WATERBORNE ENVIRONMENTAL

November 5, 2015

Key Players in Spray Drift:

Identifying and Ranking of Factors Influencing the Spray Drift

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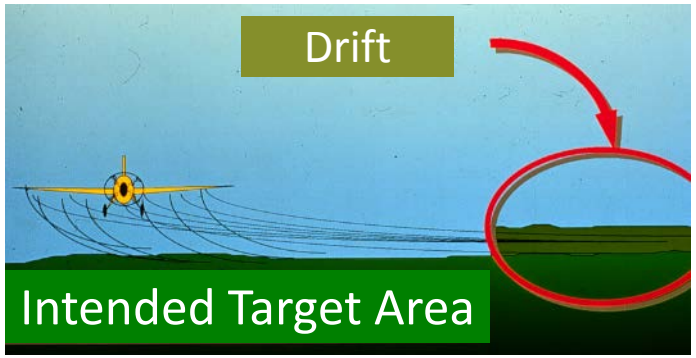
SETAC North America 36th Annual Meeting, 1-5 November 2015, Salt Lake City, UT

What is Pesticide Drift?

The unintentional airborne movement of pesticides from the intended target area

- Drift can occur during application and
- Post application (vaporization)
- Up to10% of ag-pesticide sprays drift
- 70 million pounds/year



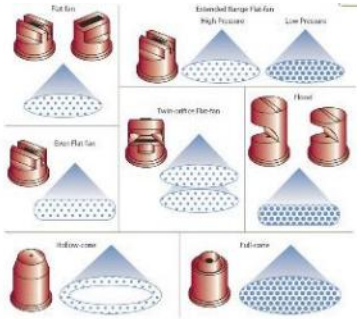
Photos: Bob Wolf Drift Education Materials

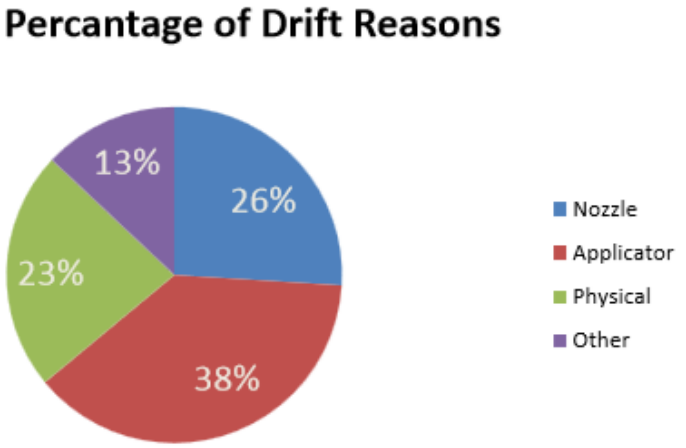
Why is drift a problem?

- Poor pest control
- Chemical wastage
- Off target crop damage
- Environmental concerns
  - Water quality
  - Air quality
- Lawsuits

Factors influencing drift

- Equipment
  - Nozzle type
  - Nozzle size
  - Nozzle pressure
  - Boom height
- Spray Characteristics
  - Formulation (physical and chemical)
- Weather
  - Wind
  - Temperature
  - Humidity
  - Inversions





Photos: Bob Wolf Drift Education Materials (agsafety.tamu.edu/Programs/Ag-Chemical/drift.ppt)
http://blogs.ext.vt.edu/soybean-update/files/2013/07/Nozzle-Patterns.jpg
http://www.pesticides-safety-training.co.uk/3600%20spraying%20(31).JPG

Spray Adjuvants

Adjuvants are added to modify the action of an agrichemical or to alter physical properties of the mixture

