Pecan scab management

Clive Bock, USDA-ARS-SEFTNRL, Byron, GA
Structure of presentation

- Describe the disease and pathogen
- Major considerations to manage pecan scab
  - Cultivars
  - Air-blast sprayers and sprayer set-up
  - Spraying options (volutes, aerial)
  - Tree size (tree management/mechanical hedge-pruning/spacing)
  - Timing of sprays (pre or post pollination)
  - Chemistry (conventional and organic)
Pecan scab (*Venturia effusa*)

- Lifecycle of *Venturia effusa*, cause of pecan scab

**Polycyclic disease (rain and wind)**

- Epidemics build up on young leaves (conidia)

**Epidemics build up on fruit (conidia)**

- Fungicide applications to control scab

- Late August to early September

**Fungus becomes dormant as stroma and overwintering conidia (twigs and shucks)**

**Overwinters as stroma and conidia**

The sexual stage of this fungus has been identified (Drs. Young and Charlton, Noble Research Institute).

The role of the spores produced by the sexual stage are unknown but may play an important role in disease development.
Cultivars, tree size, and appropriate equipment

- If planting new in the southeastern region endeavor to obtain scab resistant cultivars (Excel, Elliott, Avalon,....). Availability?
- Susceptible cultivars will require fungicide sprays in most or all seasons/locations (and they are very widely grown)
- It is possible to spray small trees with less powerful sprayers (<25-30 ft)
- Once tree height exceeds ~25 ft, a full sized orchard sprayer is a necessity
Sprayer set-up and coverage

- ⅔ to ¾ of spray directed to upper ½ of the canopy
- Adjust the vanes/sprayer nozzles accordingly
- Even with perfectly adjusted vanes, the velocity of the air declines with distance from the sprayer
- Volume can be determined based on tree size
- Sprayer calibration

Small to medium height trees (<40 ft)

Upper 10 nozzles: 2 x D7-45, 4 x D6-45, 4 x D5-45
Lower 7 nozzles: 4 x D5-45, 2 x D4-45, 1 x D3-45

88 GPA @ 1.5 mph for a 60 ft spacing

Mature, tall trees (>40 ft)

Upper 12 nozzles: 2 x D7-45, 6 x D6-45, 4 x D5-45
Lower 6 nozzles: 2 x D5-45, 2 x D4-45, 2 x D3-45

93 GPA @ 1.5 mph for a 60 ft spacing

Adapted from Sumner (2004)

Spray distribution and disease

- Spray coverage declines with tree height
- Planting distance/tree structure
- Air-blast sprayers provide good protection up to ~40 ft.
- Protection dependent on season


Fruit weight with tree height

The relationship between scab and fruit weight at different heights

Results from an experiment in 2013 (a wet, scab conducive year) in non-hedged trees of cv Desirable

- The nuts will be larger and of higher quality where spray coverage (scab control) is better
- Hedge-pruning reduces tree height and ensures more spray reaches the foliage and fruit

Tree size - hedging

- Hedge pruning reduces tree height
- More spray reaches the foliage and fruit
- Tall, non-hedged trees have significantly more severe scab (and hence yield loss)
- A 2 to 4 y cycle of hedging? In regard to scab control, shorter trees will always be better

Sprayer set-up - volutes

- Increases spray volume going to the upper canopy of tall trees
- Do not have much data on the spray coverage or efficacy of volutes applied spray

Demonstration spray results at USDA-ARS-SEFTNRL pecan field day, September 2015. Spray applied using a regular orchard sprayer (no volute) or spray applied using a volute
<table>
<thead>
<tr>
<th></th>
<th>5.0</th>
<th>7.5</th>
<th>10.0</th>
<th>12.5</th>
<th>15.0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control</strong></td>
<td>a</td>
<td>b</td>
<td>b</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td><strong>Ground</strong></td>
<td>c</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td>c</td>
</tr>
<tr>
<td><strong>Aerial</strong></td>
<td>c</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td>c</td>
</tr>
<tr>
<td><strong>Gnd_Air</strong></td>
<td>c</td>
<td>c</td>
<td>c</td>
<td>c</td>
<td>c</td>
</tr>
</tbody>
</table>

The same number/timing of aerial sprays as ground may provides a similar level of control

Both combined minimize disease throughout canopy

If limited then apply as many aerial sprays as possible to complement ground sprays during nut development

Economics?

---

The table and graph show the comparison of control, ground, aerial, and ground-air treatments for different heights and dates, with scab severity (% fruit surface scabbed) and height (m). The treatments are compared for 2013 and 2014 with different number of sprays applied. The interactions between treatment and height are statistically significant for both years, with F-values of 16.0 (P<0.0001) and 8.7 (P<0.0001) respectively.

