Herbicide Drift: Cause, Effect on Crops, and Management

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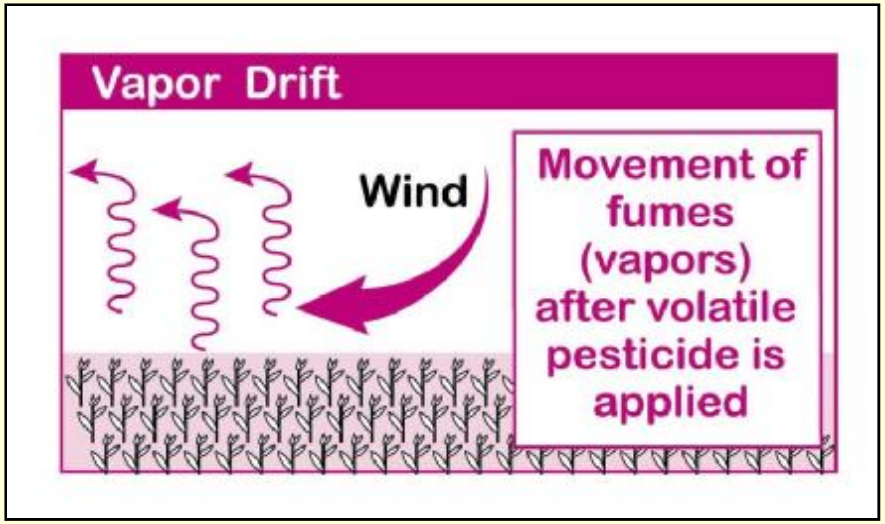
What is Herbicide Drift?

The unintentional airborne movement of herbicide outside of the target area.

Types of Drift

Vapor Drift:

Associated with volatilization



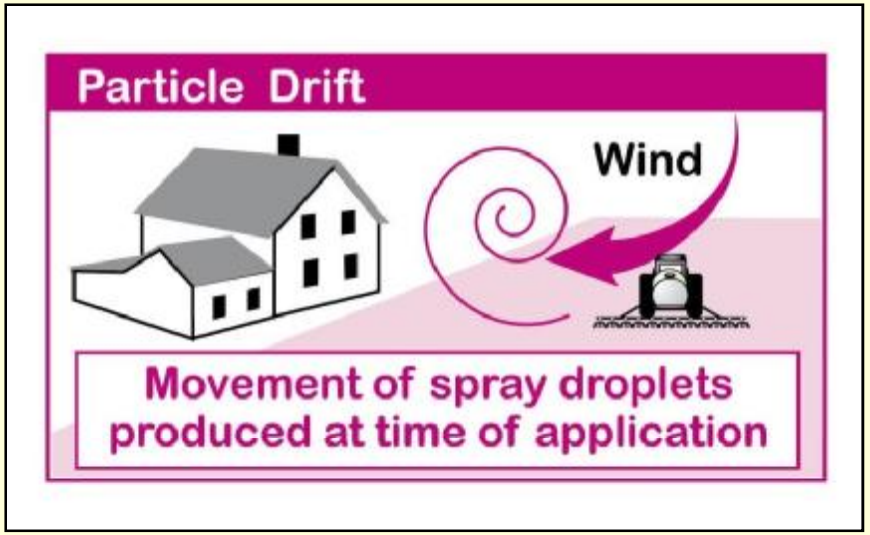
Volatilization is the process by which a substance changes from a solid or liquid state to a vapor/gas state. All chemicals have a finite vapor pressure.

Vapor pressure is the measure of pressure exerted by the gas particles of a herbicide when in equilibrium in the closed container.

The higher the vapor pressure, the greater the volatility.

Types of Drift

Particle Drift:
Occurs during application



Off-target movement in liquid form (physical drift).

Affected by weather conditions and spray droplet size, nozzle height, and wind speed.

All herbicides susceptible.

Herbicide Drift – Ground vs. Aerial Application

Aerial Applicators Often Unfairly Criticized for Drift
Ford Baldwin**,** Delta Farm Press, January 26, 2012

Off-target movement of herbicides can be attributed to both aerial and ground application.