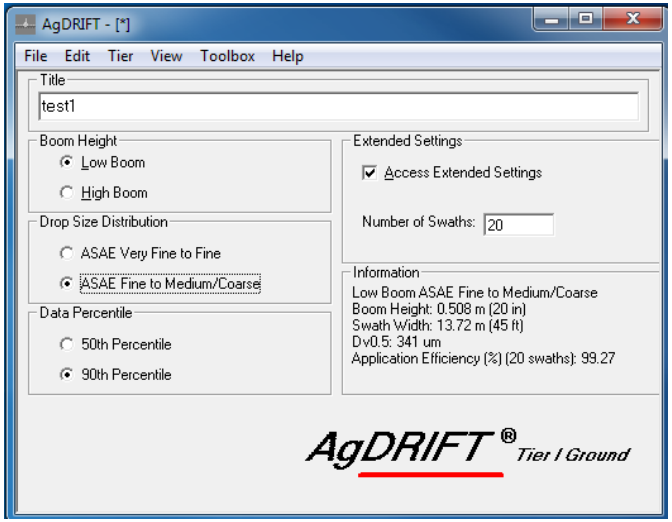
- Surfactants
- Oils
- Penetrants
- Spreaders/Stickers
- Acidifiers/Buffers
- Antifoaming agents
- Thickeners
- Polymers
- Micro-emulsions

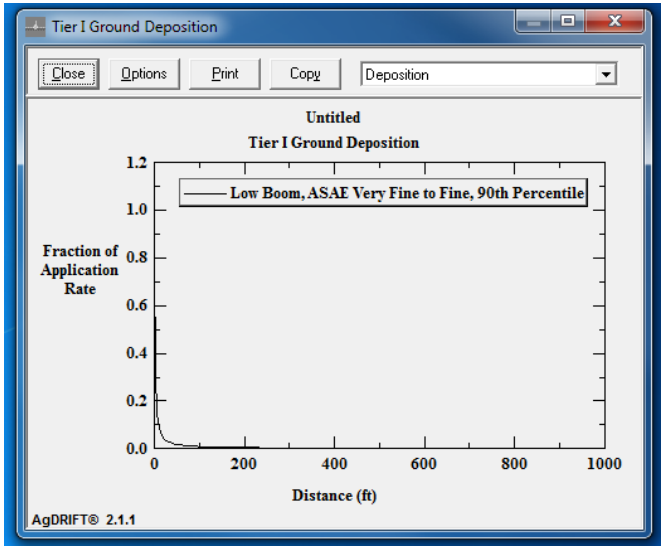
Drift Models

Models			
AGDISP	Empirical model	Mechanistic ground application – Wake model	
AGDRIFT	Empirical and Physical models	Four Tiers – Ground, Orchard, Aerial (Agriculture and Forest)	Gaussian and Lagrangian – Aerial application; Empirical – Ground and Orchard applications
REGDISP	Regression equations from field data	Nozzle, boom height, sprayer speed, wind speed	
FDM	Gaussian dispersion model	Aerial application	Time-resolved concentrations at user specified locations, Inability to model evaporation
CALPUFF	Lagrangian puff modeling system	Air quality dispersion	

AGDRIFT Tier 1 Ground

- Spray drift task force
- Boom Height
  - Low
  - high
- Drop Size Distribution
  - FINE
  - MEDIUM / COARSE
- Extended Settings
  - Number of swaths
- Info
  - Field data summary





Objectives of the study

- Identify the significant key players contributing to the spray drift (towards development of a model that includes liquid properties)
- Identify the importance of liquid composition/formulation on droplet size distribution in a wind tunnel framework

