SYNTHETIC AUXIN HERBICIDE

APPLICATOR TRAINING PROGRAM

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?

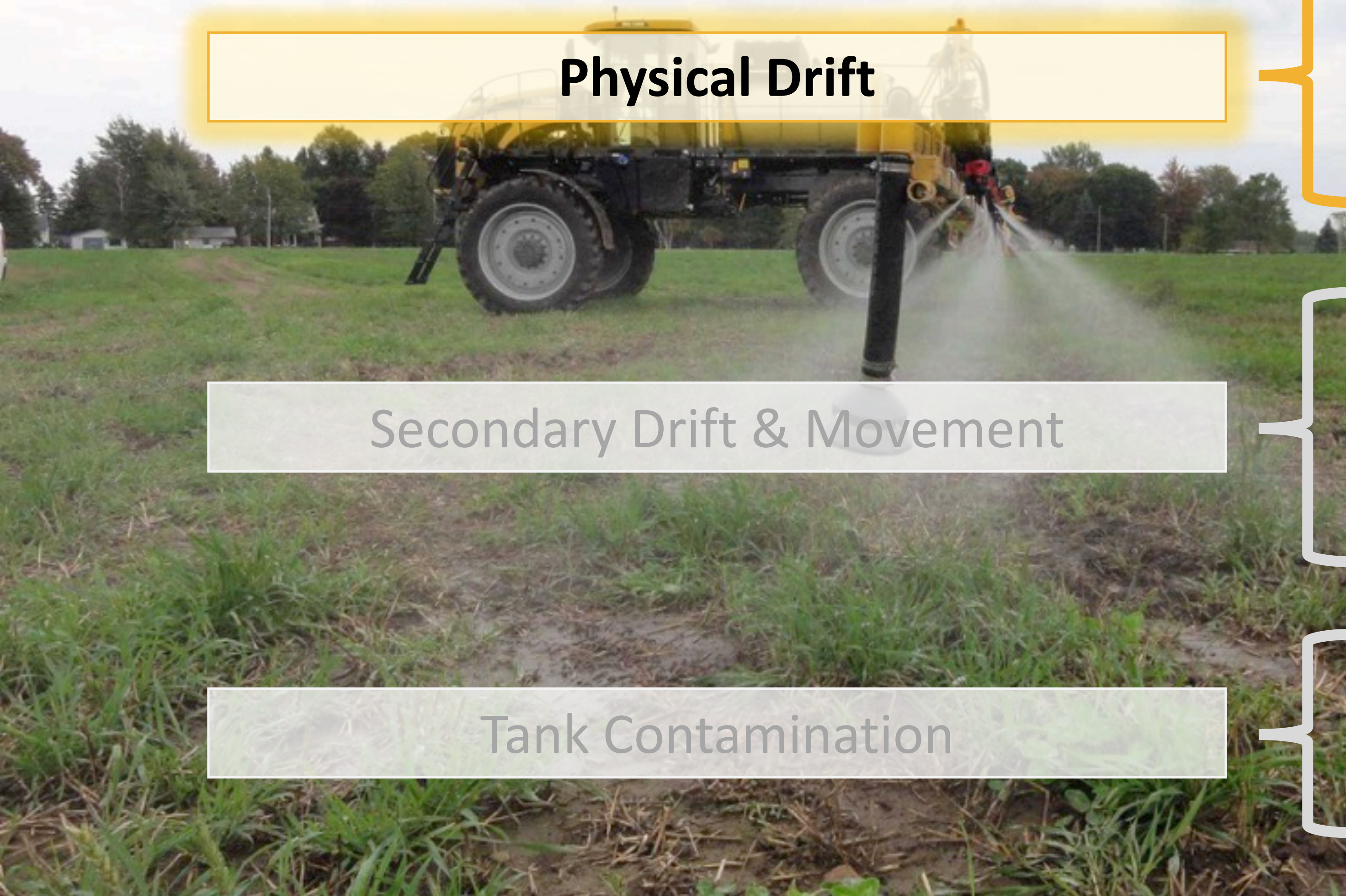
Call out the items you think could cause off-target movement

Physical Drift
- Wind speed
- Nozzle type
- Droplet size
- Sprayer speed
- Boom height

Secondary Drift & Movement
- Herbicide volatility
- Temperature
- Dust
- Water runoff

Tank Contamination
- Tank type
- Hose type
- Tank cleanout

Common Methods of Off-Target Movement



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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 <u>usually</u> 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