Weather Conditions Affecting Particle Drift

- Wind
- Temperature
- Humidity
- Temperature Inversions

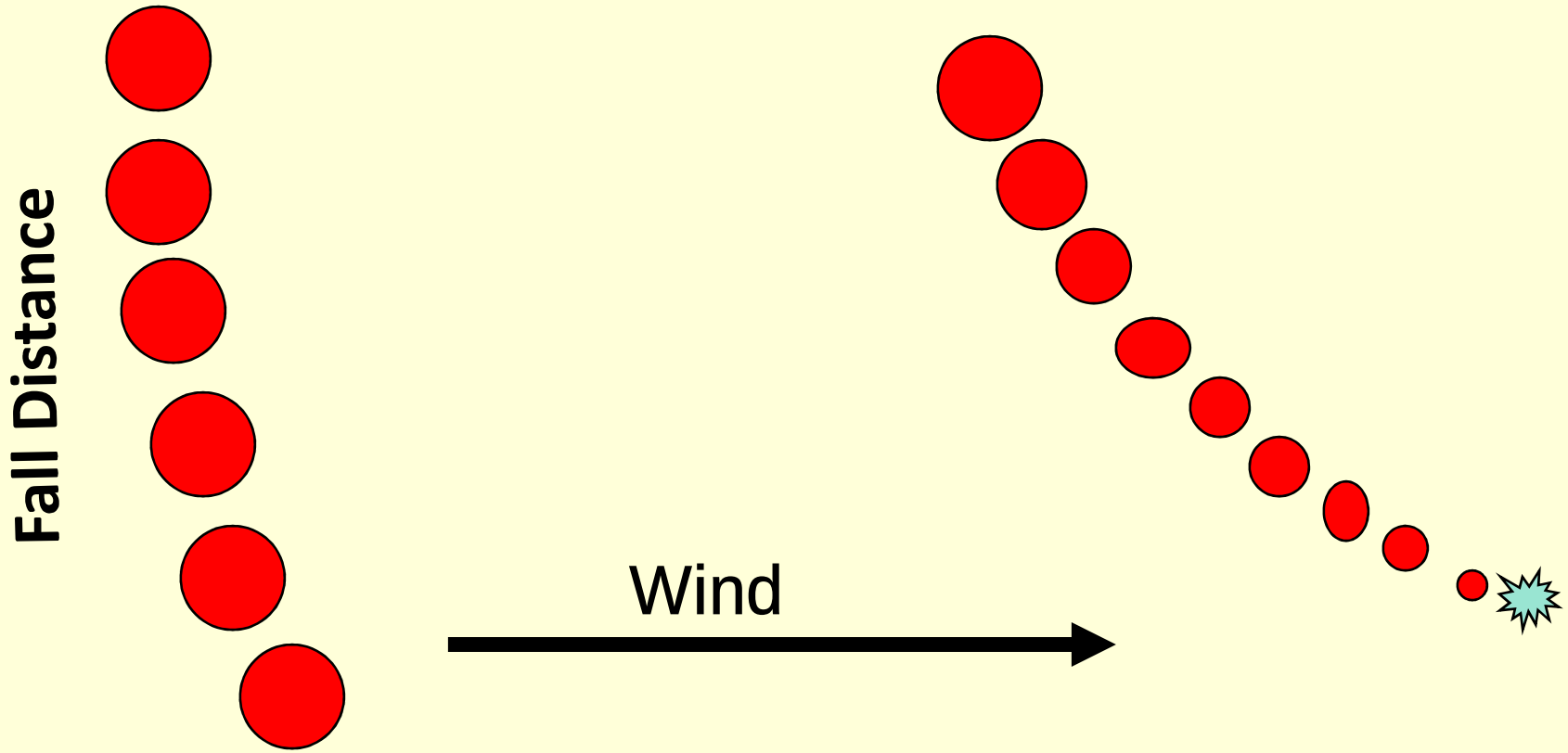
Wind

- Most common contributor to particle drift
- Wind speeds above 8 mph significantly increase the risk of particle drift to downwind areas
- Wind speeds below 3 mph are often variable and may change direction rapidly
- No wind may be indicative of a temperature inversion