Wind Tunnel at University of Nebraska, Lincoln

- One of only two drift tunnels in US (high speed and low speed)
- 4 ft X 4 ft wind tunnel and 48 ft in length for deposition measurements
- Laminar flow in wind tunnel
- Measure droplet size using laser diffraction method
- Study potential drift and efficacy of droplets produced
- Vary nozzle types, orifices, pressure, and spray solution
- Three replicates
- Two datasets
  - Spray solutions
  - Spray solutions + Adjuvants

http://pat.unl.edu/

ASABE droplet spectrum classification

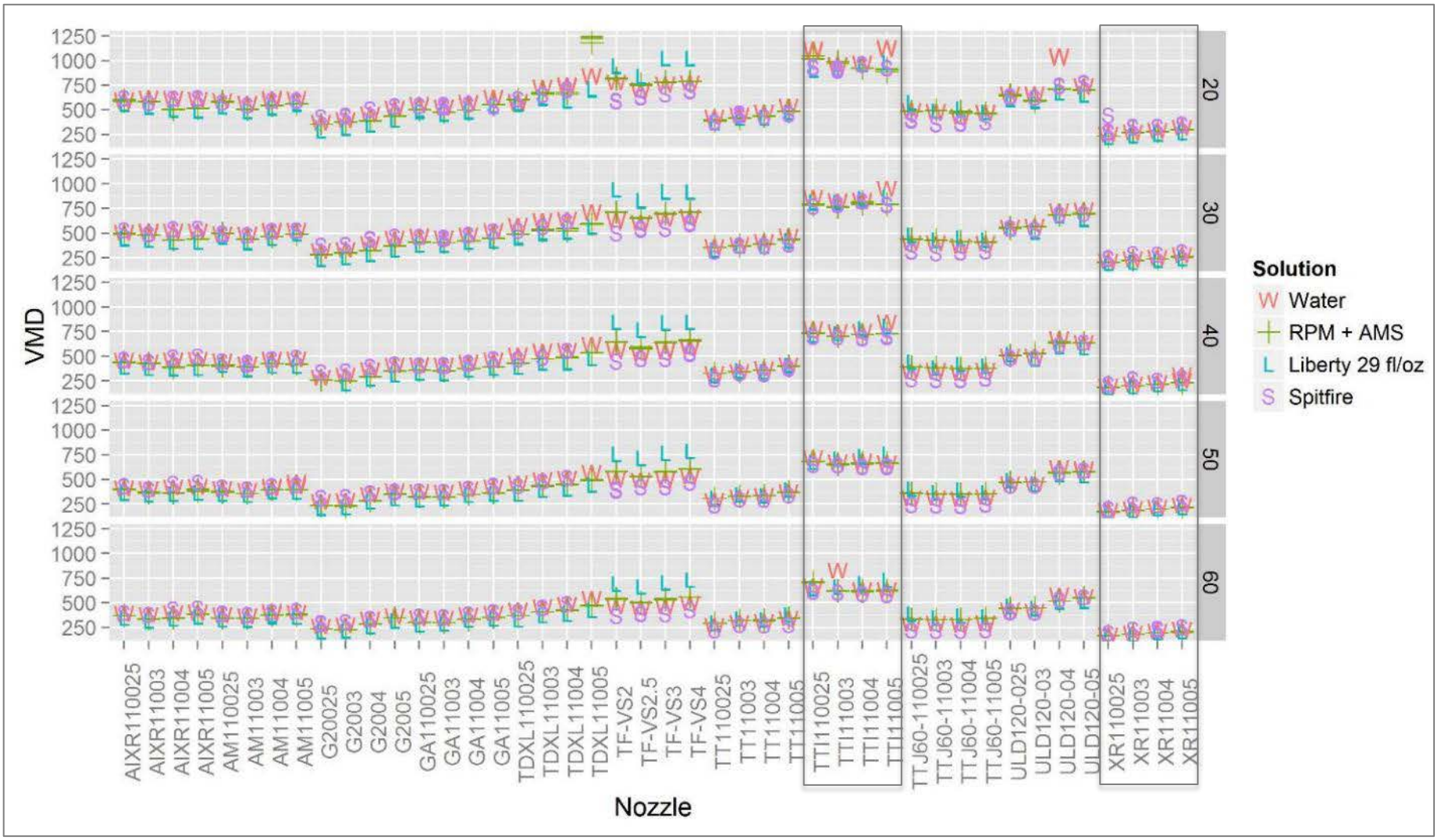
- Droplet size is essential to improve product performance on pesticides and reduce potential drift
- VMD – Volume Median Diameter (a value where 50% of the total volume of liquid sprayed is made up of drops with diameters larger than the median value and 50% with smaller diameters)
- Relative Span is the measure of the width of the volume distribution relative to the VMD
- RS = (D[0.9]-D[0.1])/VMD

