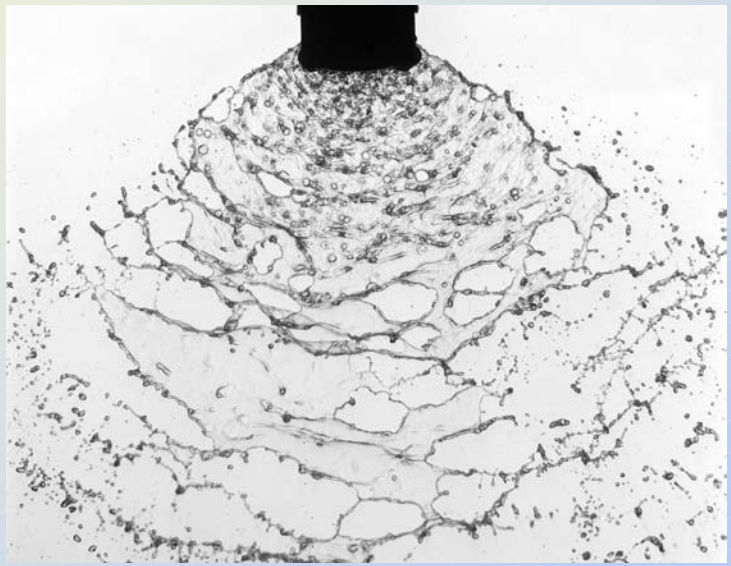
Aerial Application of Herbicides using Low Drift Nozzles and Tank Mixes



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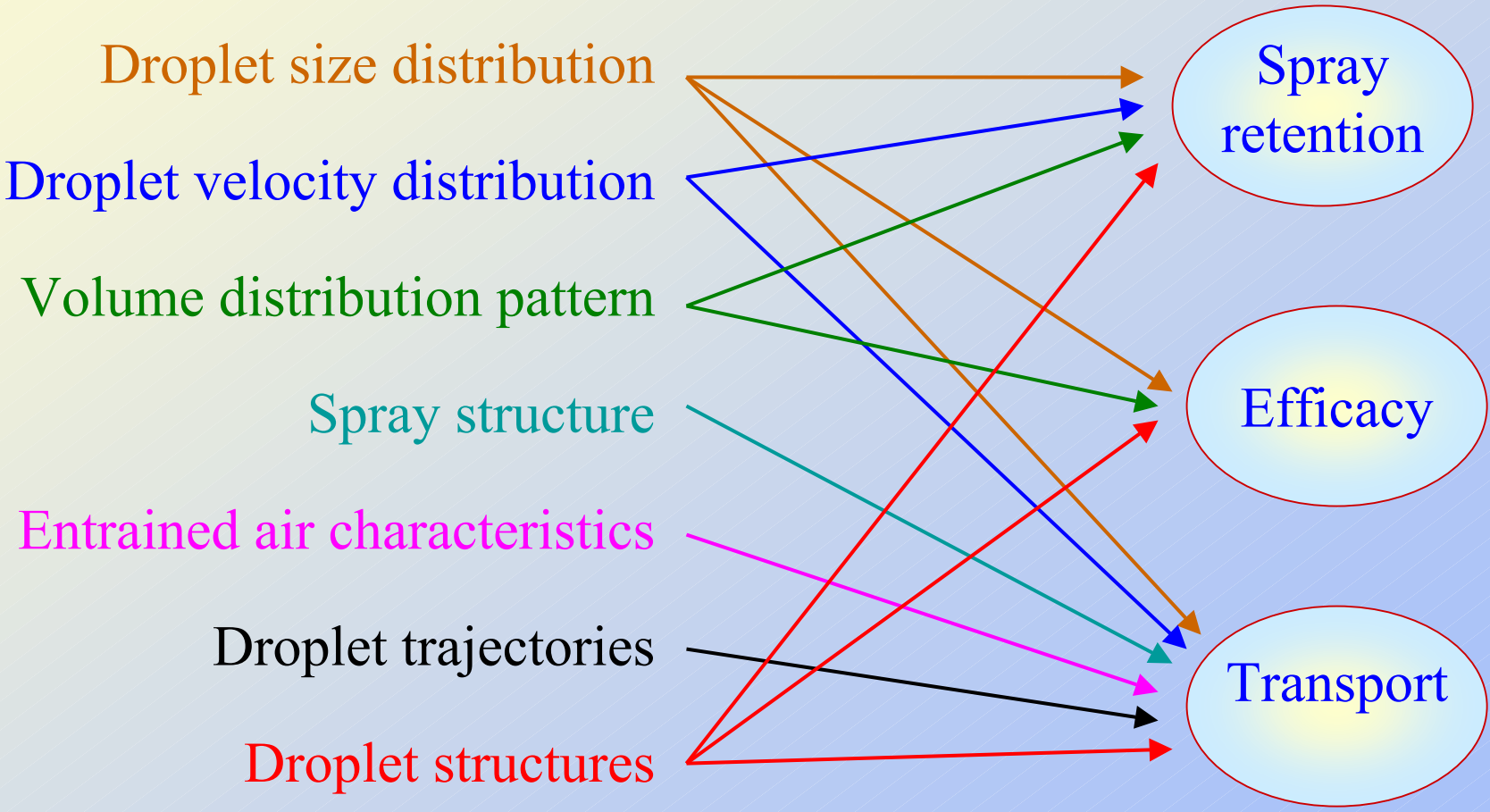
First Things First: Spraying is a Complex Process



