Common Methods of Off-Target Movement

Module 2

In this module:

- Details and best management practices to help you prevent off-target movement due to:
  - Physical drift
  - Secondary drift
  - Tank contamination
Which of these factors can influence off-target movement of pesticides?

*Call out the items you think could cause off-target movement*

- Physical Drift
- Secondary Drift & Movement
- Tank Contamination
- Wind speed
- Nozzle type
- Droplet size
- Sprayer speed
- Boom height
- Herbicide volatility
- Temperature
- Dust
- Water runoff
- Tank type
- Hose type
- Tank cleanout
Common Methods of Off-Target Movement

- Physical Drift
- Secondary Drift & Movement
- Tank Contamination

- Wind speed
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- Tank cleanout
Physical Drift
Definition and How it Occurs

Physical drift occurs when the droplets leaving the sprayer do not reach the intended target.

Physical drift is influenced by:
- Wind speed
- Boom height
- Nozzle Selection
- Droplet Size
- Sprayer Speed
Physical Drift

Distinguishing Characteristics

Physical drift can usually be distinguished as clear patterns of injury that are more severe closest to the spray source.
Important!

Do Not Rely on Formulation Alone to Prevent Drift

Wind speed
Nozzle type
Droplet size
Sprayer speed
Boom height
Wind Speed

Sources of Physical Drift

700% Increase In Drift

90 ft. downwind

Always read and follow the labeled wind-speed requirements!

Diagram Provided by Dr. Greg Kruger, University of Nebraska
Historical Wind Speeds

Example: Hourly Average Wind Speeds in Southeast Missouri by Month*

*Hourly wind-speed averaged from the years 2000 to 2015
Historical Wind Speeds

Example: Hourly Average Wind Speeds in Northwest Missouri by Month*

*Hourly wind-speed averaged from the years 2000 to 2015
How are you checking the wind speed?

Best Practice: Check Wind Speeds at the Site of Application

<table>
<thead>
<tr>
<th>Method of checking wind speed</th>
<th>Percent of respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online at the closest weather station</td>
<td>27</td>
</tr>
<tr>
<td>Hand-held anemometer</td>
<td>10, 35</td>
</tr>
<tr>
<td>Smart phone app</td>
<td>16, 26</td>
</tr>
<tr>
<td>Estimate by looking at surroundings</td>
<td>12, 47</td>
</tr>
</tbody>
</table>

Source: Bish & Bradley (2017)
Nozzles and Droplet Size

Sources of Physical Drift

- Wind speed
- Nozzle type
- Droplet size
- Sprayer speed
- Boom height
Relationship of Nozzle Type and Droplet Size

Comparison of Two Different Nozzle Types

Extended Range Flat Fan Spray Tip

Turbo TeeJet Induction Nozzle

Videos Provided by Dr. Greg Kruger, University of Nebraska
Droplet Sizes in Real World Terms

Comparison of Droplet Sizes with Familiar Objects

- Pencil lead: 2000 µm
- Paper clip: 850 µm
- Staple: 420 µm
- Toothbrush bristle: 300 µm
- Sewing thread: 150 µm
- Human hair: 100 µm

Illustration Provided by Dr. Greg Kruger, University of Nebraska
Droplet Size to Weight Relationship

Result of Doubling the Diameter of a Spray Drop

200 µ
→
400 µ

2X Increase in Droplet Size

4.2 Micrograms
→
33.6 Micrograms

2X Increase in Diameter = 8X Increase in Weight!

Illustration Provided By Monsanto
## How far will spray particles move?

### Relationship of Droplet Size to Distance Traveled

<table>
<thead>
<tr>
<th>Droplet Size</th>
<th>Diameter (in µm)</th>
<th>Time to fall 10 ft</th>
<th>Travel distance in 3 mph wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fog</td>
<td>5</td>
<td>66 min</td>
<td>15,840 ft</td>
</tr>
<tr>
<td>Very fine</td>
<td>20</td>
<td>4.2 min</td>
<td>1,100 ft</td>
</tr>
<tr>
<td>Fine</td>
<td>100</td>
<td>10 sec</td>
<td>44 ft</td>
</tr>
<tr>
<td>Medium</td>
<td>240</td>
<td>6 sec</td>
<td>28 ft</td>
</tr>
<tr>
<td>Coarse</td>
<td>400</td>
<td>2 sec</td>
<td>8.5 ft</td>
</tr>
</tbody>
</table>

**Bottom line?** Using nozzles that produce droplets smaller than the labeled requirements will likely cause significant problems with drift!