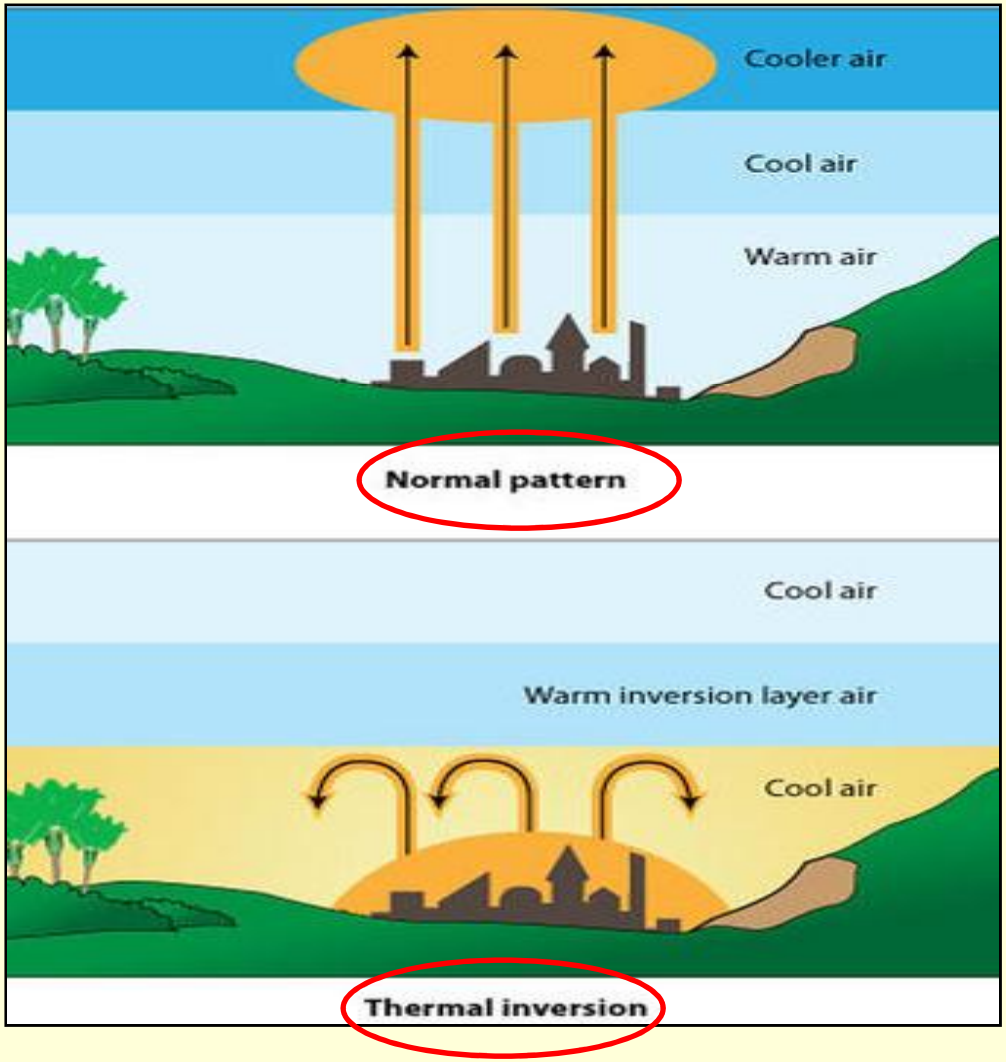
Temperature and Humidity: Evaporation of Droplets

High Relative Humidity
Low Temperature

Low Relative Humidity
High Temperature



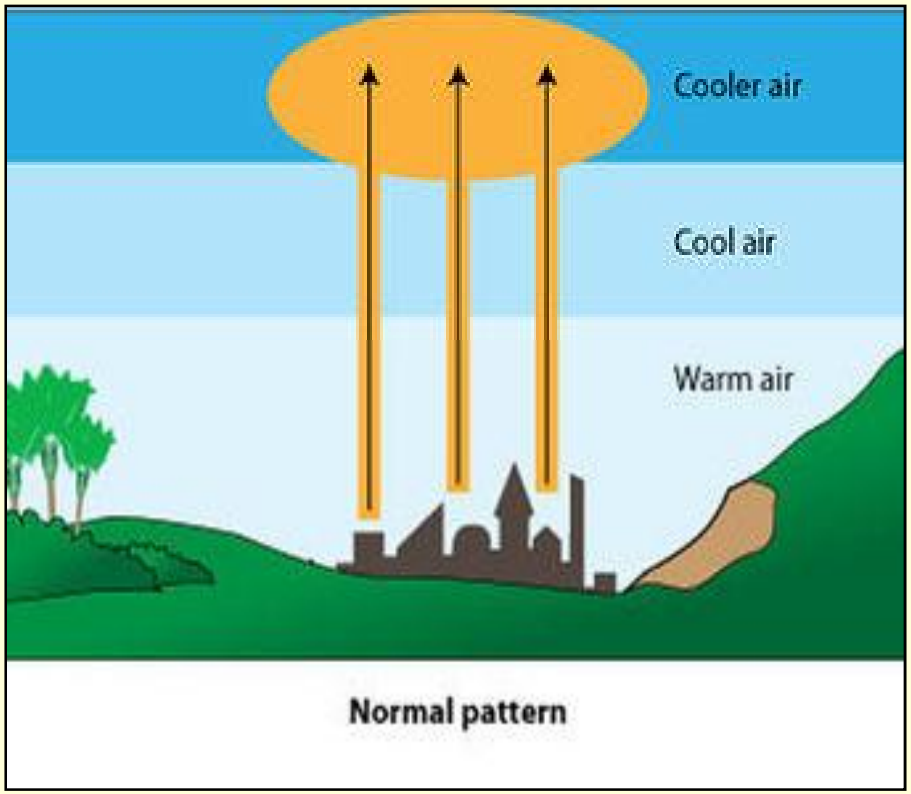
Normal Atmospheric Conditions vs. Temperature/Thermal Inversion



