Efficacy and Drift: Recognizing the Conflicts on the Label

Scott Bretthauer
Department of Agricultural and Biological Engineering
Droplet size

- Droplet diameters measured in microns (µm)
- 1 micron = 1/25,000 of an inch
- All nozzles produce a range of droplet sizes, known as the droplet size spectrum
Droplet size: influences coverage and spray drift

Small droplets provide better coverage but are more likely to drift

Need to select droplet size based on application: balance need for coverage with drift reduction
Droplet size and number

Effect of droplet size on coverage

Half droplet size
produces 8 x more droplets
Drift
Droplet deposition

- Small droplets (fine) deposit more efficiently than larger (medium and coarse) droplets - need to get there
- Large droplets can rebound
- Large droplets can shatter into smaller droplets
- Target influences deposition
  - Plant part - leaf, stem, etc.
  - Orientation and interception angle
  - Wetability - cuticle surface
Volume Median Diameter

Half the spray volume contained in smaller drops

VMD

Half the spray volume contained in larger drops
### ASABE Standard S-572

Nozzle Classification by Droplet Spectrum

<table>
<thead>
<tr>
<th>Category</th>
<th>VMD (microns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Fine (VF)</td>
<td>&lt; 150</td>
</tr>
<tr>
<td>Fine (F)</td>
<td>150 – 250</td>
</tr>
<tr>
<td>Medium (M)</td>
<td>250 – 350</td>
</tr>
<tr>
<td>Coarse (C)</td>
<td>350 – 450</td>
</tr>
<tr>
<td>Very Coarse (VC)</td>
<td>450 – 550</td>
</tr>
<tr>
<td>Extremely Coarse (XC)</td>
<td>&gt; 550</td>
</tr>
</tbody>
</table>
Choose nozzles that provide good coverage for product and minimize drift

Droplet size spectrums recommended for various pesticide uses

<table>
<thead>
<tr>
<th>Droplet Spectrum (by ASABE S572)</th>
<th>Contact insecticide and fungicide</th>
<th>Systemic insecticide and fungicide</th>
<th>Contact foliar herbicide</th>
<th>Systemic foliar herbicide</th>
<th>Soil-applied herbicide</th>
<th>Incorporated soil-applied herbicide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very fine VF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fine F</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium M</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Coarse C</td>
<td></td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Very Coarse VC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Extremely Coarse XC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>
Cumulative volume distribution

- VMD (50%)
- VD(0.1) (10%)
- VD(0.9) (90%)
- RS (relative span)
Increasing coverage

Two ways to increase coverage:

- Decrease droplet size
- Increase spray application rate (GPA)

<table>
<thead>
<tr>
<th>Example #1:</th>
<th>Example #2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 GPA</td>
<td>5 GPA</td>
</tr>
<tr>
<td>500 µm droplets</td>
<td>250 µm droplets</td>
</tr>
<tr>
<td>1.2 billion droplets/acre</td>
<td>2.3 billion droplets/acre</td>
</tr>
</tbody>
</table>
Tank mixing example

- Fungicide application rate: 6 fl oz per acre
- Field size: 50 acres
- Ground spray application rate: 20 GPA
  - Amount of product needed: 300 fl oz
  - Amount of spray solution needed: 1000 gallons
- Aerial spray application rate: 5 GPA
  - Amount of product needed: 300 fl oz
  - Amount of spray solution needed: 250 gallons
- 5 GPA tank mix is 4 times the concentration of the 20 GPA tank mix
Deposition – lower canopy

μg/cm²

Treatment

M-5  M-15  VC-5  VC-15

A  B  BC  A

C
Disease and yield

SBRR % (10/17/07)

M-5  M-15  VC-5  VC-15  Control

0  5  10  15  20  25  30  35  40  45

Yield (bu/acre)

M-5  M-15  VC-5  VC-15  Control

A  A  A  A  B

A  A  A  AB  B
Glyphosate and GPA
Weed Control 28 DAT

Control (%)