Classification Category	Symbol	Color Code	Approximate VMD
Very Fine	VF	Red	<100
Fine	F	Orange	100-175
Medium	M	Yellow	175-250
Coarse	C	Blue	250-375
Very Coarse	VC	Green	375-450
Extremely Coarse	XC	White	>450

Dataset -1 (Ground Spray App)

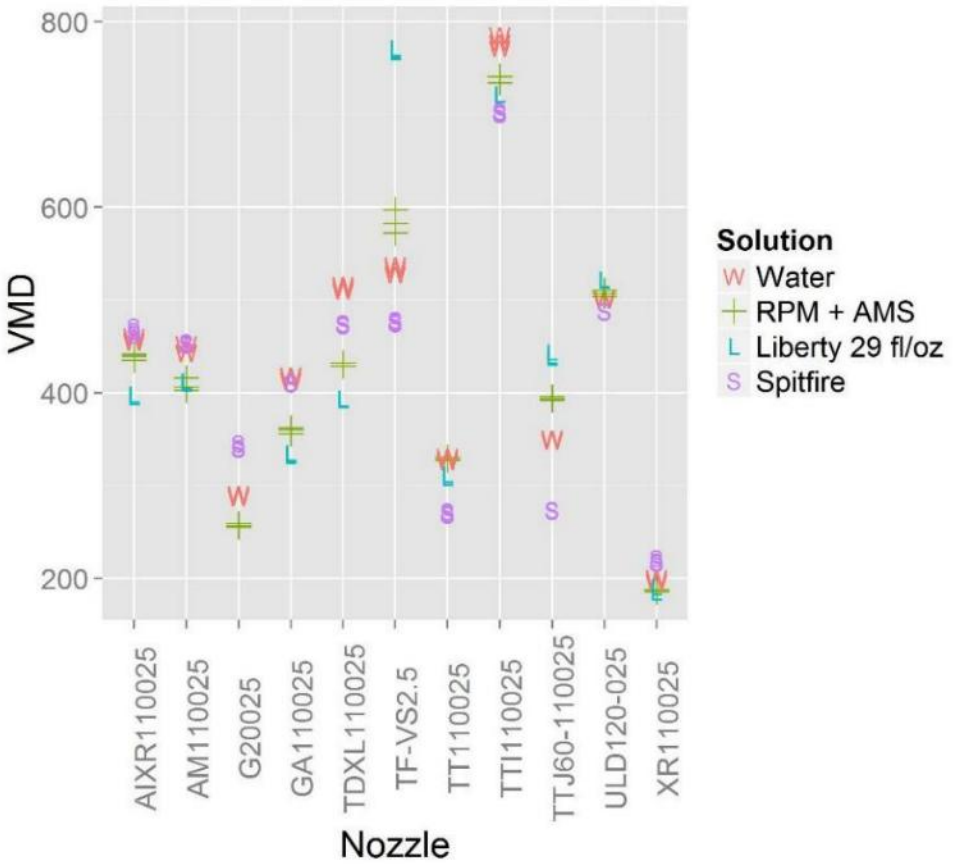
- 11 Nozzle types
  - Air induction, Air mix, Ultra low drift, Turbo twinjet, Turbo flood, Turbo drop, Turbo teejet, Extended range, AI extended range, guardian, guardian air
- 5 Pressures
  - 20,30,40,50,60
- 4 Nozzle Orifices
  - 3,4,5,25
- 4 Liquids
  - Water, RPM+AMS, Liberty, Spitfire
- 3 replicates (2640 data points)