What Causes Drift?

- Application parameters, especially droplet size and spraying technique (nozzle selection, etc)
- Weather effects, especially wind speed and direction
- Tank mix effects, especially when using certain adjuvants

- Research by SDTF and others provides some useful information for minimizing drift, but not complete information on tank mix effects

Objectives: Rotary Wing Aerial Applications for Site-Preparation Work

Evaluate the effects of tank mixing on drift potential

- Select materials and concentrations for spray mixes
- Determine physical properties of spray mixes (esp. DST)
- Measure spray droplet size distributions
- Correlate composition of spray mix with droplet size and drift potential

Check effects of different nozzle types on drift potential

- Measure spray droplet size for different spray mixes

Surfactant Types

- Oils: **blends of many oil types and emulsifiers**

  Form emulsions in water
- Adjuvants**, blends of different materials**

  Surfactants, solvents, oils, water
- Silicone **(trisiloxane) surfactants**

  Produce very low surface tensions

  Low water solubility, form emulsions in water
- Nonionics **(NIS) ethoxylated surfactants**

  Water-soluble above HLB 4-5

  Reduce Surface Tension to minimum at 0.5% in water
- Anionics: **fatty acids, phosphate esters, sulfonates**

Test materials - emulsions and solutions

Surfactants

Seed oil containing >50% esterified seed oil

