Flying Fast and Under Pressure

Brad Fritz
Scott Bretthauer
Challenge

The Industry is Progressing to Meet the Needs of Modern Agriculture.

Which means Larger and Faster Aircraft
Faster Airspeeds = Smaller Droplets

- VERY COARSE
- COARSE
- MEDIUM
- FINE
- VERY FINE

Airspeed (m/s)

DV_{0.5} (μm)

150 mph
“Don’t Fly more than 150 mph”

“How can we operate above 150 mph?”
Why *Higher* Pressure?

**INFORMATION ON DROPLET SIZE:** The most effective way to reduce drift potential is to apply the droplets of the most effective size for the intended application. The best drift management strategy is to maintain sufficient coverage and control. Applying larger droplets can decrease drift if applications are made improperly, or if the application is made at a lower pressure (see Wind, Temperature, and Humidity, and Temperature). The volume median diameter (VMD) value is the median droplet size of the spray pattern. The optimum Rage herbicide VMD is 450 microns with fewer than 10% of the droplets being 200 microns or less. Use sprayer nozzles that meet these VMD guidelines.

**CONTROLLING DROPLET SIZE:**
- **Volume –** Use high flow rate sprayers with higher rated flow rates.
- **Pressure –** Do not use nozzle types lower than those recommended by the manufacturer’s recommended pressure produces larger droplets. Use higher flow rate nozzles with higher rated flow rates.
- **Number of Nozzles –** Use the manufacturer’s recommended number of nozzles. Solid stream nozzles orient the droplets and the lowest drift. Use a VMD of 450 microns with fewer than 10% of the droplets being 200 microns or less.
- **Nozzle Orientation –** Use solid stream nozzles. Significant deflection is produced by angled nozzles. Solid stream nozzles produce larger droplets.
- **Nozzle Type –** Use nozzle types, namely solid stream nozzles. Solid stream nozzles produce larger droplets.

**AERIAL APPLICATIONS:**
Uniformly apply with properly calibrated aerial equipment in 5 or more gallons of water per acre. When applied POSTEMERGENCE, the addition of a non-ionic surfactant AND fertilizer solution are required for optimum weed control. Apply a non-ionic surfactant at the rate of 0.25% v/v of spray solution AND ammonium sulfate at the rate of 2.5 lb/acre. (See MIXING INSTRUCTIONS).

To avoid injury to sensitive crops from drift, aerial applicators must adhere to the following SPECIAL AERIAL USE DIRECTIONS AND PRECAUTIONS:

- **Nozzle height above ground must be a maximum of 10 feet.**
- **Nozzles must be pointed toward the rear of the aircraft. The downward angle of the nozzle should not be greater than 20 degrees.**
- **To minimize wing-tip vortex roll, nozzles or spray boom must not be located any closer to end of wing or rotor than three-fourths the distance from the center of the aircraft.**
- **Use a maximum spray pressure of 40 psi.**
- **A buffer zone must be established between the area to be sprayed and sensitive crops.**
- **DO NOT spray when wind velocity is greater than 5 mph.**

Coarse sprays are less likely to drift; therefore, do not use nozzles or nozzle configurations which dispense spray as fine spray droplets. Do not angle nozzles forward into the airstream and do not increase spray volume by increasing nozzle pressure.
Why?

Atomization is driven by change in velocity seen by the spray plume.

- **Airspeed**: 120 to 180 mph
- **Spray speed**: 30 to 60 psi to 30 to 60+ mph
Differential Velocity

150 mph air

Droplets out of a nozzle

Droplet A – 30 mph
Droplet B – 60 mph

Droplet A “sees” 120 mph air and breaks up into finer droplets

Droplet B “sees” 90 mph air and breaks up into courser droplets or remains intact

or
What We Did

#10 and #15 Orifice
8° deflection
140 and 170 mph
40, 65 and 90 psi
Overall Airspeed Effect

In All Cases, went from MEDIUM to FINE
### Orifice Effect – Across all Pressures

#### #10 to #15

<table>
<thead>
<tr>
<th>Speed</th>
<th>VMD</th>
<th>Fines</th>
</tr>
</thead>
<tbody>
<tr>
<td>140 mph</td>
<td>390 – 413 µm</td>
<td>3.9 – 3.1%</td>
</tr>
<tr>
<td>170 mph</td>
<td>268 – 282µm</td>
<td>8.8 – 7.9%</td>
</tr>
</tbody>
</table>