Effects of nozzle types on VMD



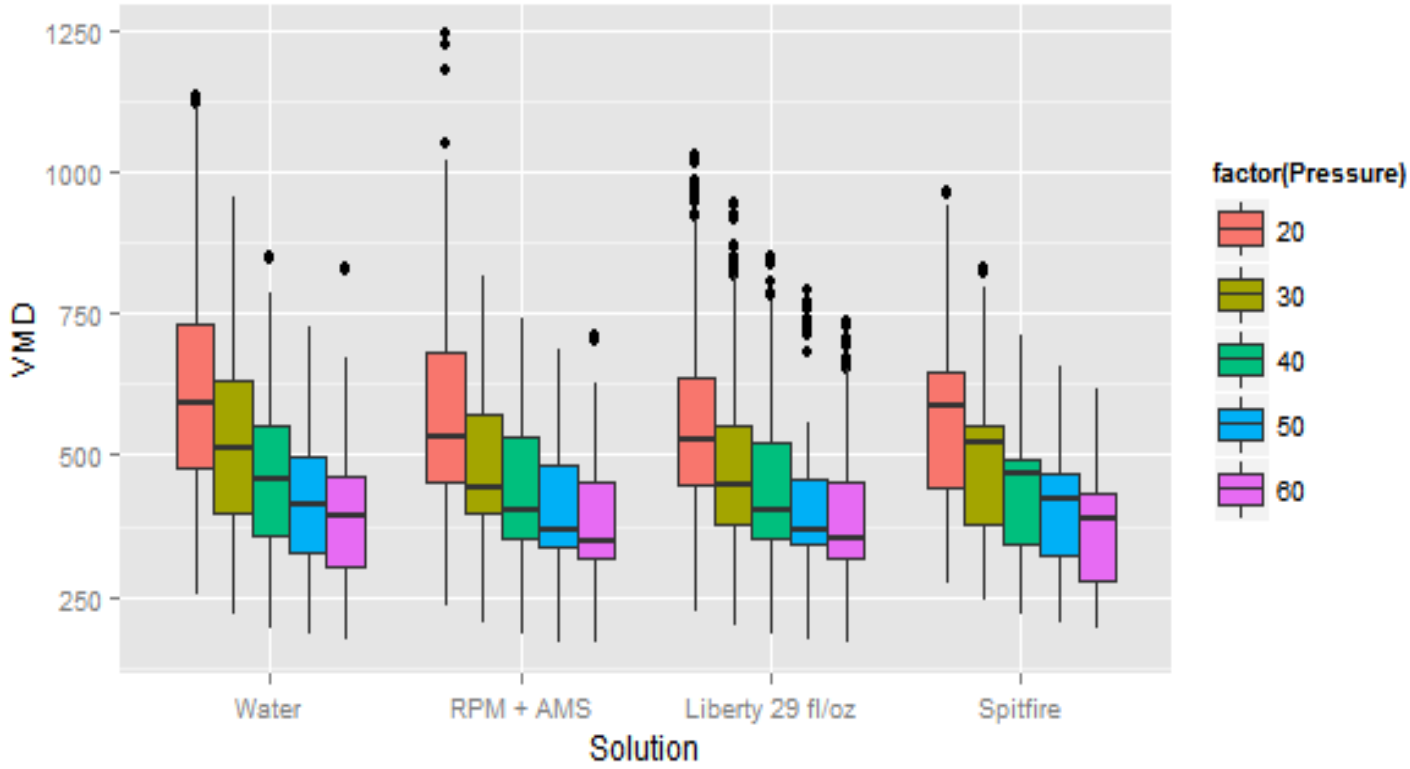
VMD at pressure 40 for orifice 25

- 3 replicates are shown in the graph
- No consistent trends were observed for solutions with different nozzles
- Extended range nozzle produced droplets around 200 microns (Medium)
- TurboTeeJet Induction nozzle produced droplets around 750 microns
- Large variation in VMD between solutions were found for Turbo FloodJet and Turbo TwinJet



