Spraying pecans for disease: sprayer set up, calibration, application and limitations

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Spray applications are needed to manage disease and insect pests

- Depending on cultivar, pecan is susceptible to a number of diseases and pests in the southeastern US
- They can cause significant, and sometimes total economic loss
- Management requires regular and sometimes intense application of fungicides and insecticides
- Orchard air-blast sprayers are the most commonly used equipment for application of sprays
- May be used to apply nutrients too

Today:

- Describe the process of orchard air-blast sprayer set up and calibration
- Go over points to ensure optimal coverage
- Present some results of research on disease control using these sprayers
- Assess some of the limitations
- Summarize presentation
Sprayer set up – tree height and volume of spray

- Apply appropriate volume to maximize spray coverage and minimize drift and spray wastage

- Up to 25 ft: 20 GPA
- 25 to 50 ft: 50-90 GPA
- >50 ft: 100-150 GPA

Sprayer set up - partitioning of spray volume

- Need to direct appropriate amount of spray towards upper and lower canopy
- Adjust direction of nozzles and vanes
- Maximizes deposition in these sectors
- Tree size should be taken into consideration

Small to medium height trees (<40 ft)

Mature, tall trees (>40 ft)

Sprayer calibration – volume, speed and associated calculations

- The basis for applying the correct amount of pesticide
- Probably not done often enough
- Important because if sprayer is calibrated for a particular volume (e.g. 100 GPA), spraying more (or less) will impact disease/pest management

There are knowns and unknowns:

- Knowns:
  - Gallons per acre (GPA) desired (usually 25 to 150)
  - Sprayer pressure – pounds/square inch (PSI, 60 to 260 psi)
  - Miles per hour (MPH) desired (1-3 mph)
  - Number of nozzles on sprayer (variable)
  - Tree row width (between rows, variable)
  - Spraying one or both sides of the sprayer

- Unknowns:
  - Gallons per minute (GPM) output needed
  - Nozzles (sizes and placement)
Sprayer calibration – volume, speed and associated calculations

Example:

(1) GPA = 100
(2) PSI = 150 at the manifold
(3) MPH = 1.5 (selected travel speed, usually 1.5 – 2.5 mph)
(4) Number of nozzles = 18
(5) Row width = 60 feet
(6) Spraying from both sides of sprayer

- Need to calculate i) gallons per minute needed based on desired requirements, and ii) the actual nozzle output required which is used to select a suitable range of nozzles:

\[
GPM = \frac{GPA \times MPH \times \text{Row Spacing} (\text{ft})}{495 \text{ (spraying both sides)}}
\]

\[
\text{Nozzle output} = \frac{\text{Total GPM}}{\text{No. nozzles}}
\]

- Nozzle volumes at different pressures are obtained from manufacturers specification tables

Mature, tall trees (>50 ft)
Sprayer calibration – volume calculations

Example:

\[
GPM = \frac{\text{GPA} \times \text{MPH} \times \text{Row Spacing (ft)}}{495} \text{ (spraying both sides)}
\]

\[
18.18 = \frac{100 \times 1.5 \times 60}{495}
\]

Flow rate = 18.18 GPM (~18 GPM)

Large trees need:
- \( \frac{3}{4} \) of the volume directed to the upper \( \frac{1}{2} \) of the tree
- \( \frac{1}{4} \) of the volume directed to the lower \( \frac{1}{2} \) of the tree

Thus:
- \( \frac{3}{4} \times 18 = 13.5 \) GPM
- \( \frac{1}{4} \times 18 = 4.5 \) GPM

- Need to select discs and whirls accordingly to provide these volumes

Nozzle output = \( \frac{\text{Total GPM}}{\text{No. nozzles}} \)

1 GPM = \( \frac{18}{18} \)
Sprayer calibration - nozzle selection

- Appropriate nozzle selection should be made to:
  - Ensure the correct selection of droplet sizes
  - Output the correct volume

- Discs and swirl plates in spray nozzles used for pecan air-blast sprayers:
  - Nozzle discs: D3-D7
  - Core or swirl plates: 25 to 45
Aiming for 18 GPM (13.5 GPM upper, 4.5 GPM lower)