C. Waterhemp
G. Ragweed

Carrier Volume

5 GPA
10 GPA
15 GPA
20 GPA

Bryan Young, SIU
Ground: Nozzles and droplet size

- Nozzle design
- Orifice size
  - Small orifices create finer droplets
  - Larger orifices create coarser droplets
- Pressure
  - Lower pressure creates coarser droplets
  - Higher pressure creates finer droplets
- Nozzle fan angle
  - Narrow angles create coarser droplets
  - Wider angles create finer droplets
Aerial: Speed and pressure

- **Speed** - determines the force of the high speed air flow into which spray is forced
  - Influences shearing effect

- **Pressure** - forcing spray out at speeds similar to air flow reduces shearing effect
  - High pressure tends to increase droplet size
  - Low pressure tends to decrease droplet size
Aerial: Deflection angle

- Alter the angle at which spray enters high speed air flow - key tool in managing droplet size
- Change degree of air shear
  - Increase shear creates smaller droplets
  - Decrease shear creates larger droplets

- Large droplets
- Medium droplets
- Fine droplets
USDA ARS aerial nozzle models

- Based on extensive wind tunnel research
- Applicator enters orifice size, deflector angle, pressure, and air speed
- Model calculates VMD and other droplet size statistics and graphs spectrum
- Valuable tool for setting up aircraft for correct droplet size
- Flat fan example
Label examples

- Aerial: Select spray nozzles, pumping pressure, and sprayer height to provide medium-to-fine spray droplets that penetrate throughout the crop canopy. Spray calibration must be conducted to confirm spray droplet sizes.

- Aerial: Nozzles must always point backward parallel with the airstream and never be pointed downward more than 45 degrees.
Label examples

- Use nozzle types and arrangements that will provide optimum coverage while producing a minimal amount of fine droplets.
- Do not exceed 30 psi spray pressure unless otherwise required by the manufacturer of drift reducing nozzles.
Label examples

- Ground: Use standard low-pressure herbicide sprayers equipped with boom and flat-fan nozzles. Use nozzle sizes that deliver a medium-fine droplet in 15 to 20 gallons total spray per acre at 40 to 50 psi and at ground speeds not in excess of 3 to 4 mph.
Label examples

- Aerial: Nozzles must always point backward parallel with the airstream and never be pointed downwards more than 45 degrees.

- Aerial: Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flow produce larger droplets.

- Aerial: Use the lower spray pressures recommended for the nozzle. Higher pressure reduces droplet size and does not improve canopy penetration.
Ground: Product should be applied in a minimum of 10 gallons of water per broadcast acre. Flat-fan nozzles are recommended. Do not use air-inducting or flood type nozzles. Use a minimum pressure of 30 psi. Under dense weed/crop canopies, higher spray pressure and increased gallonage are important in obtaining thorough spray coverage.
Label examples

- Complete coverage and uniform application are essential for the most effective results.
- Use the largest droplet size consistent with pest control. Formulation of very small droplets may be minimized by appropriate nozzle selection, by orienting nozzles away from the airstream as much as possible and by avoiding excessive spray boom pressure.
Label examples

- **Volume**: Use high flow rate nozzles to apply the highest spray volume. Nozzles with higher rated flows produce larger droplets.

- **Pressure**: Use the lower spray pressures recommended for the nozzle. Higher pressure reduce droplet size.
Thorough spray coverage of the plant foliage is essential for optimum control. Apply in sufficient water to ensure good coverage. Finished spray volumes should be increased under extreme pest populations or dense plant foliage.
Label examples

- Aerial: Droplet size for air applications should be in the medium size category as defined in the August 1999 ASAE S572 publication.

- Aerial: Use nozzle types and arrangements which will provide maximum coverage and minimize the potential for off target movement of spray particles.
Product may be applied with all types of spray equipment commonly used for making ground and aerial applications.

Equip sprayers with nozzles that provide accurate and uniform application.

Nozzles should be the same size and uniformly spaced across the boom.
Questions?

Scott Bretthauer
sbrettha@illinois.edu
(217) 333-9418