Spray Penetration

Helping it Sink In

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@nozzle_guy
There are three places spray can go once it leaves your nozzles.
On the target crop

On the ground: miss or runoff

Into the air: drift
To achieve sufficient coverage, you have to know your target.
The nature of the pest, its location, and the product’s mode of action should impact how you spray.

It starts with the nozzle...
- A nozzle produces a range of droplet sizes.
- The median droplet size (VMD) changes with pressure.

The diagram shows a bell curve indicating the distribution of droplet sizes, with the median droplet size, $D_{v0.5}$ (VMD), marked at the peak of the curve.
Droplet Behaviour
Tom Wolf, Agrimetrix R&T

- At the tip, most droplets are moving at ~70 km/h

- 50 cm away, it’s a different story...

All Droplets: 70 km/h

Coarser Droplets: 28 km/h
Finer Droplets: 7 km/h

- Do the slow-moving fine droplets fall straight down?
Droplet size affects droplet direction.
• Imagine dividing the canopy into top, middle and ground (bottom)
• Look straight down from the nozzle – how deep can you see?

• Targets in line-of-sight are most easily covered
• Actually, spray behaves more like this…
• The droplets in the spray fall at different rates, and behave differently
• Coarser move in straight lines

• They move down and with direction of travel
• Finer move with wind, and are influenced by everything

• When (if) they hit a target, many things can happen…
Droplet Size and Coverage

- **<150 µm**
  - Fine droplets
  - Cover more surfaces, but drift

- **150-300 µm**
  - Medium droplets
  - Provide good coverage with moderate drift

- **>300 µm**
  - Coarse droplets
  - May run off, bounce or miss small targets, but have low drift

- **>300 µm (Al)**
  - Similar to coarse but may also shatter and improve coverage
So, ideally, droplets cannot be:

- Too big: Bounce off leaf or miss target
- Too small: Evaporate or drift off target

“They have to be juuuuuuuust right”
Spray Shape – Twin Fans in Soybean (2014)
Water-sensitive papers placed in canopy

Place papers deep in canopy, close to plants

Located at top node

#A - Yellow-up
#B - Yellow-down

Located mid-way between top papers and ground

#C - Face sprayer retreat
#D - Face sprayer advance

Sprayer Direction
Results – No difference, but too many variables?

<table>
<thead>
<tr>
<th>NOZZLE CONFIGURATION</th>
<th>ASABE DROPLET CATEGORY and GROUND SPEED (kph)</th>
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<tbody>
<tr>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>24.1 kph</td>
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<tr>
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<td>HyPro - GuardianAIR 110</td>
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<td>Greenleaf - AGTADF</td>
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<td>Al buz - AVI Twin 110</td>
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<td>16.1 kph</td>
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<td>TeeJet - Turbo TeeJet</td>
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<tr>
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<td>TeeJet - 3070 Al Dual</td>
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<tr>
<td></td>
<td>TeeJet - Turbo Twinjet</td>
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</table>

Legend:
- **Advance**
- **Retreat**
- **Up**
- **Down**

CUMULATIVE COVERAGE (% AREA)

Tom Wolf, Agrimetrix R&T

- 5 mph, 20” boom, AIXR Coarse / Very Coarse

- Higher volume means improved coverage

Tom Wolf, Agrimetrix R&T

- 10 mph, 20” boom, AIXR Coarse / Very Coarse

- Higher speeds reduce coverage

![Bar Chart](chart.png)

Spray deposit (% of applied)

- 1-Upper:
  - 6.4 gpa: 40
  - 12.8 gpa: 42
  - 19.2 gpa: 35

- 2-Mid:
  - 6.4 gpa: 13
  - 12.8 gpa: 18
  - 19.2 gpa: 17

- 3-Lower:
  - 6.4 gpa: 2
  - 12.8 gpa: 6
  - 19.2 gpa: 6
Tracers in Broadleaf Canopy: Pressure + Spray Shape (2015)

Tom Wolf, Agrimetrix R&T

- 10 mph, 20” boom, Guardian Air 1x / Twin, Coarse & Very Coarse

- Neither pressure, nor shape affect coverage

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<th>Spray deposit (% of applied)</th>
<th>Double</th>
<th>Single</th>
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<tbody>
<tr>
<td>1-Upper</td>
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<td>54</td>
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<tr>
<td>2-Mid 20 psi</td>
<td>23</td>
<td>23</td>
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<tr>
<td>3-Lower</td>
<td>16</td>
<td>23</td>
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<tr>
<td>1-Upper 40 psi</td>
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<td>46</td>
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<tr>
<td>2-Mid 20 psi</td>
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<td>26</td>
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<tr>
<td>3-Lower</td>
<td>17</td>
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<td>1-Upper 60 psi</td>
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<td>27</td>
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<tr>
<td>3-Lower</td>
<td>14</td>
<td>21</td>
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Coverage must always be tempered with off-target movement.