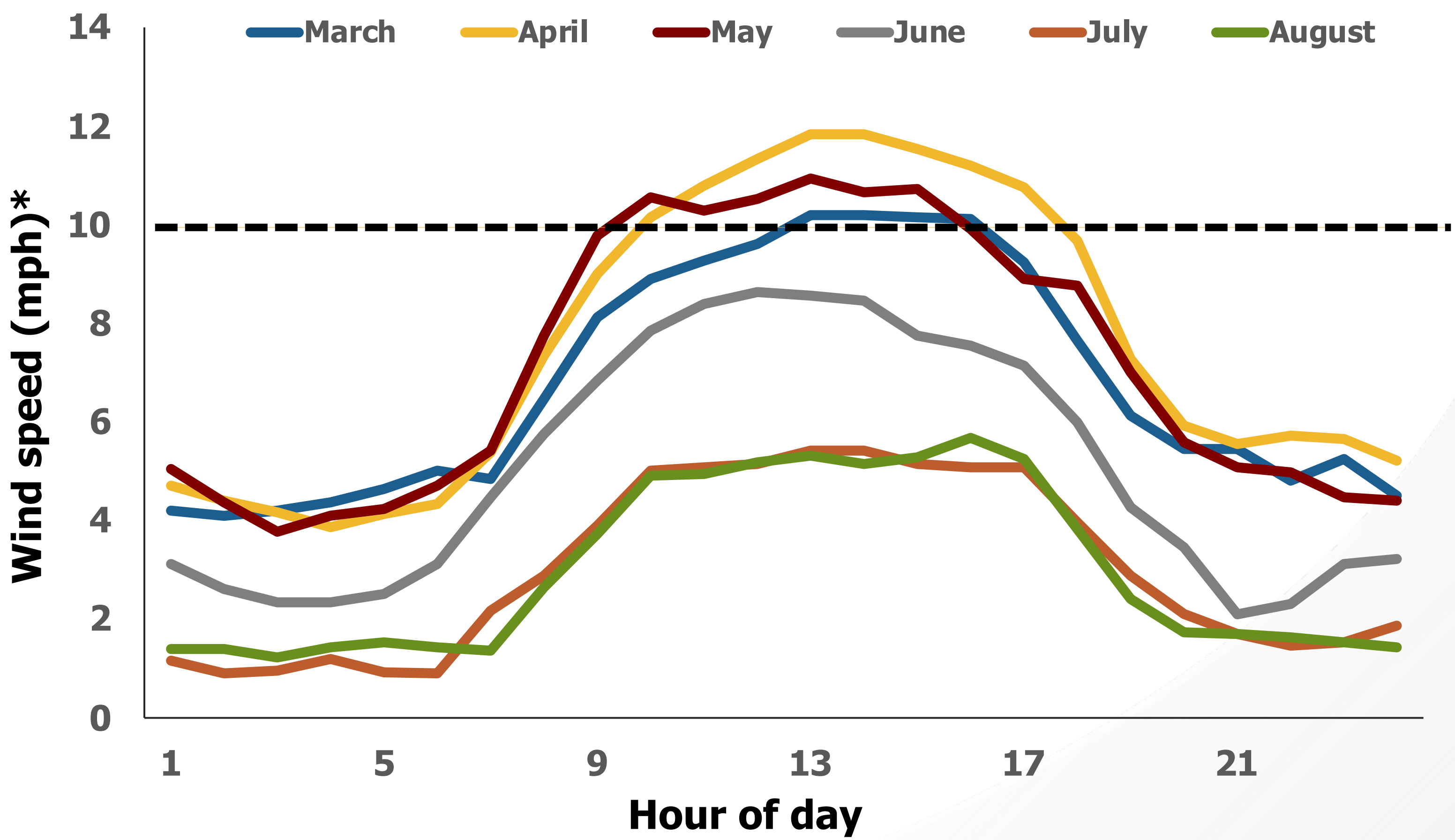
90 ft. downwind

Always read and follow the labeled wind-speed requirements!

Diagram Provided by Dr. Greg Kruger, University of Nebraska

Historical Wind Speeds

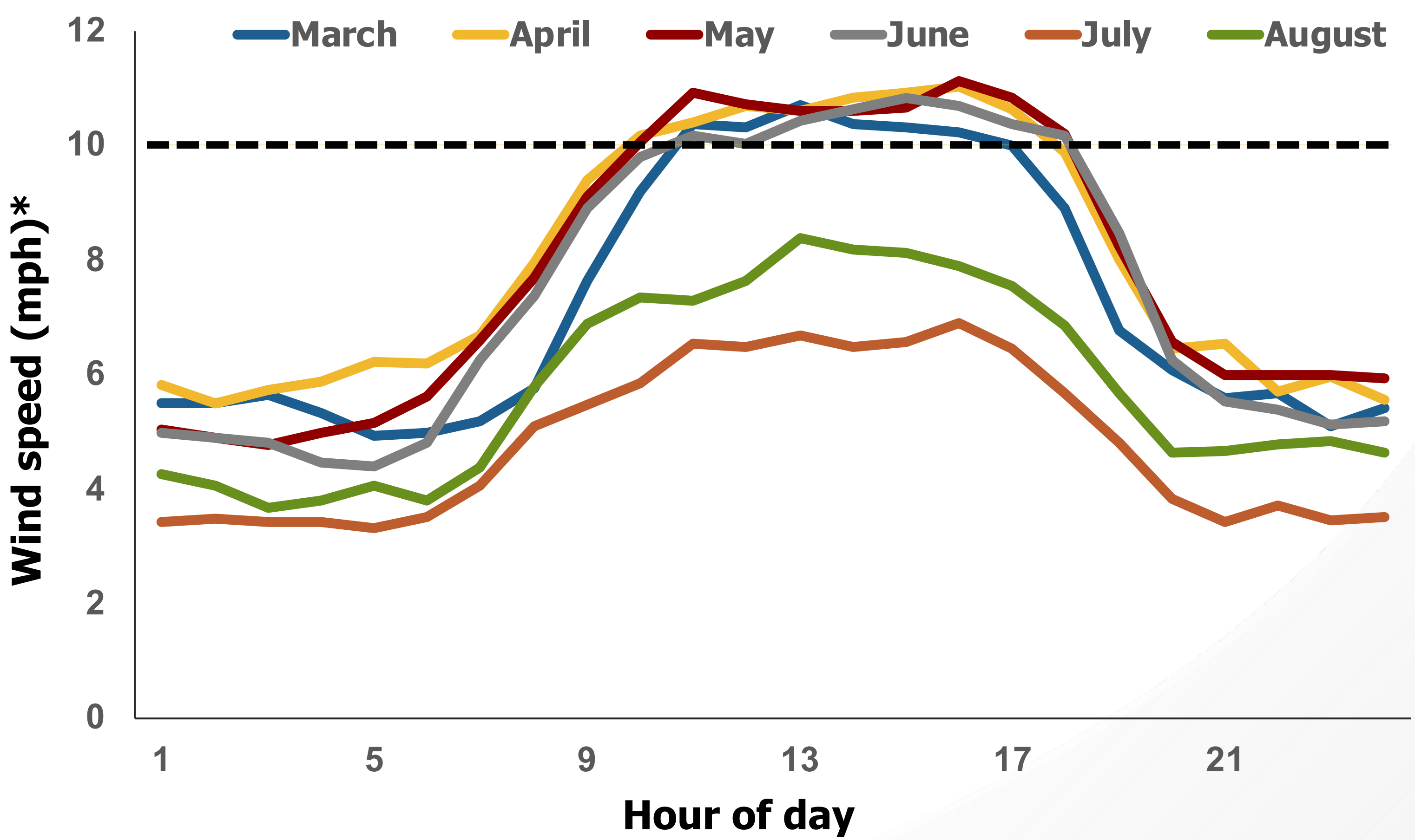
Example: Hourly Average Wind Speeds in Southeast Missouri by Month*