Effects of Nozzle Pressure on VMD

- Increasing pressure had resulted in lower VMDs across all nozzles and liquids tested
- Nozzle pressure had similar effects across 4 liquids tested

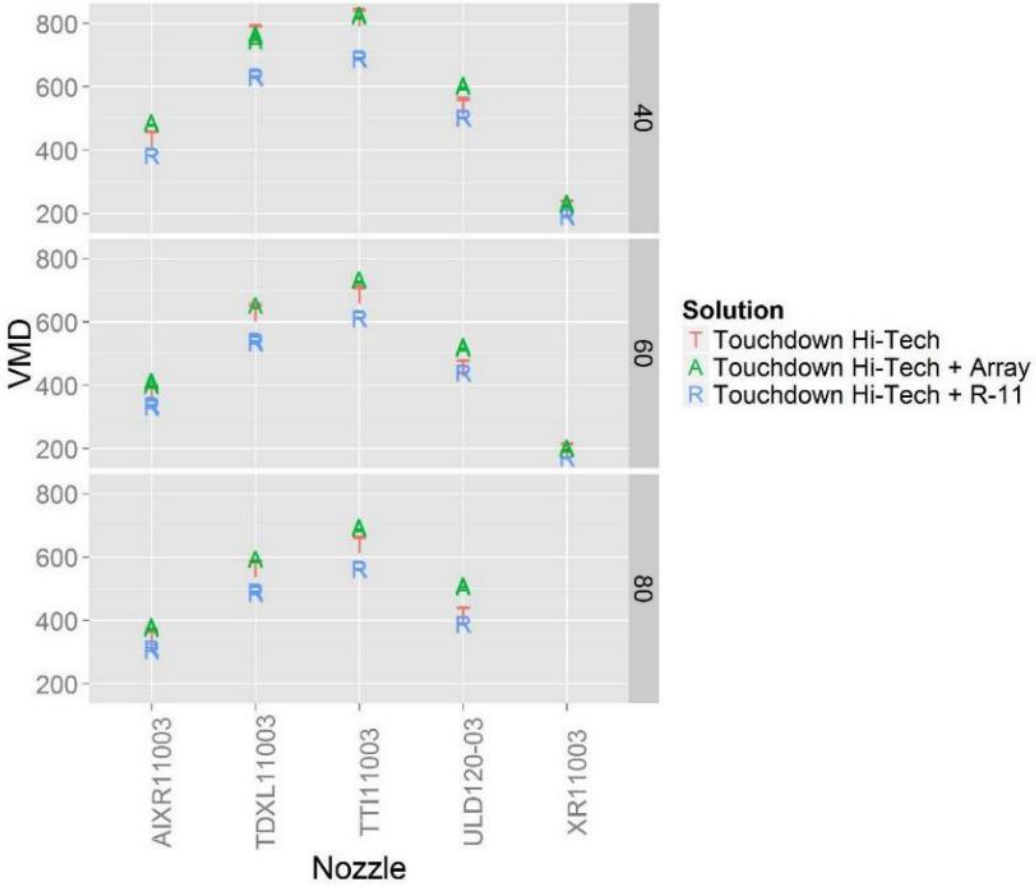


Dataset – 2 (Spray solution with adjuvants)

- 5 Nozzle types
  - Extended range, Air induction extended range, Ultra low drift, Turbo drop venturi nozzle, Turbo teejet induction
- 3 pressures
  - 40, 60, 80
- 1 orifices
  - 3
- 3 solutions
  - Touchdown Hi-Tech
  - Touchdown Hi-Tech + R11 (Surfactant)
  - Touchdown Hi-Tech + Array (Polymer)
- 3 replicates (135 data points)