#### 20°

<table>
<thead>
<tr>
<th>Speed</th>
<th>VMD</th>
<th>Fines</th>
</tr>
</thead>
<tbody>
<tr>
<td>140 mph</td>
<td>322 – 368 µm</td>
<td>5.0 – 3.8%</td>
</tr>
<tr>
<td>170 mph</td>
<td>224 – 254 µm</td>
<td>11.5 – 9.1%</td>
</tr>
</tbody>
</table>
Orifice Effect – Across all Pressures

#10 to #15

40°

140 mph
VMD: 299 – 314 µm
Fines: 5.8 – 5.4%

170 mph
VMD: 226 – 314 µm
Fines: 11.3 – 12.2%
Spray Angle and Atomization

SS

20°

40°
# Increasing Pressure – All Orifices

## SS

<table>
<thead>
<tr>
<th>Pressure Range</th>
<th>VMD</th>
<th>Fines</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 to 65 to 90 psi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>140 mph</td>
<td>352 – 398 – 454 µm</td>
<td>4.5 – 3.5 – 2.6%</td>
</tr>
<tr>
<td>170 mph</td>
<td>249 – 272 – 304 µm</td>
<td>9.9 – 8.4 – 6.8%</td>
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<tr>
<td>140 mph</td>
<td>310 – 347 – 378 µm</td>
<td>5.5 – 4.3 – 3.4%</td>
</tr>
<tr>
<td>170 mph</td>
<td>217 – 244 – 259 µm</td>
<td>12.5 – 10.0 – 8.8%</td>
</tr>
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</table>
Pressure Effect – All Orifices

40°

40 to 65 to 90 psi

140 mph  VMD: 282 – 306 – 331 µm
Fines: 6.6 – 5.6 – 4.5%

170 mph  VMD: 206 – 225 – 239 µm
Fines: 13.6 – 11.5 – 10.0%
Summary – For Nozzles/Airspeeds Tested

<table>
<thead>
<tr>
<th>VMD</th>
<th>FINES</th>
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<tbody>
<tr>
<td>- 4 µm</td>
<td>+ 0.2%</td>
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<tr>
<td>1 mph</td>
<td>1 mph</td>
</tr>
<tr>
<td>+1.6 µm</td>
<td>- 0.1%</td>
</tr>
<tr>
<td>1 psi</td>
<td>1 psi</td>
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</tbody>
</table>

NOTE: These results are only valid for the nozzles tested and 40 to 90 psi and 140 to 170 mph.
Summary – For Nozzles/Airspeeds Tested

VMD
- 3.5 µm
1 mph

FINES
+ 0.2%
1 mph

VMD
+1.1 µm
1 psi

FINES
- 0.1%
1 psi

NOTE: These results are only valid for the nozzles tested and 40 to 90 psi and 140 to 170 mph
Summary – For Nozzles/Airspeeds Tested

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value 1</th>
<th>Value 2</th>
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<tbody>
<tr>
<td>VMD</td>
<td>-3 µm</td>
<td>+0.8 µm</td>
</tr>
<tr>
<td>Airspeed</td>
<td>1 mph</td>
<td>1 psi</td>
</tr>
<tr>
<td>Fineness</td>
<td>+0.2%</td>
<td>-0.1%</td>
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NOTE: These results are only valid for the nozzles tested and 40 to 90 psi and 140 to 170 mph.
## So…How Fast and Still MEDIUM??

<table>
<thead>
<tr>
<th>No.</th>
<th>Pressure (psi)</th>
<th>Speed (mph)</th>
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<tbody>
<tr>
<td>#10</td>
<td>65</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>150</td>
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<tr>
<td>#15</td>
<td>65</td>
<td>145</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>151</td>
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<td>#10</td>
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</tr>
<tr>
<td></td>
<td>90</td>
<td>169</td>
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</table>
Other Interesting Things…

Potential Plumbing Issues
Other Interesting Things...

Unexpected Obstacles
Things To Consider

• Spray Pattern
  - Scott Bretthauer Testing Setups

• Efficacy
  - Just because you can go faster and get a MED sprayer doesn’t mean it’s the best!!!

• Safety Concerns
  - Higher speed = less reaction time.
  - Possibly higher pressures...

• Unforeseen Issues with Higher Pressures...

How Disastrous Would This Be???
Bottom Line

• Higher Pressures can be used to fly faster…..
  – Normal pressures (<60 psi)
    • 150 mph MAX for MEDIUM
  – At 90 psi
    • 169 mph MAX for MEDIUM
• Where do we draw the line?
• Visit us...We want your feedback.