Herbicides

Physical Measurements

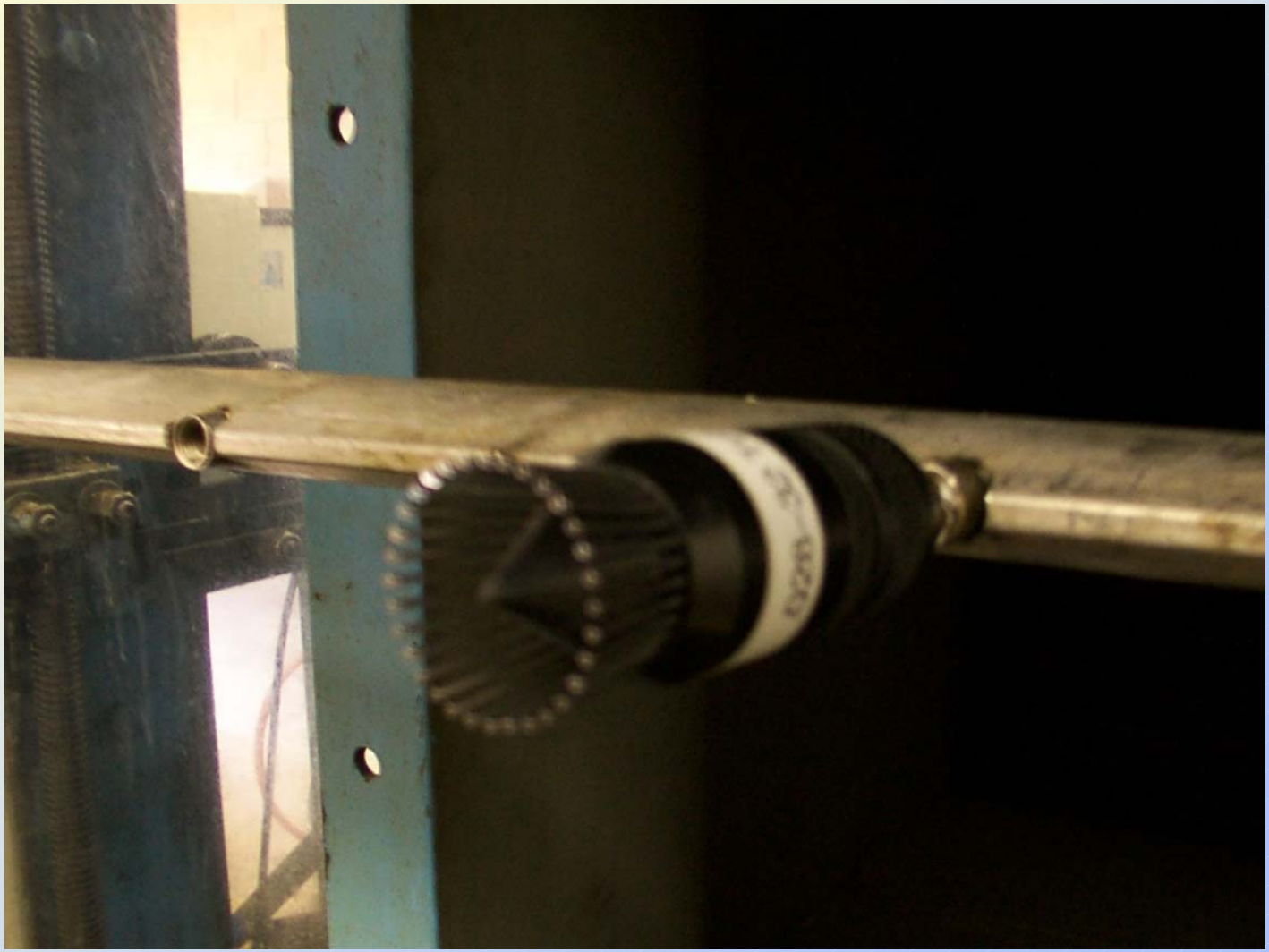
- Dynamic Surface Tension (DST)
  - *Bubble pressure method*
- Emulsion formation
  - *Visual turbidity*
- Spray droplet size distribution
  - *Wind tunnel experiments*
  - *Malvern laser scattering equipment*
  - *VMD and "fines"*

Nozzle Types Evaluated

- CP helicopter flat fan
- D10-46 hollow cone
- CP 30 degree deflector
- CP solid stream
- Accu-flo multiple orifice solid stream
- TVB multiple orifice solid stream

CP Helicopter Flat Fan Nozzle

Accu-Flo Nozzle



Spray Measurements Replicated

Effect of Pesticide Products and Surfactants on Spray Properties

- Most products decrease DST compared to water
- (NIS) Surfactants lower DST even further
- Increasing concentrations give finer sprays
- Drift potential increases with high surfactant concentration

- Avoid addition of excess (NIS) surfactant

Effect of emulsifiable oil concentration on spray properties and droplet size of water and Herbicide.

Herbicide	% Oil	DST mN/m	VMD microns	%<153 microns
Water only	0	72.6	739	1.2
Herbicide	0	37.2	556	2.7
Herbicide	0.5	42.6	656	0.4
Herbicide	1.0	42.8	684	0.4
Herbicide	2.5	44.0	693	0.3
Herbicide	6.25	44.5	713	0.3
Herbicide	12.5	46.6	705	0.5
Herbicide	25	41.2	723	0.3

Effect of emulsifiable seed oil on the percentage of fine droplets

% fine droplets<153 microns

	0% Oil	0.5% Oil	1.0% Oil	2.5% Oil
Water, check	1.2	0.4	0.3	0.4
Herbicide	2.7	0.3	0.5	0.3