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

Historical Wind Speeds

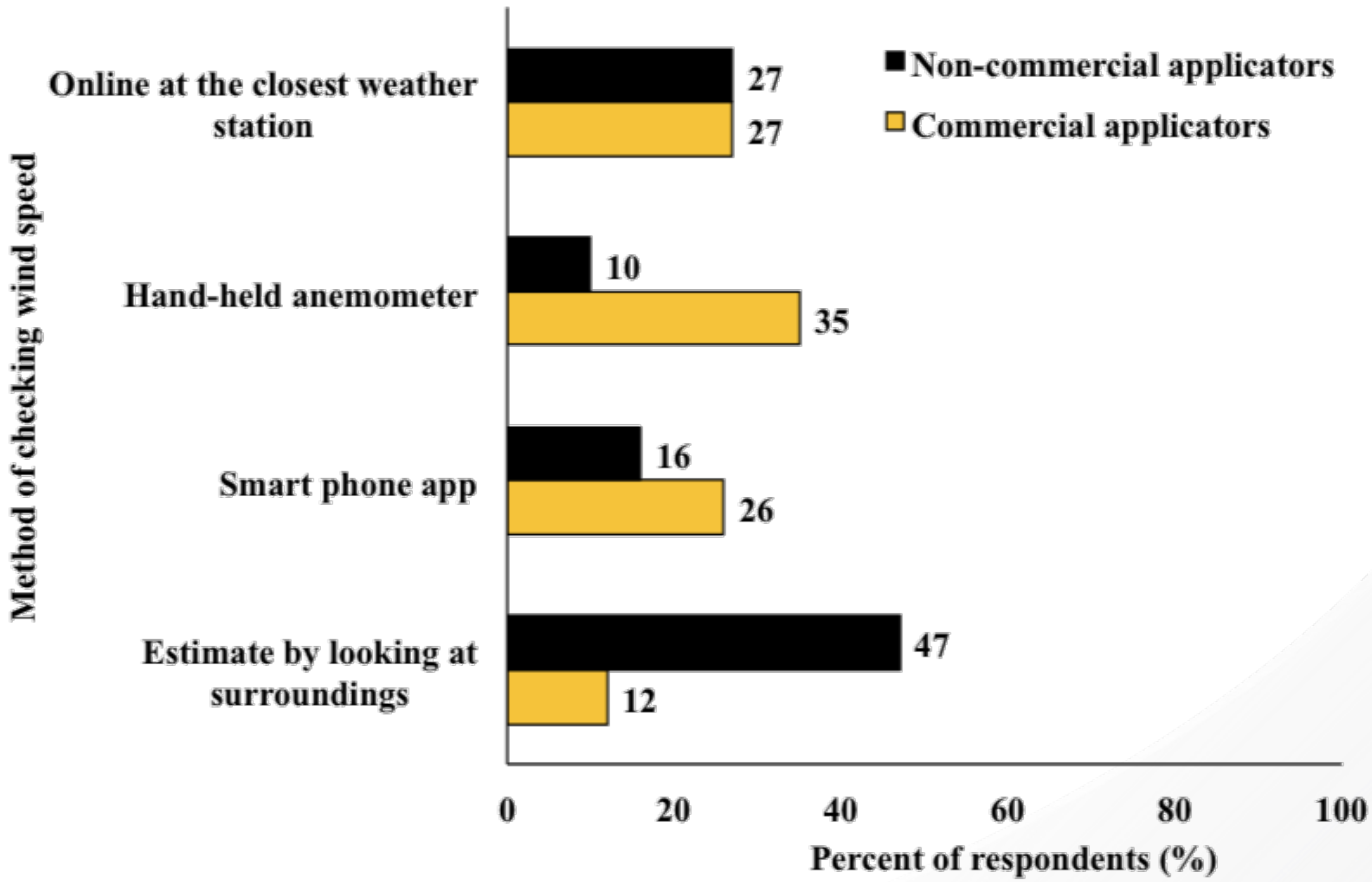
Example: Hourly Average Wind Speeds in Northwest Missouri by Month*

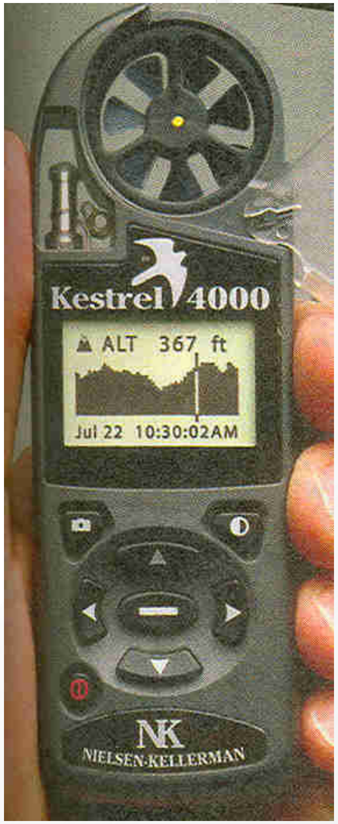


*Hourly wind-speed averaged from the years 2000 to 2015

How are you checking the wind speed?

Best Practice: Check Wind Speeds at the Site of Application





Source: Bish & Bradley (2017)

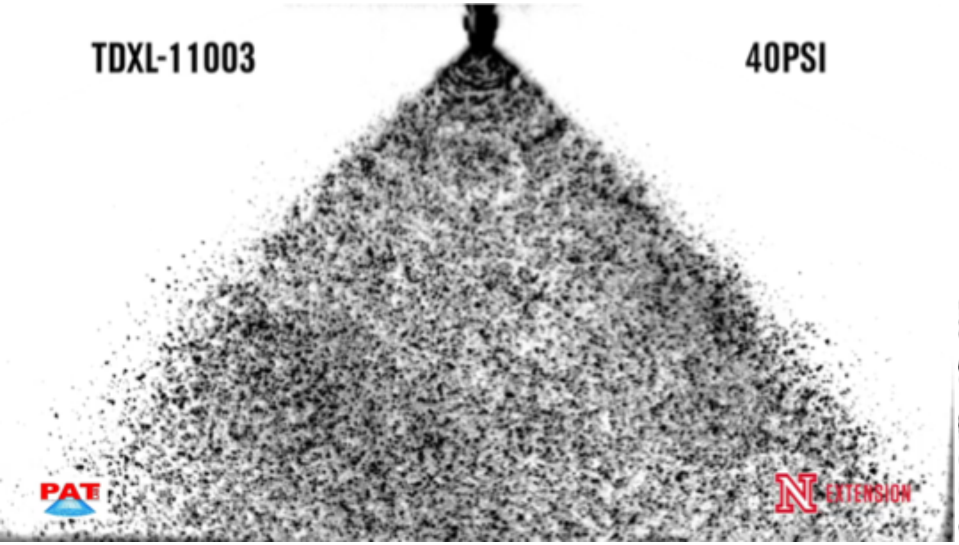
Nozzles and Droplet Size

Sources of Physical Drift

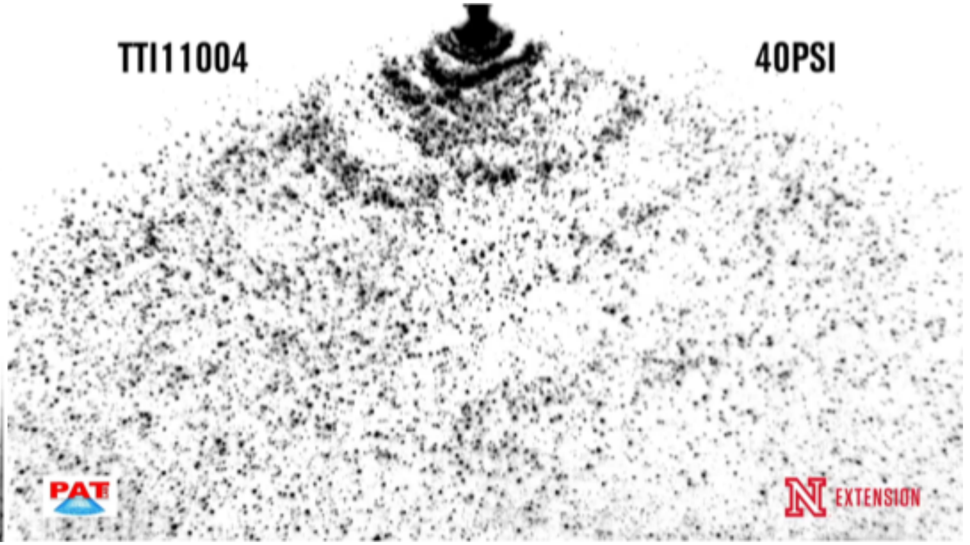
- ✓ Wind speed
- Nozzle type
- Droplet size
- Sprayer speed
- Boom height