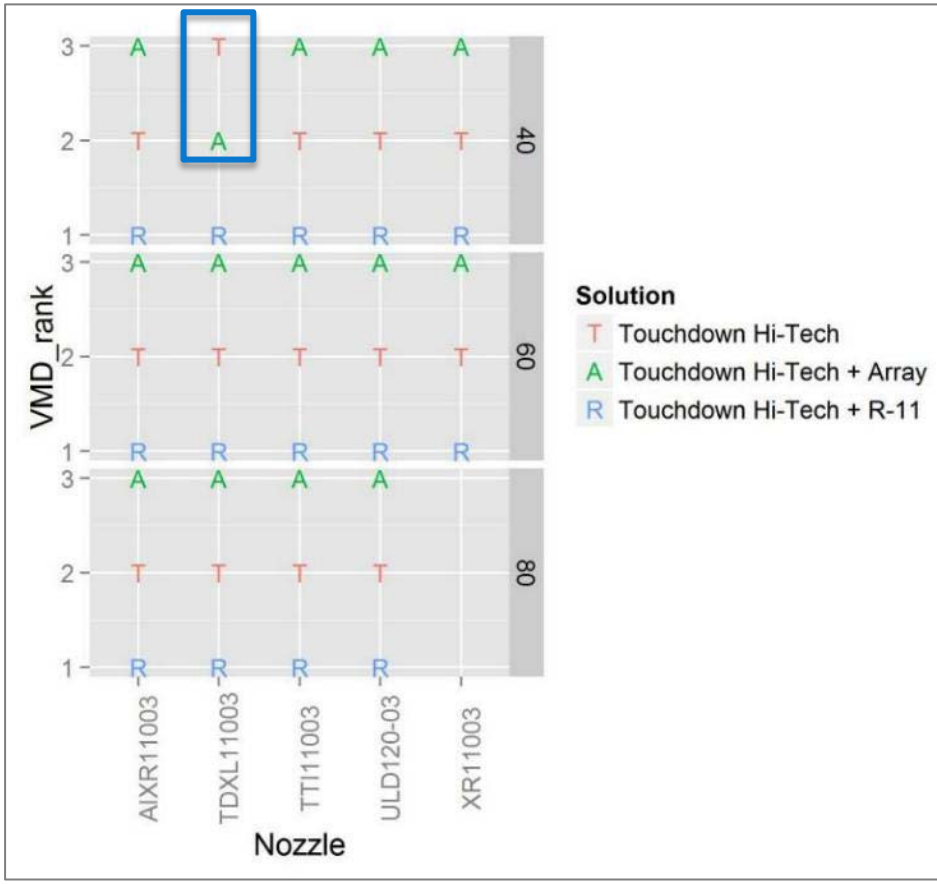
Effects of Adjuvants on VMD

- XR < AIXR < ULD < TDXL < TTI
- Polymer created larger droplets and meant reduce drift (increases surface tension)
- Nonionic surfactant created smaller droplets (reduce surface tension)
- R11 had the lowest mean VMD among three solutions
- The magnitude of increase by Array was smaller than the magnitude of decrease by R11.



Ranking

- Rankings were computed on the means of VMDs
- R11 always ranked one (low mean VMDs)
- Consistent trends were observed except for TurboDrop medium pressure nozzle at pressure 40 PSI



Conclusions

- Turbo TeeJet Induction nozzle has produced higher VMDs of all the nozzles and solutions tested
- Higher pressures consistently produced smaller VMDs
- Adjuvants affected the droplet sizes across the pressures and nozzles tested (polymer created larger droplets and surfactant created smaller droplets)
- Nozzle orifice sizes didn’t have significant impact on the droplet diameter

Outlook

- Complete the wind tunnel experiments with various adjuvants and nozzles available in the market
- Estimate relative span and develop drift deposition curves
- Connect spray liquid properties (Surface tension, viscosity) to drift
- Complete the ranking analysis using nozzle, adjuvant, pressure, wind speed
- Develop a multiple regression model that uses physical properties of liquid composition and nozzles (short-term goal) and a full fledged mechanistic model (long-term goal) to simulate ground spray drift

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