Normal Atmospheric Conditions

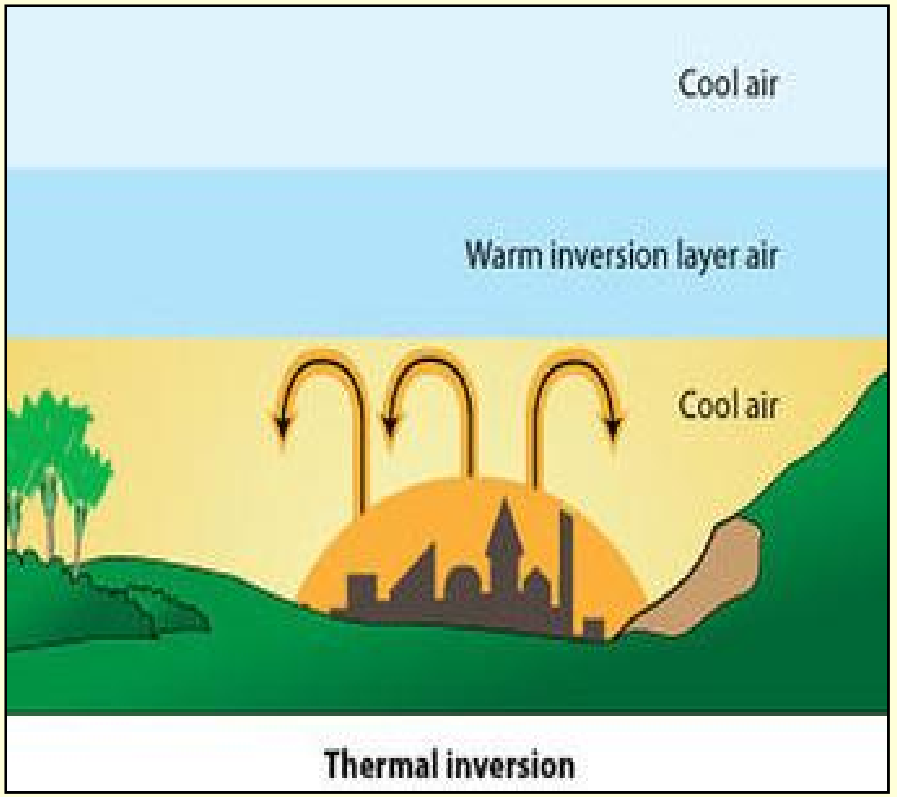
Under normal conditions:

- Warmest air is near the earth's surface (sun warms the soil and heat is radiated).
- Temperature decreases with altitude/height so that cooler air is above warm air.
- As warm air rises it is replaced with cooler air which is heavier causing a mixing action of the atmosphere.



Temperature/Thermal Inversion

- Is the “inverse” of the normal condition and temperature <u>increases</u> with altitude/height.
- From dusk to early morning, earth’s surface can lose heat causing surface air to be cooler than air above it.
- Because the cool air sinks (heavier), the stagnant layer of warm air becomes “sandwiched” between the cool layers of air.
- Wind movement is needed to breakup the warm inversion layer.



Temperature/Thermal Inversions

- Can occur at any altitude/height and can be very close to the ground or very high
- Can occur at any time

Temperature/Thermal Inversions

- With little wind or air movement one could assume that it is is a good time to spray.

  <u>In actuality, it's the worst time…</u>

- Little wind or air movement during inversion results in suspension and trapping of small spray drops in the inversion layer.

- Spray droplets will eventually move out of the treatment area as a concentrated cloud

- Inversions usually occur on clear, calm mornings and nights. Windy or turbulent conditions prevent inversion formation.