Relationship of Nozzle Type and Droplet Size

Comparison of Two Different Nozzle Types



Extended Range Flat Fan Spray Tip

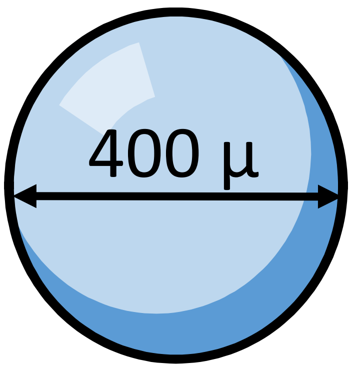


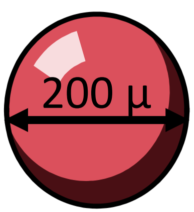
Turbo TeeJet Induction Nozzle

Videos Provided by Dr. Greg Kruger, University of Nebraska

Droplet Sizes in Real World Terms

Comparison of Droplet Sizes with Familiar Objects





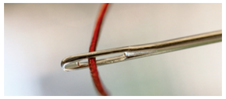
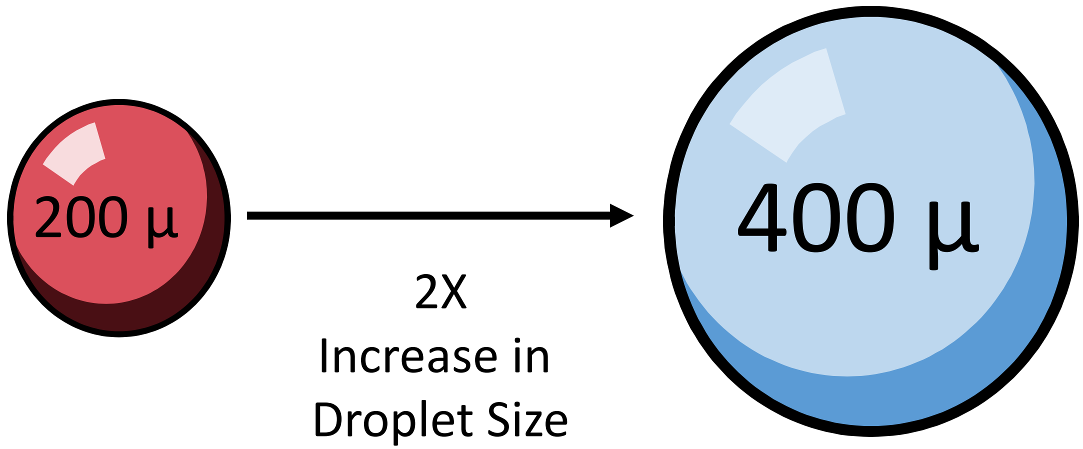
Pencil lead		2000 μm
Paper clip		850 μm
Staple		420 μm
Toothbrush bristle		300 μm
Sewing thread		150 μm
Human hair		100 μm

Illustration Provided by Dr. Greg Kruger, University of Nebraska

Droplet Size to Weight Relationship

Result of Doubling the Diameter of a Spray Drop



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

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

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

Source: Hofman & Solseng (2017)

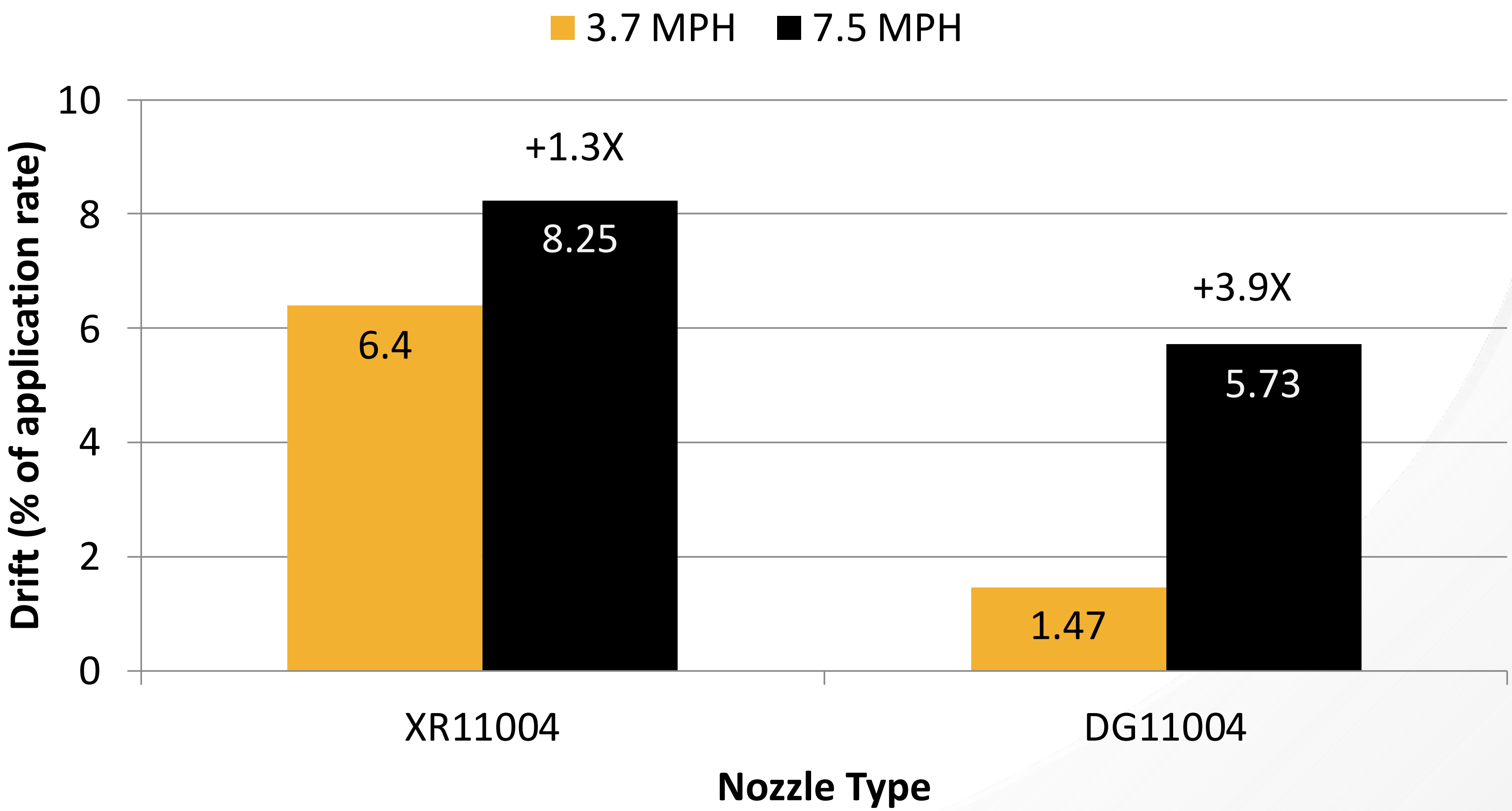
Sprayer Speed

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



Source: Van de Zande et al., (2004)