Ground = 100 GPA  
Aerial = ~10 GPA  

Bock et al. (unpublished)
Chemistry and timing of sprays (pre/post pollination)

- UGA spray guide outlines well the chemistries and timing of sprays available for managing pecan scab
- Two periods: Pre pollination (10-14 day intervals) and post pollination (10 to 21 day intervals)
- Some fungicides are known to be inherently efficacious on leaf or nut scab
- Tin and Elast on fruit (also combinations and Quadris top)
- Phosphites and other products on foliage
- Fungicide resistance is an issue and should be considered in the program
Fungicides available to manage pecan scab (GA Pest Management Handbook, http://www.ent.uga.edu/pmh/)

<table>
<thead>
<tr>
<th>No.</th>
<th>Fungicide group</th>
<th>FRAC code</th>
<th>Common name</th>
<th>Trade names</th>
<th>Risk of resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MBCs (benzimidazoles)</td>
<td>1</td>
<td>thiophanate-methyl</td>
<td>Topsin-M</td>
<td>High</td>
</tr>
<tr>
<td>2</td>
<td>DMIs (sterol inhibitors)</td>
<td>3</td>
<td>Propiconazole</td>
<td>Orbit, Propimax, Bumper, Quilt, Quilt Excel</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Febuconazole</td>
<td>Enable</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tebuconazole</td>
<td>Folicur, Tebuzeole, Monsoon, Orius, Toledo, Absolute</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Metaconazole</td>
<td>Quash</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Difenconazole</td>
<td>Quadris Top</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>QoIs (strobilurins)</td>
<td>11</td>
<td>Kresoxim-methyl</td>
<td>Sovran</td>
<td>Medium-low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Azoxystrobin</td>
<td>Abound, Quilt, Quilt Excel, Quadriss Top</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pyraclostrobin</td>
<td>Headline</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Trifloxystrobin</td>
<td>Absolute</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Guanadines</td>
<td>U12</td>
<td>Dodine</td>
<td>Elast</td>
<td>Medium-low</td>
</tr>
<tr>
<td>5</td>
<td>Organotins</td>
<td>30</td>
<td>Fentin hydroxide</td>
<td>SuperTin</td>
<td>Medium-low</td>
</tr>
<tr>
<td>6</td>
<td>phosphites</td>
<td>33</td>
<td>Phosphorous acid</td>
<td>Phostrol, Prophylt Fungiphite, Reliant</td>
<td>Medium-low</td>
</tr>
<tr>
<td>7</td>
<td>Ziram</td>
<td>M3</td>
<td>Zinc dimethylidithiocarbamate</td>
<td>Ziram</td>
<td>Low</td>
</tr>
</tbody>
</table>
Phosphites – updates

- Fungicide resistance is an issue in scab
- Phosphites are efficacious – particularly on foliage
- We have demonstrated that higher rates effective on fruit
- Worked with the pecan industry to generate data on phosphite usage in light of recent phosphite MRLs in the EU
- MRL ruling in Dec 2017 = 500 ppm

Phosphites are efficacious – fruit and foliage

- Residues were an issue 2013-2018 – now resolved

Higher rates are more efficacious – especially on fruit

Higher rates are more efficacious – especially on fruit

Rate of phosphite (in 100 g/acre)

Scab severity (percent area infected)

Residues were an issue 2013-2018 – now resolved

Phosphite applied at 3 pt/100 g/acre

Scab severity (percent area infected)

Phosphite applied at 3 pt/100 g/acre

Organic chemistry to manage scab

- Historically Bordeaux mixture (hydrated lime + copper sulfate) was used to manage scab (~1960)

- We have tested Bordeaux mixture in multiple trials over several years and at two sites. Number of applications:
  - Byron, GA 2011 (6), 2012 (5), 2014 (5), 2015 (6) and 2016 (6)
  - Colquitt, GA 2014 (5) and 2015 (5)

- Efficacy is not reliable, and level of control is not particularly impressive

- Although some historical reports indicated it could be effective

Fruit disease assessments:
- Colquitt, GA 2014 (20 Aug) and 2015 (1 Sep)

Means within the same year with different letters are significantly different ($\alpha = 0.05$)
New organic chemistry?

- Explored a range of OMRI approved alternatives to Bordeaux mixture
- A total of 5 sprays applied in both 2012 and 2014
- Assessments made on 19 October 2012 and 18 August 2014
- Regalia consistently, and to a lesser extent Serenade reduced severity of pecan scab
- Efficacy variable between years with different products (inoculum pressure?)

<table>
<thead>
<tr>
<th>Product</th>
<th>2012 Scab severity</th>
<th>2014 Scab severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bordeaux mix</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Compost tea</td>
<td>cd</td>
<td>cd</td>
</tr>
<tr>
<td>Sodium bicarbonate</td>
<td>bc</td>
<td>bc</td>
</tr>
<tr>
<td>Serenade</td>
<td>ab</td>
<td>a</td>
</tr>
<tr>
<td>Sulphur</td>
<td>ab</td>
<td>a</td>
</tr>
<tr>
<td>Nordox 75WG</td>
<td>bc</td>
<td>ab</td>
</tr>
<tr>
<td>Regalia</td>
<td></td>
<td>d</td>
</tr>
</tbody>
</table>

Summary

- Scab is a difficult disease to manage.
- Fortunately there are several angles from which we can approach management of scab:
  - Cultivars (if planting a new orchard select a scab resistant cultivar if possible)
  - Tree spacing (wider the better to reduce scab)
  - Tree size (hedge-pruning?)
  - Chemistry (alternate modes of action). Organic options available
  - Ground and aerial application (ensure calibrated appropriately)
Acknowledgements

Funding:

Georgia Commodity Commission for Pecans
USDA-ARS project 6606-21220-011-00D
USDA-National Institute of Food and Agriculture award #2013-51106-21234
(Organic Transitions Program)

Collaborators and technical assistance at the USDA-ARS, Byron:

Dr. Mike Hotchkiss, Dr. Bruce Wood (retired), Wanda Evans, Minling Zhang,
Unicka Stokes, Sue Burrell, Jason Shipp, Caylee Carson, Sarah Morrel

Collaborators at the University of Georgia, Tifton:

Dr. Tim Brenneman, Dr. Lenny Wells, Dr. Katy Stevenson
Thank you

Questions?