Temperature/Thermal Inversions

- Temperature inversions should be identified before *ground and aerial* herbicide applications.
- Drift from inversion: documented case shows damage occurring over a 15 mile area from a late afternoon application in calm wind
- Smoke generators or smoky fires can be used to detect inversion conditions. Smoke will not continue to rise but will drift along at a constant height under the inversion blanket.

Temperature Inversions: Rules and Regulations from Other States

- Arkansas has set specific rules regarding temperature inversions to help minimize the risk of drift for both aerial and ground applications.
- Applicators must record ambient temperature in the treated field.

Temperature Inversions: Rules and Regulations from Other States

- *To make application*:
  - Temperature must increase 3°F from the morning low at the time of application for applications made before noon
  - Temperature must not decrease more than 3°F from the afternoon high for applications made after noon.
  - The applicator should also use other legal means available to him/her to verify that an inversion does not exist.

Managing Spray Drift
Nozzle Selection

- Be aware of nozzle type and droplet size
  - Spray droplets 100 microns or less are more susceptible to drift
  - Use the lower end of the pressure recommended range for the particular nozzle to produce course droplets

- Match nozzle to type of pesticide and whether its action is contact or systemic
  - Larger spray droplets reduce coverage of foliage
  - For contact herbicides coverage of foliage is more important vs. systemic herbicides