* (1-5 m from last nozzle)

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

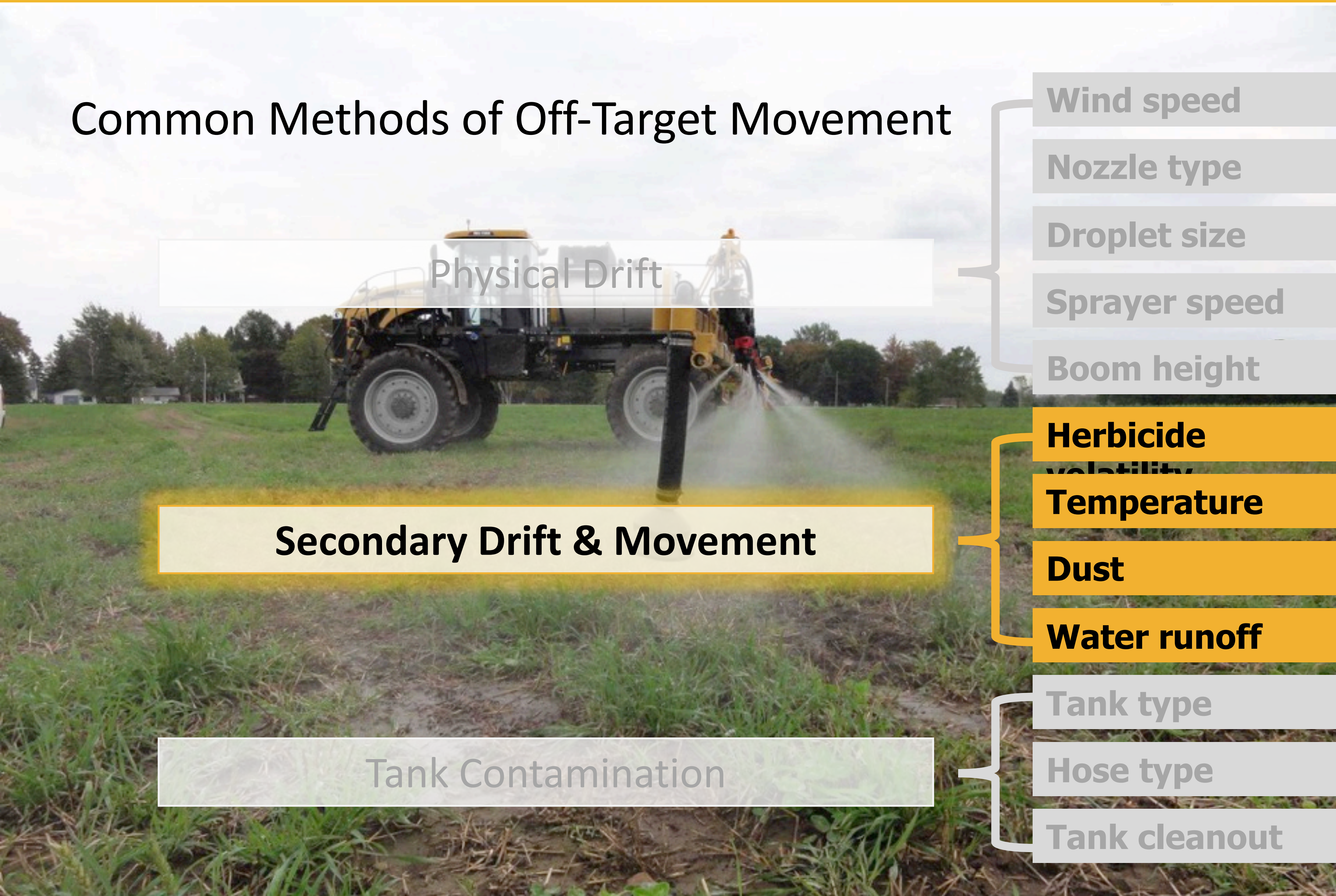
18 inch increase

350% Increase In Drift

90 ft. downwind

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

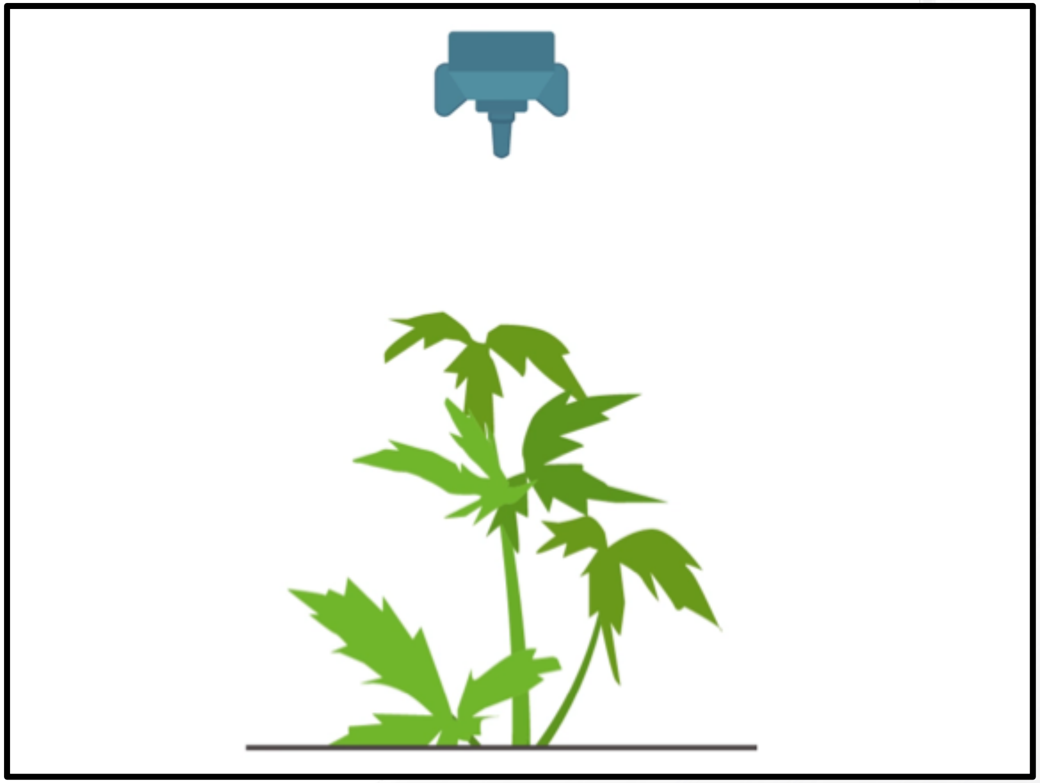
Secondary Drift & Movement
- Herbicide volatility
- Temperature
- Dust
- Water runoff