*Source: Hofman & Solseng (2017)*
Sprayer Speed

Sources of Physical Drift

✓ Wind speed
✓ Nozzle type
✓ Droplet size
Sprayer speed
Boom height
Influence of Sprayer Speed on Spray Drift Deposition*

Increasing Tractor Speed Can Increase Drift Potential

Boom Height

Sources of Physical Drift

- Wind speed
- Nozzle type
- Droplet size
- Sprayer speed
- Boom height
Boom Height

Increasing Boom Height Can Increase Drift Potential

Always read and follow the labeled boom height requirements!

Illustration Provided by Dr. Greg Kruger, University of Nebraska
Common Methods of Off-Target Movement

- Physical Drift
- Secondary Drift & Movement
- Tank Contamination

Factors:
- Wind speed
- Nozzle type
- Droplet size
- Sprayer speed
- Boom height
- Herbicide volatility
- Temperature
- Dust
- Water runoff
- Tank type
- Hose type
- Tank cleanout
Herbicide Volatility

Definition and How it Occurs

- Occurs when the herbicide lands on the intended target, but evaporates and moves off-target before absorption.

- Injury due to volatility is less discernable than injury due to physical drift.

- New formulations reduce, but do not eliminate, drift due to herbicide volatility.
## Factors that Influence Herbicide Volatility

2,4-D and dicamba volatility are influenced by:

<table>
<thead>
<tr>
<th>Factor</th>
<th>Influence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Temperatures:</strong></td>
<td>Higher temperatures generally leads to ↑ volatility</td>
</tr>
<tr>
<td><strong>Humidity:</strong></td>
<td>Lower humidity generally leads to ↑ volatility</td>
</tr>
<tr>
<td><strong>Surface:</strong></td>
<td>Volatility is generally greater from leaves vs. soil</td>
</tr>
<tr>
<td><strong>Formulation (salt):</strong></td>
<td>Acids are generally the most volatile; only use approved formulations</td>
</tr>
<tr>
<td><strong>Carrier Volume (GPA):</strong></td>
<td>Lower carrier volumes lead to ↑ volatility</td>
</tr>
<tr>
<td><strong>Droplet Size:</strong></td>
<td>Fine droplets can result in ↑ volatility than coarse or ultra coarse droplets</td>
</tr>
<tr>
<td><strong>Tank Mixes:</strong></td>
<td>Other products can ↑ volatility of specific herbicides (e.g., AMS can increase the volatility of dicamba)</td>
</tr>
</tbody>
</table>

Sources: Behrens & Lueschen (1979); Long & Young (2017)
The Salt in the Formulation Matters

Example: Relative Volatility of Engenia

In trials, Engenia exhibited 70% lower volatility relative to DGA-based Dicamba.
The Salt in the Formulation Matters

Comparison of Three 2,4-D Formulations with Different Salts

Source: Sosnoskie, et al. (2015)
Low Volatility ≠ Zero Volatility

Soybean “Indicator Plant” Response following Application of Engenia and XtendiMax

Hours After Treatment:  0  0.5-2  2-8  8-16  16-24  24-72

*Photos taken 21 days after in-field application*
Temperature Inversions

Sources of Secondary Drift

- During an inversion, herbicide droplets may be trapped in air masses that settle-in above the Earth’s surface.
- If the air mass moves, the trapped herbicide droplets may land off-target when it dissipates.