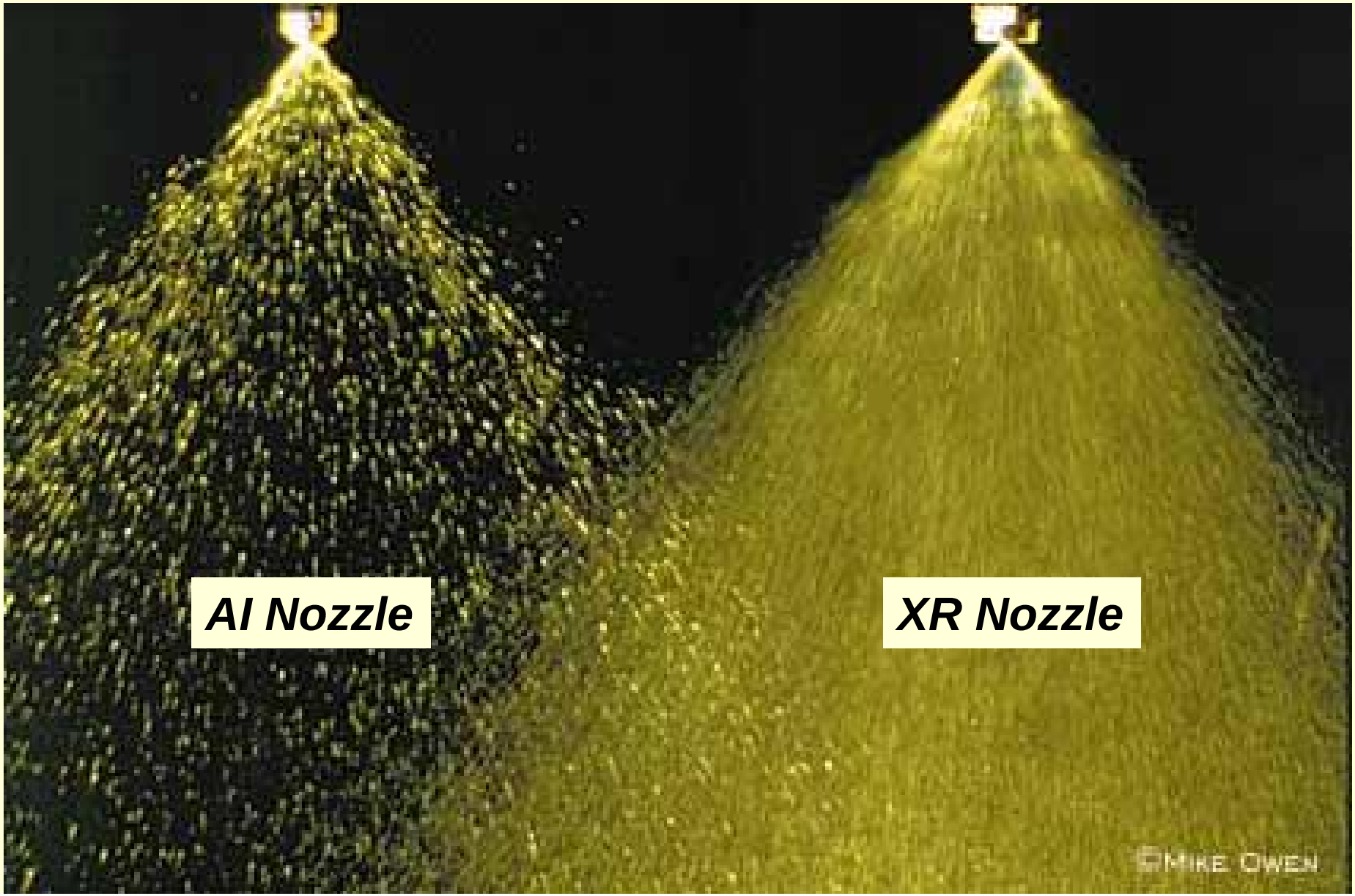
Managing Spray Drift

The bigger they are the faster they fall…

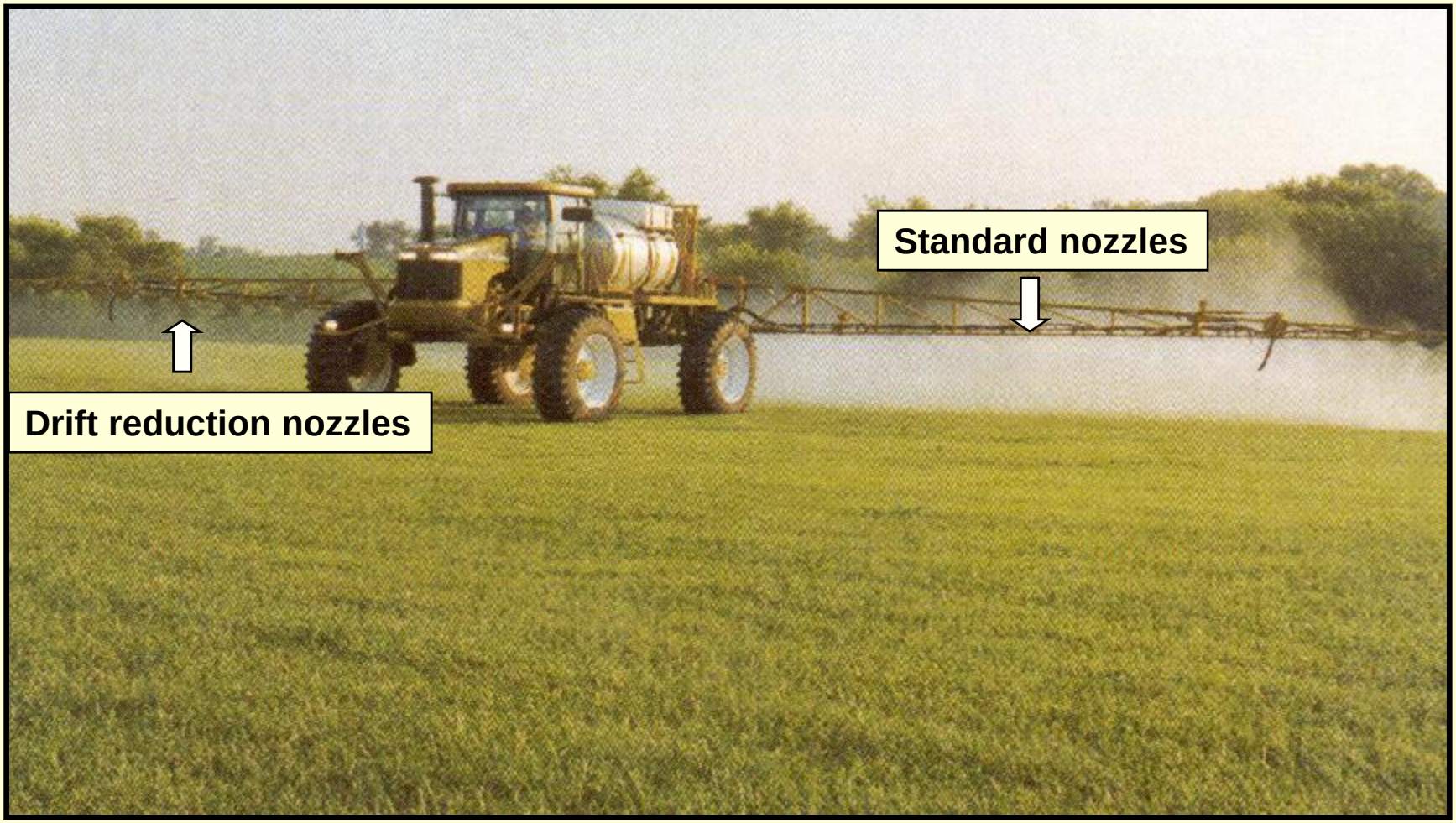
Droplet	Width (in mm)	Time to fall 10 feet	Travel distance in 3 mph wind
Fog	5	66 min	3 miles
Very fine	20	4 min	1100 ft
Fine	100	10 sec	44 ft
Medium	240	6 sec	28 ft
Coarse	400	2 sec	8.5 ft
Xtra Coarse	1,000	1 sec	4.7 ft