Tank Contamination
- 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

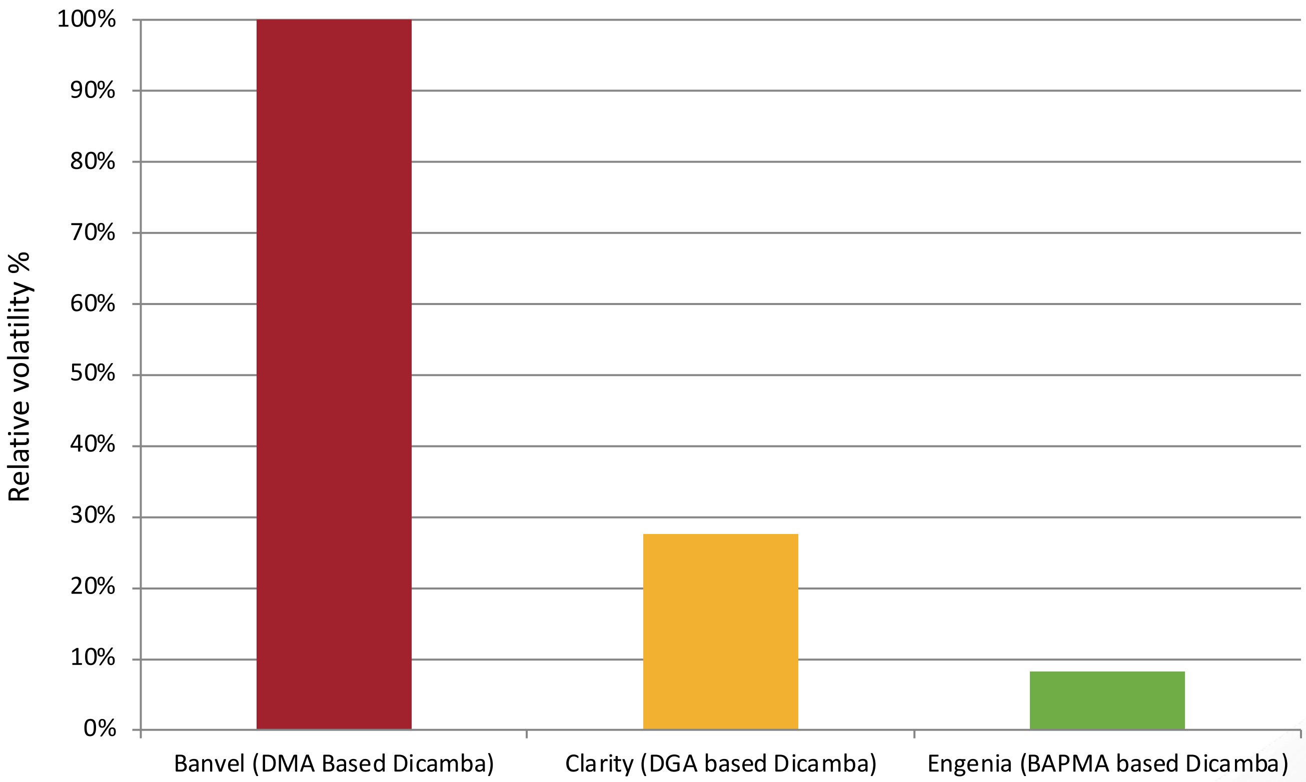
2,4-D and dicamba volatility are influenced by:

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

Sources: Behrens & Lueschen (1979); Long & Young (2017)

The Salt in the Formulation Matters

Example: Relative Volatility of Engenia



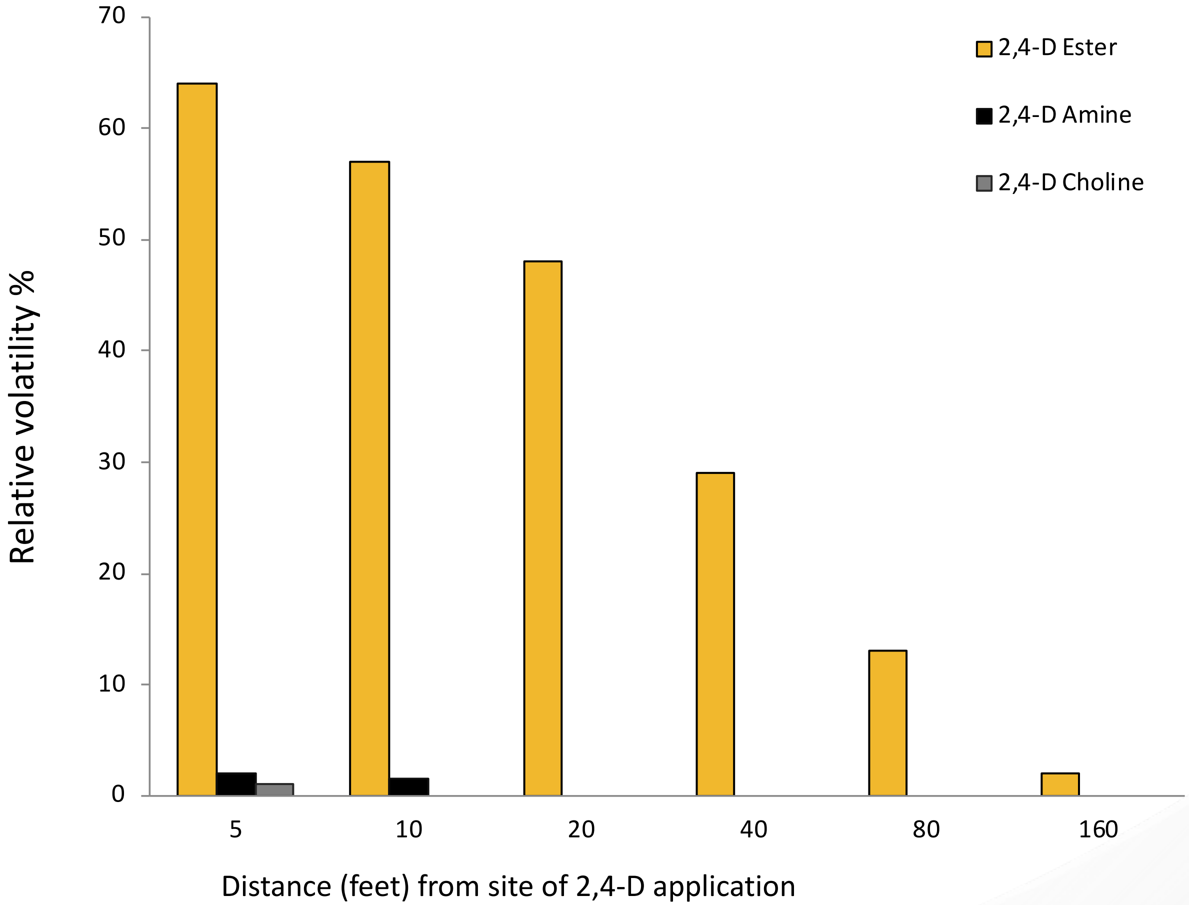
Volatility ratings collected using five different measurement techniques: Field testing, Humidome, TGA, C^{14}, & Incubator

In trials, Engenia exhibited 70% lower volatility relative to DGA-based Dicamba.