Obtained 17.80 GPM (13.84 GPM upper, 3.96 GPM lower), which is close enough

<table>
<thead>
<tr>
<th>Spray direction (volume)</th>
<th>Disc</th>
<th>Whirl</th>
<th>Flow rate per nozzle</th>
<th>Number of nozzles</th>
<th>Total volume per nozzle size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper ½ (¾ GPM)</td>
<td>5</td>
<td>45</td>
<td>0.86</td>
<td>4</td>
<td>3.44</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>45</td>
<td>1.15</td>
<td>2</td>
<td>2.30</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>45</td>
<td>1.35</td>
<td>6</td>
<td>8.10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Subtotal 13.84</td>
</tr>
<tr>
<td>Lower ½ (¼ GPM)</td>
<td>3</td>
<td>45</td>
<td>0.44</td>
<td>2</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>45</td>
<td>0.68</td>
<td>2</td>
<td>1.36</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>45</td>
<td>0.86</td>
<td>2</td>
<td>1.72</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Subtotal 3.96</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total 17.80</td>
</tr>
</tbody>
</table>
Sprayer calibration – nozzle output check

- Sprayer now calibrated to deliver 17.80 GPM (13.84 GPM upper, 3.96 GPM lower)
- Suitable for spraying large trees
- Now need to confirm **actual** output

Sprayer calibration – checking output and speed

1. Checking volume
   - Set sprayer at operating PSI
   - Connect hose to nozzles
   - Run sprayer. Collect output for 60 seconds and measure volume (GPM). Repeat if necessary (can use flow meter as alternative)
   - Can also operate for a measured period and check volume required to refill

2. Checking speed
   - Measure a distance of 300 feet
   - Set tractor speed and record time
     (Can also measure distance travelled in a set time period)

<table>
<thead>
<tr>
<th>Speed (mph)</th>
<th>Time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>136</td>
</tr>
<tr>
<td>2.0</td>
<td>102</td>
</tr>
<tr>
<td>2.5</td>
<td>82</td>
</tr>
<tr>
<td>3.0</td>
<td>68</td>
</tr>
<tr>
<td>3.5</td>
<td>58</td>
</tr>
</tbody>
</table>

\[
\text{Time to travel 300 ft at different speeds}
\]

Attach hose to nozzles

1. Measure volume sprayed in a given time period
2. Check speed by travelling set distance

\[
distance = speed \times time
\]

\[
speed = \frac{distance}{time}
\]

\[
time = \frac{distance}{speed}
\]

5280 ft/mile
60 minutes in an hour
Sprayer calibration – checking output and speed

3. Calculate actual GPA being applied:

\[
GPA = \frac{\text{GPM}_{\text{measured}} \times 495}{\text{MPH} \times \text{Row Spacing (ft)}}
\]

As before, 495 is a conversion factor for two-sided spraying. Use 990 as the denominator for single-sided spraying.

If discrepancy between chosen GPA and measured GPA is small, adjust pressure slightly to increase or decrease flow.
Calibration is important!!

- Calibration should be checked:
  1) immediately following setting up the sprayer with new nozzles, and
  2) periodically during the season

- If actual speed/distance/time or GPM values are different to those calculated, there is an issue:
  - Worn nozzles
  - A leak
  - Wrong calculations
  - Speedometer or pressure gauge malfunctioning

- If >10% error compared to the original calibration or calculated output there is an issue that should be rectified

- Even when correctly calibrated coverage has limitations......
Distribution of fruit in the tree

- Distribution of fruit on a mature tree has been characterized (Lozano-Gonzalez et al. 1992)
- Approximately 50% of the yield is in the upper half of the tree, and approximately 50% in the lower half

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


Wind speeds produced by an air-blast sprayer

Wind profile from an air-blast sprayer

- Wind speed velocity 2 m (6.5 ft) from the fan is substantial (>20 m/sec [45 mph])

- The wind impacts stationary air and consequently there is a rapid decline in wind speed:

\[ y = 15.5e^{-0.1x} \]

\[ R^2 = 0.98 \]

Bock et al., (unpublished data)
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

Hedge-pruning ~60 ft trees to ~40 ft

2013

- 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

F-value = 6.2
P-value = 0.002

2014

- Scab severity (% fruit surface scabbed)

F-value = 26.6
P-value = <0.0001

Scab severity (% fruit surface scabbed)

Use of volutes

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

Bock, unpublished results. 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
Other things to consider

- Aerial application
- Chemistry and timing of sprays (pre/post pollination)
- Scab forecasts
- Volume applied vs. concentration of active ingredient
Summary

- Sprayers should be accurately calibrated to ensure they are delivering the set quantity
- Requires ensuring volume applied and speed is appropriate
- Tall pecan trees are inherently difficult to manage disease
- Spray coverage declines with tree height
- Hedge-pruning, aerial applications and volutes?
- Need more research to advocate specific recommendations on aerial spray programs and volutes
Acknowledgements

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Questions?