Source: *Akesson and Yates, 1964, Annual Rev. Ent.*

Spray Droplet Size



Herbicide Drift – Ground Sprayers



Strategies to Reduce Drift

- Avoid spraying under adverse weather conditions
  - High winds, light & variable winds, calm air, temperature inversions
- Consider using buffer zones
- Select nozzles to increase droplet size; use lower end of the pressure recommended range to produce course droplets
- Lower spray (boom) height
  - Drift hazard doubles as nozzle height doubles
  - The greater the distance between the nozzle and the target area, the greater the impact of wind velocity on drift
- Avoid high application speeds/rapid speed changes
- Consider using drift reduction additives

Future Weed Management Technologies and Potential Drift Issues

- DT (Dicamba-Tolerant) Soybeans (Monsanto) - Will allow for use of ***dicamba*** and glyphosate
- Glyphosate/Dicamba/Glufosinate Cotton (Monsanto) - Will allow for use of glyphosate, ***dicamba***, and glufosinate (Liberty)
- Enlist Weed Control System with Colex-D™ Technology in Soybeans and Cotton (Dow AgroSciences) – Will allow for use of glyphosate, ***2,4-D***, and pyridine herbicides (fluroxypyr and triclopyr)

Previous Research:
Yield Reduction With Drift Rates of Glyphosate

Fraction of use rate	Glyphosate (1 X = 1.0 lb ai/A) 23 oz/A of Roundup OriginalMax						
	Rice		Corn		Wheat		
	2-3 lf	PD	6 lf	9 lf	First node	Boot	Early flower
	----------% yield reduction vs. nontreated----------						
1/8 rate 2.9 oz	83	42	78	33	72	45	54
1/16 rate 1.5 oz	15	32	43	0	29	30	25
1/32 rate 0.7 oz	6	6	22	5	--	--	--
1/64 rate 0.4 oz	6	7	8	0	8	13	2
1/128 rate 0.2 oz	4	7	4	7	--	--	--