Chart Provided by BASF

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

XtendiMax

Engenia

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

	Number of Inversions[a]		Typical Start Time	
	2015	2016	2015	2016
March	21	22	4:00-5:00 p.m.	5:00-6:00 p.m.
April	23	27	4:00-5:00 p.m.	5:00-6:00 p.m.
May	17	25	4:00-6:00 p.m.	6:00-7:00 p.m.
June	16	24	5:00-6:00 p.m.	6:00-7:00 p.m.
July	22	20	6:00-7:00 p.m.	7:00-8:00 p.m.

[a]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.

Temperature Inversions in Missouri

Example: Frequency and Timing of Surface Inversions in Northwest Missouri

	Number of Inversions[a]		Typical Start Time[b]	
	2015	2016	2015	2016
March	24	15	5:00 to 6:00 p.m.	5:00 to 6:00 p.m.
April	23	13	6:00 to 7:00 p.m.	6:00 to 7:00 p.m.
May	15	24	6:00 to 7:00 p.m.	6:00 to 7:00 p.m.
June	13	29	6:00 to 7:00 p.m.	6:00 to 7:00 p.m.
July	12	14	6:00 to 8:00 p.m.	7:00 to 8:00 p.m.

[a]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.

[b]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

Real Time Monitoring for Inversion-like Conditions

mesonet.missouri.edu

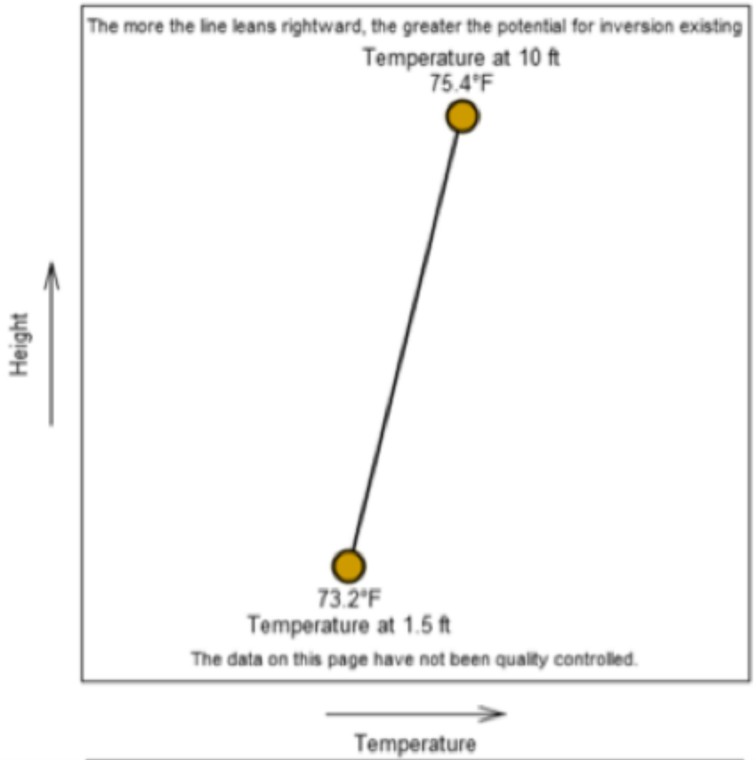
Funding for this project made possible by the Missouri Soybean Merchandising Council

Real Time Monitoring for Inversion-like Conditions

mesonet.missouri.edu

Monroe City Airport, Monroe City, MO
Jul 6, 2017 10:40 pm CDT

Updated every 5 minutes   Local conditions will vary



Monroe City, Missouri

Lat: 38.897236°, Lon: -92.218070°

Graph Description:

Little to No Inversion Potential:
line is vertical or slants leftward, i.e. | or \

