Application Strategies for Soybean Rust Control

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What application system?
Questions to Ask?

- What fungicide or combination of fungicides to use?
- Will multiple applications be necessary?
- At what stage of the disease should the application(s) occur?
- What application volume (GPA) will be needed?
- What spray nozzle type, orifice size, and pressure will be necessary for good coverage?
Questions continued:

• Will a specific droplet size be necessary?
• Are tank mix combinations with herbicides allowed?
• Will adjuvants benefit fungicide applications?
• What application system would be best to use? Aerial? Ground? Chemigation, other?
Questions continued:

• Are there any spray technologies that would help the fungicide application process?
• What environmental conditions should be avoided?
Application Strategies

• Follow the label!!!!
• Any spray system should work.
• Appropriate application practices include:
  - Starting with proper identification.
  - Selecting the correct fungicide or combination.
  - Applying at the proper time or times.
  - Selecting the proper application parameters to give ample coverage into the soybean canopy.
Spray Droplet Management!

- Need knowledge of the product being used.
- **Herbicide, Fungicide, Insecticide**
  - Systemic
  - Contact
- Uniform coverage.
- What is the target?
  - Soil
  - Grass
  - Broadleaf (smooth, hairy, waxy)
  - Leaf orientation - time of day
  - Penetration into canopy
Application Volume Critical

- Label? 10 - 15 - 20 GPA??
- How is this different from a typical herbicide application GPA?
- Will not match a fungicide application rate.
- Data supports increasing the GPA will improve canopy penetration.
- Calibration becomes essential!!!
- Speed will be a major issue - slower!!!
Application Speed

- Speed based on:
  - Field conditions
  - Nozzle type
  - Orifice size selected
  - Operating pressure requirements

- Slower will improve canopy penetration.

- Droplet size requirements will ultimately determine the parameters.

\[
GPM = \frac{GPA \times MPH \times W}{5940}
\]
1/2 of spray **volume** = smaller droplets

1/2 of spray **volume** = larger droplets
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Category</th>
<th>Code</th>
<th>Apx. VMD</th>
<th>Relative Size</th>
<th>Comparative Size</th>
<th>Atomization</th>
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<tbody>
<tr>
<td>VF</td>
<td>Very Fine</td>
<td>Red</td>
<td>&gt;150</td>
<td></td>
<td></td>
<td>Fog</td>
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<tr>
<td>F</td>
<td>Fine</td>
<td>Orange</td>
<td>151-250</td>
<td>Point of Needle</td>
<td>Human Hair (100 Microns)</td>
<td>Fine Mist</td>
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<td>M</td>
<td>Medium</td>
<td>Yellow</td>
<td>251-350</td>
<td>Sewing Thread (150 Microns)</td>
<td>Fine Drizzle</td>
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<tr>
<td>C</td>
<td>Coarse</td>
<td>Blue</td>
<td>351-450</td>
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<tr>
<td>VC</td>
<td>Very Coarse</td>
<td>Green</td>
<td>451-550</td>
<td>Staple (420 Microns)</td>
<td>Light Rain</td>
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<tr>
<td>EC</td>
<td>Extremely Coarse</td>
<td>White</td>
<td>&gt;551</td>
<td>#2 Pencil Lead (2000 Microns)</td>
<td>Thunderstorm</td>
<td></td>
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</tbody>
</table>

Source: Crop Life – July 2002
200-300 microns
# AGRICULTURAL SPRAY TIP GUIDE

![Hypro Logo](www.hypro.com)

## Broadcast and Turf Applications Chart

Pressure range at which each tip is recommended

<table>
<thead>
<tr>
<th>Spray Tips</th>
<th>Droplet Size <strong>1</strong></th>
<th>Gallons per acre (20 inch nozzle spacing)</th>
<th>GAL/1000 Ft.² (20 inch nozzle spacing)</th>
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</thead>
<tbody>
<tr>
<td>PS Range</td>
<td>GPM</td>
<td>4</td>
<td>5</td>
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<td>15-20-50</td>
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<td>20-50</td>
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<td>30-50</td>
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<td>50-60</td>
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<td>0.11</td>
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<tr>
<td>60-70</td>
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<td>60</td>
<td>0.12</td>
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</table>

Tip Filter Mesh Recommendation:

- 015 - 0.15 gallons per minute at 40 psi
- ASAE S-572 Droplet Classification at 40 psi
- Spray tip part number tells you the type of spray tip (organized by droplet size):
  - ULD - Ultra Lo-Drift
  - AVI - Air Injected Anti-Drift
  - TR - Total Range
  - VP - Variable Pressure
  - AXI - Wide Range
  - LD - Lo Drift
  - ADI - Anti Drift
  - F - Fan
  - API - Flat Fan