Thesis research for J. Ellis, J. Bond, and C. Roider

Dicamba-Tolerant Soybeans

CONCERN—Dicamba Drift to Sensitive Crops

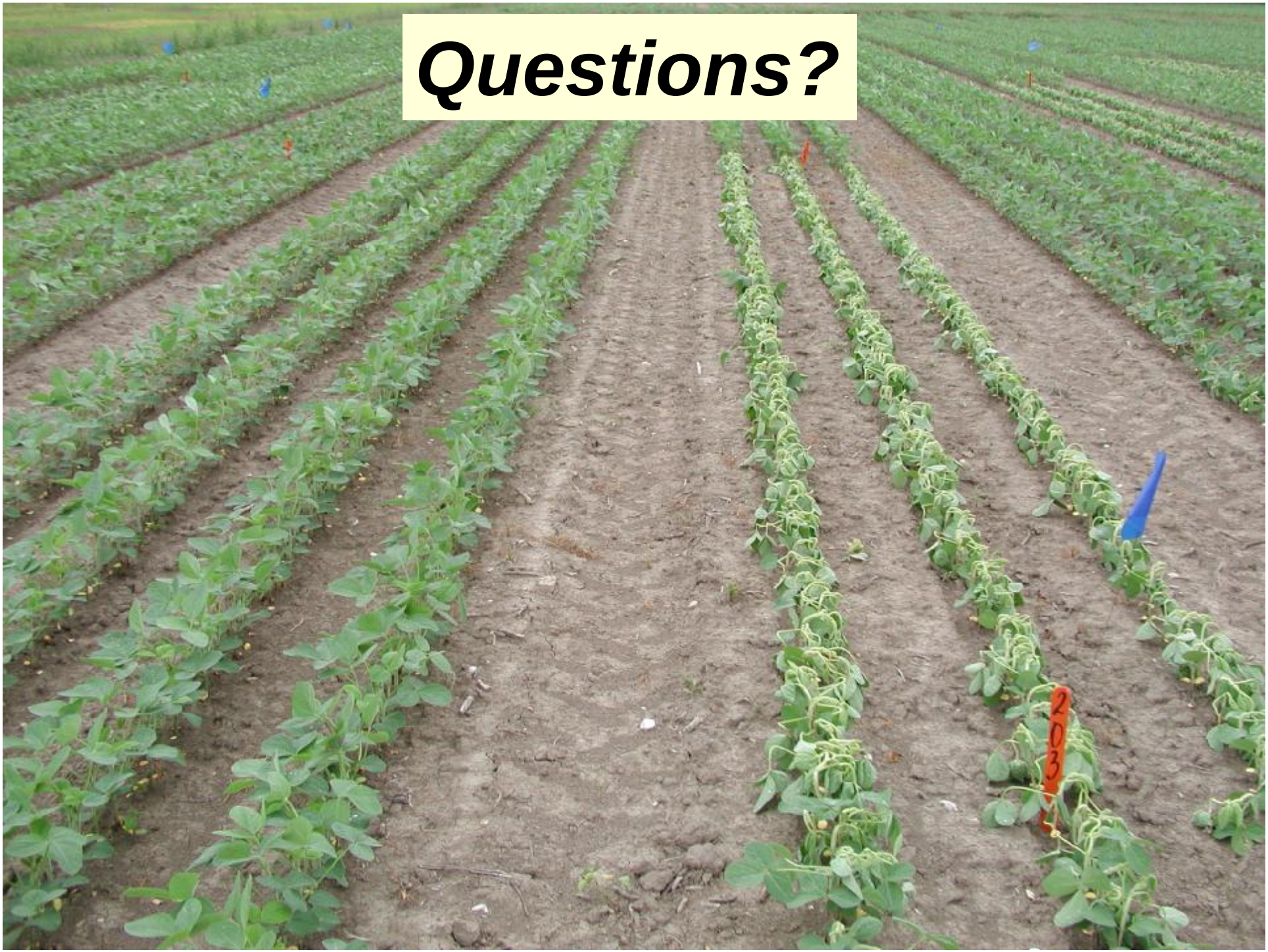
Soybean Response to Drift Rates of Clarity

Fraction of use rate of Clarity @ 16 oz/A	Yield reduction vs. nontreated (%)	
	V4 application	R1 application
1/8 rate (½ oz)	60	79
1/16 rate (1 oz)	34	56
1/32 rate (0.5 oz)	25	50
1/64 rate (0.25 oz)	8	43
1/128 rate (0.125 oz)	3	31
	Compares with 4-7% reduction for glyphosate at 1/128 rate	
1/256 rate (0.063 oz)	--	23
1/512 rate (0.031 oz)	--	17

Data provided by J. Griffin, D. Stephenson, and D. Miller

Conclusions – My Thoughts..

- Although off-target movement of some herbicides can be attributed to volatility, injury is most often the result of physical drift (particle drift).
  - Case in point – Drift issues with glyphosate in Louisiana are not due to volatility
- Off-target movement of herbicides can be attributed to both aerial and ground applications.
  - Aerial Applicators Often Unfairly Criticized for Drift – Dr. Ford Baldwin, Delta Farm Press, January 26, 2012
  - Elimination of aerial application of herbicides will not eliminate drift problems
- With the new dicamba and 2,4-D technologies on the horizon, off-target herbicide movement is of great concern.
- When any herbicide is applied whether by air or ground, strategies should be implemented to avoid off target injury due to drift (buffer zones, weather conditions, low drift nozzles, etc.)
- If drift issues continue to be a problem in Louisiana, regulations by LDAF will surely follow and herbicide use could be seriously affected.


Questions?
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Vapor Drift/Volatilization

- **Can be <u>Both</u> Negative and Positive:**
  - *Negative* - herbicide moves off the target (drift); poor weed control
  - *Positive* - herbicide moves within the soil (as much as 4 inches for EPTC and about 1 inch for trifluralin) filling the pore spaces and promoting distribution and uniformity within the soil; this enhances weed control
- **Factors Affecting:**
  - *Temperature* - higher temperature, greater volatility; worst time to apply a volatile herbicide in respect to loss due to volatility is during mid-day
  - *Soil moisture* - high soil water content increases volatility (water vapor acts as a carrier)
- **Methods to Decrease Volatilization:**
  - Soil incorporation (traps herbicide within the soil and prevents loss)
  - Use of special formulations - granular, micro-encapsulated, salt vs. ester
  - Apply when conditions are unfavorable for volatilization (e.g., lower temperature)