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

Disclaimer

Dust and Water Movement

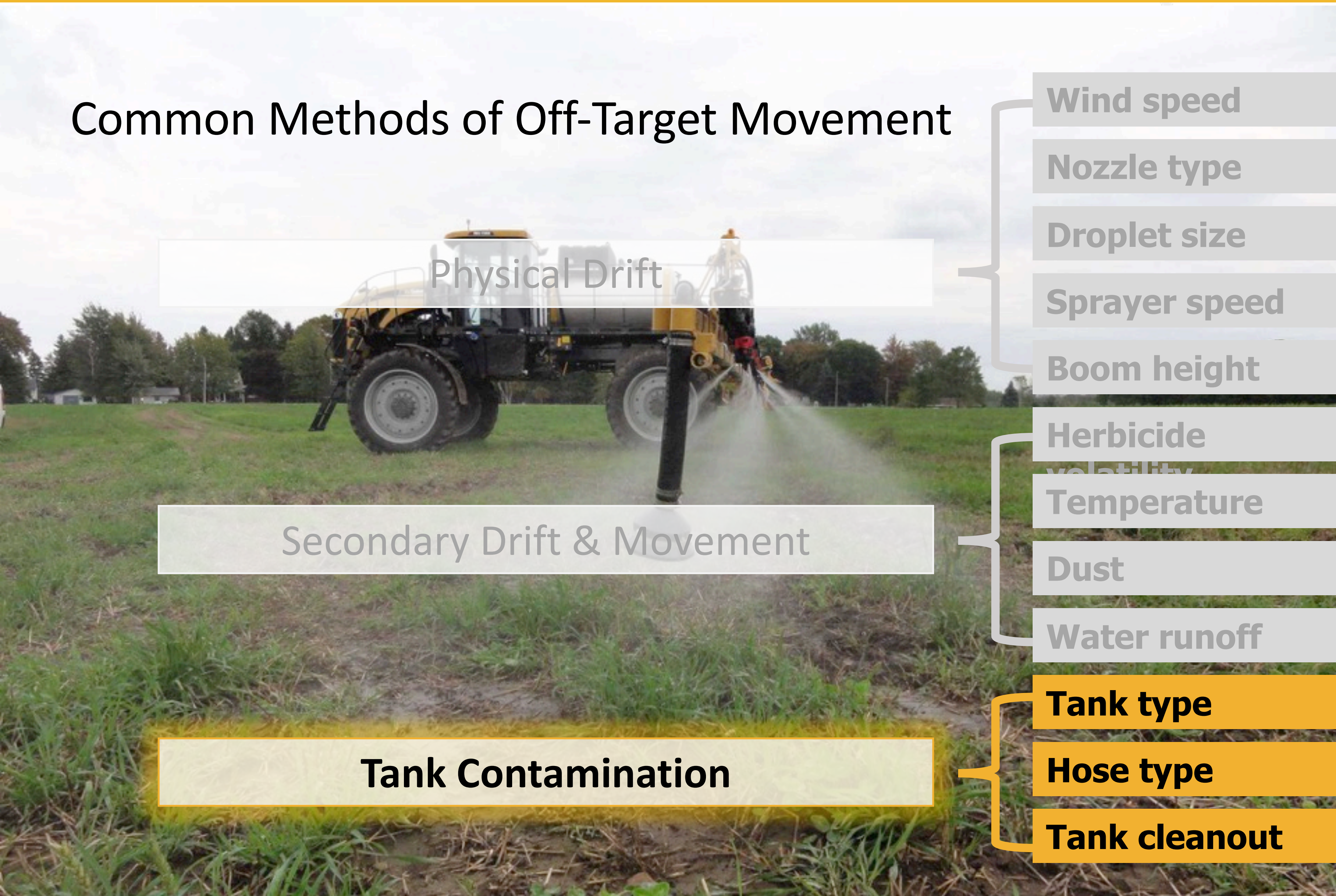
Sources of Secondary Drift

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

- Heavy rainfall events can cause movement due to runoff from nearby fields

✓ Herbicide Volatility
✓ Temperature
Dust
Water Runoff

Common Methods of Off-Target Movement



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- Tank type
- Hose type
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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

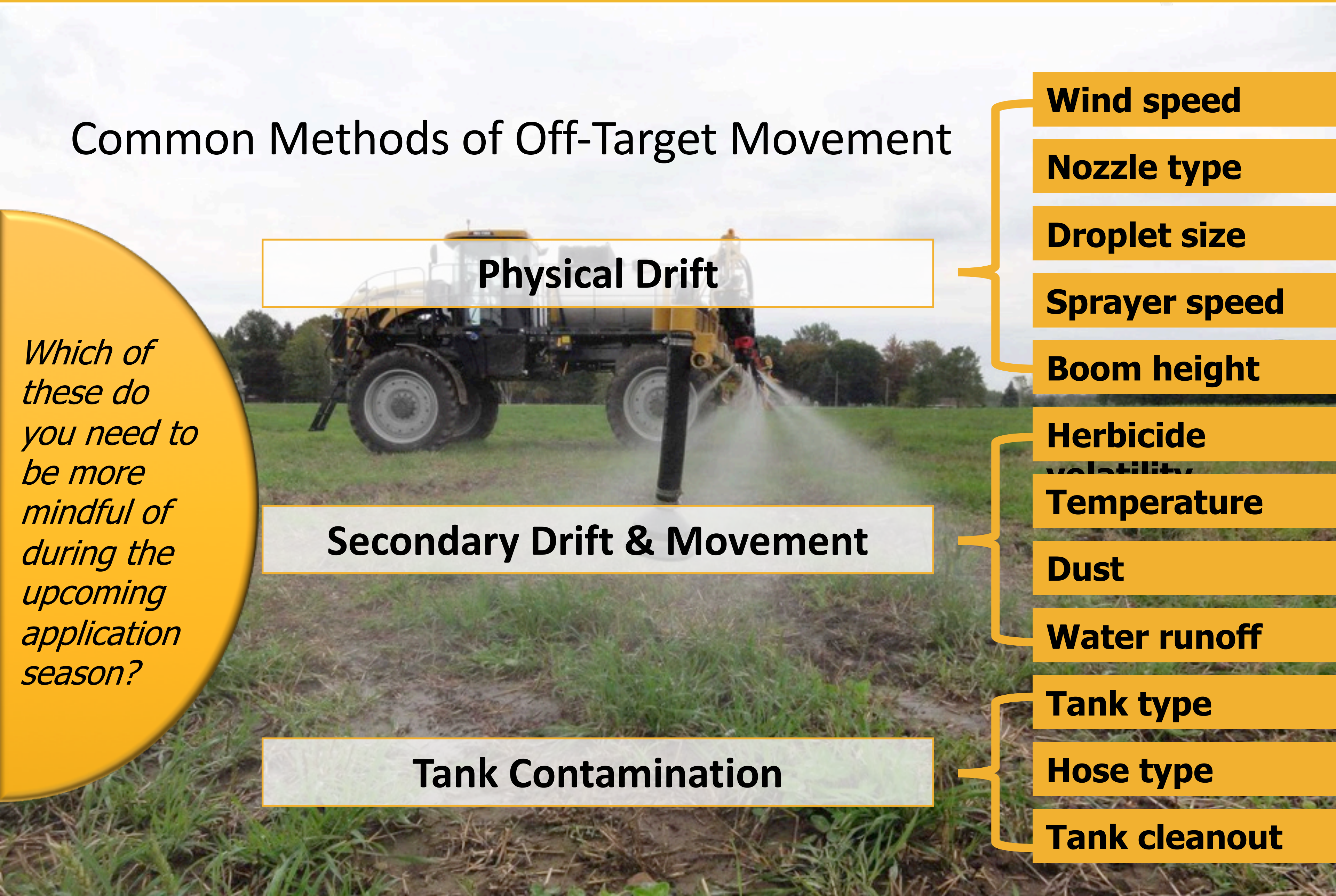
Single rinse water

Double Rinse 1^{st} rinse water; 2^{nd} rinse ammonia

Triple Rinse 1^{st} rinse water; 2^{nd} rinse ammonia; 3^{rd} rinse water

	Yield
Non-treated control	**48 Bu/A**
Single rinse	**37 Bu/A**
Double Rinse	**44 Bu/A**
Triple Rinse	**48 Bu/A**

Common Methods of Off-Target Movement



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

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Acknowledgements

Module Authors

- Dr. Kevin Bradley
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- University of Missouri-Columbia

Mizzou weed science

Other Contributors

Dr. Stanley Culpepper, University of Georgia

Dr. Greg Kruger, University of Nebraska

Dr. Larry Steckel, University of Tennessee

Missouri Department of Agriculture

Sources

Behrens, R. & Lueschen, W. E. (1979). Dicamba Volatility. *Weed Science, 27*(5), 486-493.

Bish, M. D., & Bradley, K. W. (2017). Survey of Missouri Pesticide Applicator Practices, Knowledge, and Perceptions. *Weed Technology*, *31*(2), 165-177.

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Sosnoskie, L. M., Culpepper, A. S., Braxton, L. B., & Richburg, J. S. (2015). Evaluating the volatility of three formulations of 2, 4-D when applied in the field. *Weed technology*, *29*(2), 177-184.

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