Herbicide Volatility

Temperature

Dust

Water Runoff
Recognizing Temperature Inversions

Conditions, Indicators, and Duration

✧ Usual conditions at onset:
  • Sunset
  • Clear to partly cloudy skies
  • Light winds

✧ Often indicated by:
  • Ground fog
  • Smoke not rising
  • Dust hanging over road
  • Dew or frost

✧ May continue until surface temperature and wind increase
Temperature Inversions in Missouri

Example: Frequency and Timing of Surface Inversions in Southeast Missouri

<table>
<thead>
<tr>
<th>Month</th>
<th>Number of Inversionsa</th>
<th>Typical Start Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2015</td>
<td>2016</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>2016</td>
</tr>
<tr>
<td>March</td>
<td>21</td>
<td>22</td>
</tr>
<tr>
<td>April</td>
<td>23</td>
<td>27</td>
</tr>
<tr>
<td>May</td>
<td>17</td>
<td>25</td>
</tr>
<tr>
<td>June</td>
<td>16</td>
<td>24</td>
</tr>
<tr>
<td>July</td>
<td>22</td>
<td>20</td>
</tr>
</tbody>
</table>

aInversions were classified as air temp at 46 cm above surface < air temp at 168 cm < air temp at 305 cm; temperature differences had to occur for > 1 hour in duration and intensity had to be > 1.0°C between 305 and 46 cm air temperatures.

©Kevin Bradley, University of Missouri
Temperature Inversions in Missouri

Example: Frequency and Timing of Surface Inversions in Northwest Missouri

<table>
<thead>
<tr>
<th>Number of Inversions&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Typical Start Time&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2015</td>
</tr>
<tr>
<td></td>
<td>2015</td>
</tr>
<tr>
<td>March</td>
<td>24</td>
</tr>
<tr>
<td>April</td>
<td>23</td>
</tr>
<tr>
<td>May</td>
<td>15</td>
</tr>
<tr>
<td>June</td>
<td>13</td>
</tr>
<tr>
<td>July</td>
<td>12</td>
</tr>
</tbody>
</table>

<sup>a</sup>Inversions were classified as air temp at 46 cm above surface < air temp at 168 cm < air temp at 305 cm; temperature differences had to occur for > 1 hour in duration and intensity had to be > 1.0°C between 305 and 46 cm air temperatures.

<sup>b</sup>Mode was used to determine typical start times.
Detecting Surface Inversions

Using Smoke Grenades to Validate Inversion Conditions

Released at 4:00 PM, No Inversion Present

Released at 7:30 PM, Inversion Present

At Release

During Dispersion

50 Seconds After Release
Real Time Monitoring for Inversion-like Conditions

mesonet.missouri.edu
Real Time Monitoring for Inversion-like Conditions

mesonet.missouri.edu

Graph Description:

Little to No Inversion Potential:
line is vertical or slants leftward, i.e. | or \n
Inversion Potential:
line slants rightward, i.e. / (The more the line leans rightward, the greater the potential for inversion existing)

American Meteorological Society definition of Temperature Inversion
Dust and Water Movement

Sources of Secondary Drift

- Excessive dust can carry herbicide particles away from the intended target

- Heavy rainfall events can cause movement due to runoff from nearby fields
Common Methods of Off-Target Movement

- Physical Drift
- Secondary Drift & Movement
- Tank Contamination

Factors:
- Wind speed
- Nozzle type
- Droplet size
- Sprayer speed
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- Temperature
- Dust
- Water runoff

- Tank type
- Hose type
- Tank cleanout
Spray Tank Contamination

Tank Contamination Can Lead to Crop Injury

Leaving as little as 8 fl oz of solution in a 1,200 gallon spray tank can result in significant injury to a subsequent sensitive soybean variety!
Spray Tank Cleanout Procedures

Improper Cleanout Procedures can Lead to Yield Loss

Comparison of Three Equipment Cleanout Procedures Following Dicamba Application

Non-treated control

Single rinse water

Double Rinse 1

1st rinse water; 2

2nd rinse ammonia

Triple Rinse 1

1st rinse water; 2

2nd rinse ammonia; 3

3rd rinse water

Yield: 48 Bu/A 37 Bu/A 44 Bu/A 48 Bu/A
Common Methods of Off-Target Movement

Physical Drift

Secondary Drift & Movement

Tank Contamination

Which of these do you need to be more mindful of during the upcoming application season?

Wind speed
Nozzle type
Droplet size
Sprayer speed
Boom height
Herbicide volatility
Temperature
Dust
Water runoff
Tank type
Hose type
Tank cleanout
Common Methods of Off-Target Movement

Module 2

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Acknowledgements

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Sources


