Studying Secondary Dicamba Drift

Mandy Bish, Shea Farrell, and Kevin Bradley
University of Missouri
Studying Secondary Drift

Occurs when pesticide droplets move after the application

Does not typically leave a distinct injury pattern

Commonly associated with environmental and weather factors

- volatility
- temperature inversions
- runoff
- binding to dust
Secondary Drift
An example

Sensitive soybean injured by dicamba application.

These plants were covered during the application, but still show dicamba injury.
How/why is dicamba moving?

If we can understand it, we increase our ability to reduce it.

Presentation summary:

Inversion monitoring update

Air sampling study

Environmental study
Monitoring inversions review & update

+ inversion
Clear sky, no wind, near dusk

Warmer air
Cooler air

no inversion
Cumulus clouds, wind

Cooler air
Warmer air
Inversions result in stable air masses. Particles can be suspended in these air masses. Smoke bombs are a good visual of this.

<table>
<thead>
<tr>
<th>Released at 4:00, No Inversion Present</th>
<th>Released at 7:30, Inversion Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>at release</td>
<td>at release</td>
</tr>
<tr>
<td>during dispersion</td>
<td>during dispersion</td>
</tr>
<tr>
<td>50 seconds after release</td>
<td>50 seconds after release</td>
</tr>
</tbody>
</table>
Surface-level temperature inversions are common during Missouri evenings.

### Three-year trend for time that inversions began forming, Columbia, MO (2015-2017)

<table>
<thead>
<tr>
<th>Month</th>
<th>Number of inversions</th>
<th>Average start time</th>
<th>Earliest</th>
<th>Latest</th>
</tr>
</thead>
<tbody>
<tr>
<td>April</td>
<td>58</td>
<td>6:07 PM ± 1 hour</td>
<td>4:10 PM</td>
<td>11:25 PM</td>
</tr>
<tr>
<td>May</td>
<td>56</td>
<td>6:16 PM ± 2 hours 20 minutes</td>
<td>2:50 AM</td>
<td>11:20 PM</td>
</tr>
<tr>
<td>June</td>
<td>53</td>
<td>6:01 PM ± 3 hours 26 minutes</td>
<td>0:01 AM</td>
<td>10:25 PM</td>
</tr>
<tr>
<td>July</td>
<td>46</td>
<td>7:03 ± 30 minutes</td>
<td>5:15 PM</td>
<td>8:40 PM</td>
</tr>
</tbody>
</table>

### Three-year trend for duration of inversions, Columbia, MO (2015-2017)

<table>
<thead>
<tr>
<th>Month</th>
<th>Number of inversions</th>
<th>Average duration</th>
<th>Shortest</th>
<th>Longest</th>
</tr>
</thead>
<tbody>
<tr>
<td>April</td>
<td>58</td>
<td>11:26 ± 3 hours</td>
<td>1:30</td>
<td>16:50</td>
</tr>
<tr>
<td>May</td>
<td>56</td>
<td>10:19 ± 2 hours 41 minutes</td>
<td>1:10</td>
<td>15:00</td>
</tr>
<tr>
<td>June</td>
<td>53</td>
<td>9:53 ± 2 hours 39 minutes</td>
<td>1:25</td>
<td>12:55</td>
</tr>
<tr>
<td>July</td>
<td>46</td>
<td>9:08 ± 2 hours 39 minutes</td>
<td>3:30</td>
<td>12:55</td>
</tr>
</tbody>
</table>

This is one example. For more information on inversions in Missouri check out the slide show “Knowing When to Spray, monitoring historical and real-time weather.”
But how do inversions contribute to off-target dicamba movement? Is it:

1. By herbicide droplets being suspended in the stable air mass when applied during inversion conditions?

2. By volatilizing or moving into the stable air mass after an inversion forms?

3. Some combination of both?
Studying dicamba in the air

In this study, most dicamba was collected in the evening regardless of application time.

On label application; made mid-day

Off label application; made the subsequent evening; during an inversion

Graphs are averages of 2 studies with 3 air samplers per application

© Dr. Kevin Bradley, University of Missouri
Studying dicamba in the air

Dicamba application made in the evening as an inversion formed

Larger the air temp difference = ‘stronger’ the inversion

Dicamba was detected throughout the evening NOT only at time of application

These preliminary air sample results provide support for a role of atmosphere stability

© Dr. Kevin Bradley, University of Missouri (June 8-9, 2017 Columbia, Missouri)
From the lab to the field: What can we learn from 2017 ‘real world’ applications?

Data studied:

54 successful applications*
- Missouri
- Kansas

66 applications resulting in OTM
- Missouri
- Kansas
- North Carolina
- Canada

Cases studied by date of incident

![Bar chart showing cases by date and target status.](chart.png)
Successful vs Off-target Applications

**Data retrieved:**
- Max air temp
- Ave air temp
- Max wind speed
- Total precipitation

Weather data from the nearest state-maintained station was used.

Data for day-of and day-following application were studied.
Air temperatures alone seem insufficient to explain off-target movement.

*Error bars represent standard error of the mean

© Dr. Kevin Bradley, University of Missouri
Air temperatures alone seem insufficient to explain off-target movement.

*Error bars represent standard error of the mean

© Dr. Kevin Bradley, University of Missouri
What can we learn when application date is unknown?

Data studied
54 successful applications* across 3 months
  • Missouri
  • Kansas

124 applications resulting in OTM
  • Missouri
  • Kansas
  • North Carolina
  • Canada
  • Tennessee
  • South Dakota

Data retrieved
  • Soil pH information from NRCS’s Web Soil Survey
  • Soybean acreage from National Ag Census Data
  • Date injury observed

Can we use the data to predict a successful vs off-target application?

- soil pH
- Weeks after May 1*
- % of county in soybean production

© Dr. Kevin Bradley, University of Missouri
What can we learn when application date is unknown?

Can we use the data to predict a successful vs off-target application?

Preliminary data suggest soil pH may be an indicator. Soil pH of successful applications was estimated to be 6.31. Soil pH of unsuccessful applications was estimated slightly lower 6.18.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>On-target (n=54)</th>
<th>Off-target (n=123)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil pH</td>
<td>6.31 (+0.04)</td>
<td>6.18 (+0.04)</td>
<td>0.0141</td>
</tr>
<tr>
<td>Weeks after May 1</td>
<td>7.9 (+0.34)</td>
<td>8.8 (+0.25)</td>
<td>0.0362</td>
</tr>
<tr>
<td>% Soybean Acres</td>
<td>23.7 (+1.2)</td>
<td>24.1 (+0.85)</td>
<td>0.796</td>
</tr>
</tbody>
</table>
Summary

• Secondary drift is not an easy problem to investigate.
• Multiple factors are likely at play.
• Air temperatures alone seem insufficient to explain the differences between ‘successful’ & off-target applications in 2017.
• Atmosphere stability likely plays a role. This would make sense in that dicamba droplets could accumulate in a stable air mass and be moved off-target altogether in a wind gust.
• Soil pH may play a role. Soils estimated to have a lower pH were associated more closely to the off-target cases.