Spray angle:
- 120° - 120° spray pattern
- 110° - 110° spray pattern
- 80° - 80° spray pattern

Recommended Application:

Spray Tips Represented in Chart

Gallons per minute at 40 psi:

- 015 - 0.15 gallons per minute at 40 psi

Gallons per acre:

- Information applies to all tips listed on the left

Gallons per 1000 ft²:

- Applies to all tips listed on the left

---

**1** Droplet size is based on the PS Range.
Greenleaf Droplet chart:

<table>
<thead>
<tr>
<th>Low Pressure</th>
<th>15</th>
<th>30</th>
<th>45</th>
<th>60</th>
<th>75</th>
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<th>Medium Pressure</th>
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www.turbodrop.com
Nozzles Types?

- **flat spray**
- **flat-fan**
- **chamber**
- **air induced**
Double Cap & Twin Nozzles:
Air-Induction/Venturi Nozzles

Where air is drawn into the nozzle cavity and exits with the fluid.
Precautions with Venturi Nozzles

• Need higher pressure to atomize and form adequate pattern.
• Even more critical if deposition aid included in the tank mix.
• Equipment concerns at higher pressures.
• At higher pressures may improve droplet trajectory speed and improve canopy penetration.
Summary statements

• Our experience is lacking in controlling soybean rust.

• **Conventional spray systems will be challenged to achieve good canopy coverage.**

• **Calibration to determine the correct operation parameters critical.**

• **Ultimate goal is to provide correct droplet size.**
Disclaimer:

• Brand names appearing in this presentation are for identification and illustration purposes only.

• No endorsement is intended, nor is criticism implied of similar products not mentioned.
Nozzle Type Considerations for Improved Soybean Canopy Penetration: a K-State Summary

Presented at National Soybean Rust Symposium Nov. 30, 2006 St. Louis, MO

Robert E. Wolf
Summary of Work Done

• Kansas State -
  - Ground sprayer
    • Conventional sprayer and nozzles - field
    • Spray Track machine - variety of nozzles - field and laboratory
  - Electrostatic sprayer

• Iowa State/K-State -
  - Conventional and Air Assist sprayer
  - Twin and single nozzles
Kansas State-Ground Studies with Conventional Sprayer and Nozzles
Conventional Ground Sprayer:

Canopy Coverage by Nozzle Type & GPA

% Area Coverage

TT | AI | TT | AI | TT | AI
---|----|---|----|---|----
top | | | | | |
middle | | | | | |
bottom | | | | | |

Nozzle Type - Canopy Location

40 PSI

5 GPA
7.5 GPA
10 GPA
12.5 GPA
Conventional Ground Sprayer:

Total Coverage by Nozzle Type & GPA

TT Flat-fan
AI Flat-fan

% Area Coverage

5 GPA 7.5 GPA 10 GPA 12.5 GPA

TT Flat-fan AI Flat-fan
Kansas State-Ground Studies with Electrostatic
Electrostatic Sprayer - canopy:
Electrostatic Sprayer:

Canopy Coverage by Charge & Nozzle

% Area Coverage

<table>
<thead>
<tr>
<th></th>
<th>XR</th>
<th>TT</th>
<th>XR</th>
<th>TT</th>
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<td>Bottom</td>
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</table>

- No Electric
- Electric
Electrostatic Sprayer:

Coverage - Charge by Nozzle Type

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<tr>
<th>Nozzle Type</th>
<th>No Electric</th>
<th>Electric</th>
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<tbody>
<tr>
<td>XR</td>
<td>7.6</td>
<td>8.5</td>
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<tr>
<td>TT</td>
<td>9.9</td>
<td>5.2</td>
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</table>
Iowa State/Kansas State-Ground Studies with Conventional Nozzles and Air Assist
Effects of Nozzle Type and Application Type on the Control of Leaf Spot Diseases of Soybean

Objective:
• To determine effects of
  - Application rate
  - Nozzle type
  - Application technique
• On deposition, disease, and crop yield

Mark Hanna, Alison Robertson, Mark Carlton, Robert Wolf
Percent Area Coverage Bottom of Canopy – Boone & Chariton 2005

