Sprays Saved [No. (%)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>6</td>
<td>3.0 (43%)</td>
</tr>
<tr>
<td>2002</td>
<td>6</td>
<td>3.5 (50%)</td>
</tr>
<tr>
<td>2003</td>
<td>11</td>
<td>3.1 (44%)</td>
</tr>
<tr>
<td>2004</td>
<td>14</td>
<td>3.0 (43%)</td>
</tr>
<tr>
<td>2005</td>
<td>5</td>
<td>3.0 (43%)</td>
</tr>
<tr>
<td>2006</td>
<td>8</td>
<td>4.0 (57%)</td>
</tr>
<tr>
<td>2007</td>
<td>7</td>
<td>3.2 (46%)</td>
</tr>
<tr>
<td>2008</td>
<td>8</td>
<td>3.3 (47%)</td>
</tr>
<tr>
<td>2009</td>
<td>8</td>
<td>3.0 (43%)</td>
</tr>
</tbody>
</table>

No. of Orchards: 22

Average: 3.23 (46%)
Reasons for Failure on Effective Control of Apple and Peach Diseases

- Pathogen resistance: less likely
- Timely application of fungicides
- Using effective fungicides
- Cultural practices (moisture)
- Good pruning
- Soil drainage
- Weed control
Questions/Comments