- Can we take advantage of high numbers of small droplets, but avoid drift?
• 10 gpa, 6 mph Air off
Condition 1 - Air off, 11002’s (medium-fine)
Condition 2 - Air off, Air Induction 11002’s (very coarse)
Condition 3 - Air on, 11002’s (medium-fine)
Coverage improved mid canopy

- Air can improve coverage in mid-lower canopy, at expense of upper canopy. Air speed/direction must be calibrated.
Asparagus in Fern – Coverage Trials (2012)
Asparagus in Fern – Coverage Trials (2012)

Nozzles ~ 30 cm (12 in.) from target

45° target located at surface

Cylindrical target located halfway down

Horizontal target located at ground

Direction of travel
Volume improved coverage

- 187 L/ha (20 U.S. gal/acre)
- 234 L/ha (25 U.S. gal/acre)
- 280 L/ha (30 U.S. gal/acre)

Deposits per cm²

Target position:
- Top
- Middle
- Bottom

n = 15
Finer droplets improved mid-bottom coverage.
Finally – Some Tomatoes!!! (2011)
Volume, droplet size and air assist
<table>
<thead>
<tr>
<th>Nozzle Type / Sprayer Output</th>
<th>With Air Assist</th>
<th>Without Air Assist</th>
</tr>
</thead>
</table>
| 80 degree flat fans / ~550 L/ha (60 g/ac) | - Good coverage in upper canopy  
- Moderate/poor canopy penetration  
- Low drift | - Good coverage in upper canopy  
- Poor canopy penetration  
- Moderate drift |
| 80 degree air induction flat fans / ~550 L/ha (60 g/ac) | - Inconsistent upper canopy coverage  
- Poor canopy penetration  
- “No” drift | - Inconsistent upper canopy coverage  
- Poor canopy penetration  
- “No”/Low drift |
| Twinjet dual 80 degree flat fans / ~550 L/ha (60 g/ac) | - Good coverage in upper canopy  
- Moderate/poor canopy penetration  
- Moderate Drift | - Good coverage in upper canopy  
- Poor canopy penetration  
- Moderate/High drift |
| Hollow cones / ~750 L/ha (80 g/ac) | - Good coverage in upper canopy  
- Good canopy penetration  
- Low drift | - Good coverage in upper canopy  
- Good/Moderate canopy penetration  
- Very High drift |
Finer spray NEEDED Air to get into canopy
• Medium spray quality does improve coverage in a broadleaf canopy, but:

• Only advised for contact fungicide / insecticide
• It is irresponsible to use med-fine spray quality without some form of drift mitigation (e.g. shrouds, air-assist or even drift-mitigating adjuvants
• Med-fine droplets have very little momentum, so unless they are released close to canopy, in low wind, their ability to provide coverage is greatly reduced.

Steve Barnhart, Agriliance Regional Agronomist

- Aerial on soybean, Mudlake, Idaho

**InterLock + Preference (4oz/a + 1 pt/100 g)**
- Upper Canopy – 22.5 droplets/cm²
- Middle Canopy – 27.2 droplets/cm²
- Lower Canopy – 14.0 droplets/cm²

**Untreated**
- Upper Canopy – 12.25 droplets/cm²
- Middle Canopy – 10.75 droplets/cm²
- Lower Canopy – 8.25 droplets/cm²
Summary

- Know your target, and know which droplet size is most likely to hit it.
- Higher volumes can improve coverage.
- Slower speeds can improve coverage.
- Smaller drops means more drops, but the smaller they get, the more they need air assist to penetrate.
- Spray shape does not appear to affect broadleaf penetration.
- Hot, dry and windy days do not help coverage.
- Certain adjuvants can improve coverage and may improve penetration.
- Stay between medium and coarse for fungicides / insecticides.
To learn more about spraying, subscribe to www.sprayers101.com

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Dr. Jason Deveau @spray_guy

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