- TwinJet 8004 (20 GPA) 40 PSI: 6.4%
- TwinJet 8004 (12 GPA) 30 PSI: 1.78%
- Single TT11003 (18 GPA) 40 PSI: 3.95%
- Air-assist w/TJ 8004 (20 GPA) 40 PSI: 1.10%
- Turbo duo w/TT11002 (20 GPA) 40 PSI: 3.53%

Row spacing - 30” Boone, 15” Chariton
Growth stage – R4 Boone, R3 Chariton

Hanna - Iowa State, 2006
ASABE Paper# 061162
Percent Area Coverage Bottom of Canopy – Boone 2006

- TwinJet 8004 (20 GPA) 40 PSI: 0.80
- TwinJet 8004 (12 GPA) 30 PSI: 1.28
- Single TT11003 (18 GPA) 40 PSI: 1.65
- Air-assist w/Hollow Cone JA-3 (20 GPA) 94 PSI: 1.10
- Turbo TwinJet TT11003 (20 GPA) 40 PSI: 1.85
## Percent Area Coverage Bottom of Canopy - Boone 2005 & 2006

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2005</th>
<th>2006</th>
</tr>
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<tr>
<td>TwinJet 8004 (20 GPA) 40 PSI</td>
<td>1.73</td>
<td>0.80</td>
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<tr>
<td>TwinJet 8004 (12 GPA) 30 PSI</td>
<td>0.75</td>
<td>1.28</td>
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<tr>
<td>Single TT11003 (18 GPA) 40 PSI</td>
<td>1.28</td>
<td>1.10</td>
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<tr>
<td>Air-assist (20 GPA) 40, 94 PSI</td>
<td>1.10</td>
<td>1.10</td>
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<tr>
<td>Turbo TwinJet TT11003 (20 GPA) 40 PSI</td>
<td></td>
<td>1.85</td>
</tr>
</tbody>
</table>

### Treatments

- **2005** – TwinJet 8004 @ 40 PSI
- **2006** – HollowCone JA-3 @ 94 PSI
Droplets/sq. cm Bottom of Canopy - Boone 2005 & 2006

- TwinJet 8004 (20 GPA) 40 PSI: 28.5
- TwinJet 8004 (12 GPA) 30 PSI: 19.0
- Single TT11003 (18 GPA) 40 PSI: 15.3
- Air-assist (20 GPA) 40, 94 PSI: 32.3
- Turbo TwinJet TT11003 (20 GPA) 40 PSI: 0

2005 – TwinJet 8004 @ 40 PSI
2006 – HollowCone JA-3 @ 94 PSI
Kansas State-Laboratory an Field Studies with Multiple Nozzles
MATERIALS AND METHODS:

- **Part 1: Lab studies (2005 - 2006)**
  - testing with spray-track machine
  - Soybean plants simulated drilled
  - 24-inches tall
  - growth stage R1 - R2
  - 90 to 95% canopy fill

- **Application parameters**
  - Application volume - 20 GPA
  - Water and NIS @ .5% v/v
  - Boom Speed - 10 MPH
  - Flow rate required - 0.67 GPM
  - Droplet size goal - 200-300 VMD
    - high fine to mid medium (water based)
    - Pressure and orifice size - varied

- **20 nozzle types**
  - single and double orifices
MATERIALS AND METHODS:

• Part 2: Field trials (2005)
  - Ashland Bottoms, Agronomy Research Station near Manhattan, KS
  - Spray Track machine
  - Drilled soybean plants were 18-inches tall
  - Growth stage R3 - R4
  - 75% canopy fill

• Application parameters
  - Application rate - 20 GPA & Speed -10 MPH
  - Water, NIS, and Headline fungicide
  - Flow rate required - 0.67 GPM
  - droplet size - 200-300 VMD
    • high fine to mid medium
    • pressure and orifice size - varied

• 12 Nozzle types
  - single and double orifices
Spray track machine:

- Designed to simulate actual field conditions
- Aluminum bar – 24 ft
- Electric motor, gear and chain assembly
- Field generator for field studies
- Sprayer boom – 2 nozzles @ 20 inches
  - solenoid controlled with remote control
- Pressure – Air Compressor - CO$_2$ cylinder
- Spray bottles – 500 ml/180 psi rated
Lab Trial Nozzles - 2005:

- TJ Duo TTXR - Narrow
- AirMix TF 05
- TwinCap XR03 & 04
- Twinjet 06
- TJ Duo TT03 - Narrow
- TT 11006
- XR 11006
- TT 11005
- TT 11004
- TD XR 04
- TD TT 04
- TD XL 04
- SR 110-05
- SR 110-06
- MR 110-025
- ER 80-06
Field Trial Nozzles - 2005:

- TJ Duo TT03 - Narrow
- Twinjet 06
- TT 11006
- XR 11006
- SR 110-06
- TT 11005
- TT 11004
- ER 80-06
- Airmix TF 05
- TwinCap TT03
- TD XR 04
- TD TT 04
Field Trial Nozzles - 2006:
Droplet Collectors:

• Water sensitive papers were placed in the lower canopy at a height of 4-inches from ground
• 6 Water sensitive papers per treatment
• 2 replications were done
DropletScan™ used to analyze droplets

- Statistical comparisons volume medium diameter (VMD), Percentage Area Coverage (PAC), and Droplets per Square centimeter (D/SC)
- Statistical analysis with SAS Proc GLM - LS Means compared with Alpha = 0.10
Results and Discussions

• Comparison of nozzles based on Percentage Coverage Area (PAC)
• Comparison of nozzles based on Droplets per Square centimeter (D/SC)
• Comparison of nozzles based on VMD and comparing with calibrated droplet spectra of 200-300 microns
Canopy Penetration Study at 20 GPA and 10 MPH
Percent Area Coverage for Bottom Collectors

Nozzle Type (PSI) Left half are singles - Right half are doubles

Wolf – K-State, 2006
ASABE Paper# 061163
Droplets per Square Centimeter for Bottom Collectors

Canopy Penetration Study at 20 GPA and 10 MPH

Nozzle Type (PSI) Left half are singles - Right half are doubles

146 -116 (NS)
LSD=37.2
Canopy Penetration Study at 20 GPA and 10 MPH VMD for Bottom Collectors

Micron Size

Calibrated Droplet Spectra – 200-300 microns

Nozzle Type (PSI)

434 – 342 microns (NS) LSD – 85.4 microns
Calibrated Droplet Spectra – 200-300 microns
Percentage Coverage Area for Different Nozzle Types

Nozzle type (PSI) left hand are singles & right hand are doubles

10.0 – 6.4 (NS)
LSD=3.58
Droplets per Square Centimeter for different Nozzle Types

Nozzle type (PSI) left hand are singles & right hand are doubles

43 - 26 (NS)
LSD=23.25
VMD for Different Nozzle Types - Bottom of Canopy

Calibrated Droplet Spectra – 200-300 microns

Nozzle type (PSI) left hand are singles & right hand are doubles

515 - 472 microns (NS), LSD – 64.3 microns
Calibrated Droplet Spectra – 200-300 microns
Canopy Penetration – 20 GPA @ 10 MPH - Percent Area Coverage Bottom Collectors
Summary and Findings

• **Percentage Coverage Area**
  - 2005 lab trials = 5.1 - 1.6% (TT 11006 & TDXR 11006)
  - 2005 field trials = 10 - 6% (TT 11005 & ER 8006)
  - 2006 lab trials = 0.6 - 0.15% (XR & SR 11005 & TTJ 11006)
  - No significant differences in top 15 nozzles - lab 2005
  - No significant differences in top 9 nozzles - field 2005
  - On average the single nozzle configurations gave more PAC than the double nozzle configurations
  - Venturi designs at high pressures did not perform well as the conventional nozzles at lower pressures
Summary and Findings

• **Droplets per Square Centimeter**
  - 2005 lab trials - D/SC ranged from 145.5 - 75.5 (TT 11004)
  - 2005 field trials - D/SC ranged from 43 - 12 (TT 11004)
  - Lab trials - No significant differences in the top 5 nozzle configurations
  - Field trials - No significant difference in top 10 nozzle configurations
  - Lab trials - highest coverage did not necessarily have the highest number of D/SC
  - Field trials - The top three for the coverage also provided high number of D/SC
Summary and Findings

• **Volume Mean Diameter (VMD)**
  - Lab trials - VMD ranged from 434 - 260.5 microns
  - Field trials - VMD ranged from 515 to 329 microns
  - Calibrated VMD was 200 - 300 microns
  - The twin nozzle configurations more closely matched the calibrated VMD requirements
  - None of the single nozzle configurations came near the calibrated VMD requirements
  - Spread factor coefficients have not been determined to date.
Conclusions

• Twin nozzle configurations for improved canopy penetration is not supported from this study
• Conventional nozzles performed well provided that smaller orifice sizes and high pressures were selected
• Conventional Turbo and Extended range nozzles performed well in this study
• In addition to calibrating increased GPA’s for fungicide applications, an additional step to calibrate for proper D/SC is essential.
• The new Turbo TwinJet seemed to provide good coverage compared to the other top nozzles.