Effect of Emulsifiable Seed Oils

Spray

- Oils have less effect than NIS's on DST
- Oils increase spray droplet size (VMD)
- Oils greatly decrease fine droplets
- Oil rates from 0.5% to 25% effectively reduce fines

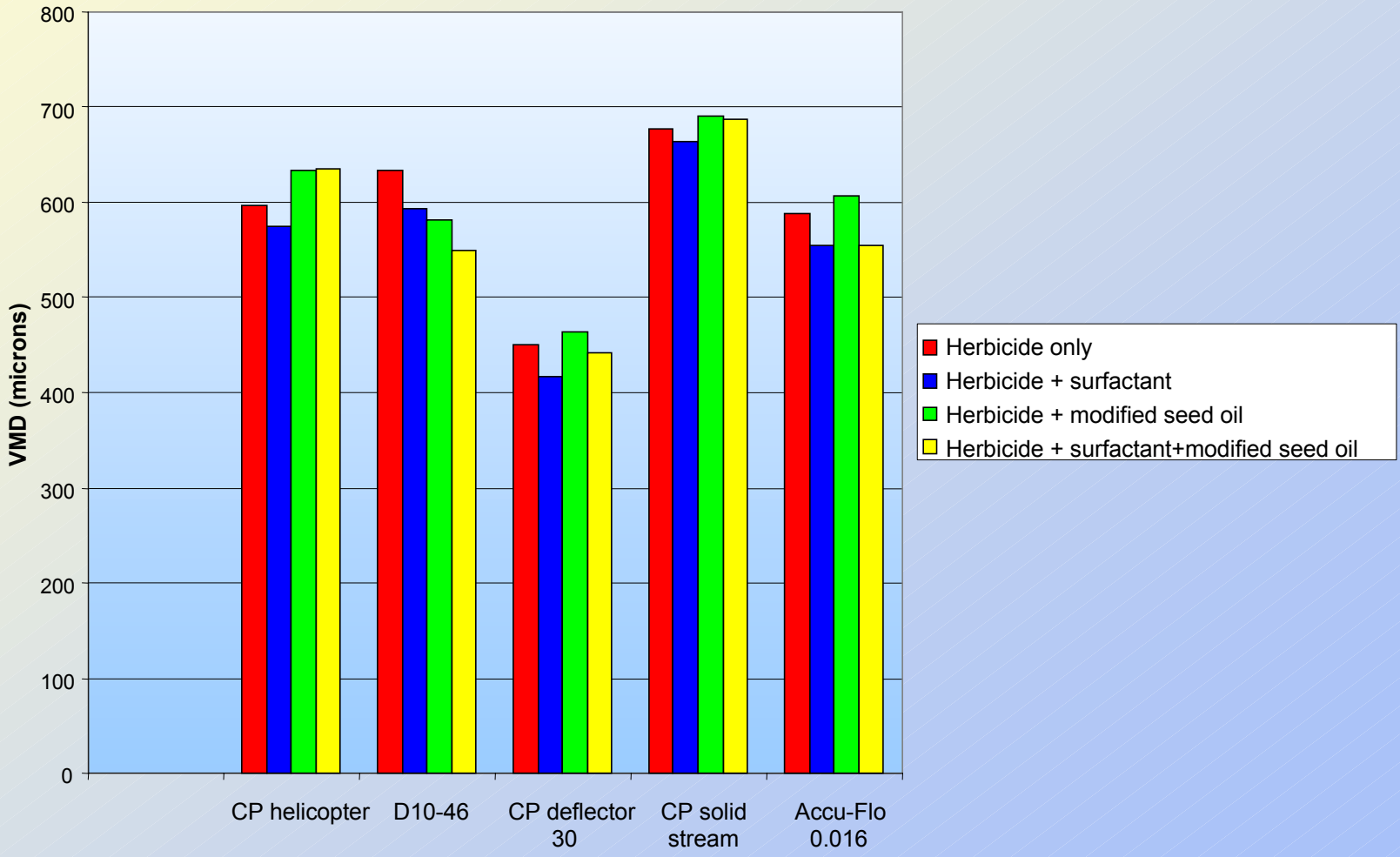
Herbicide Efficacy

- Oil addition at high levels gives penetration

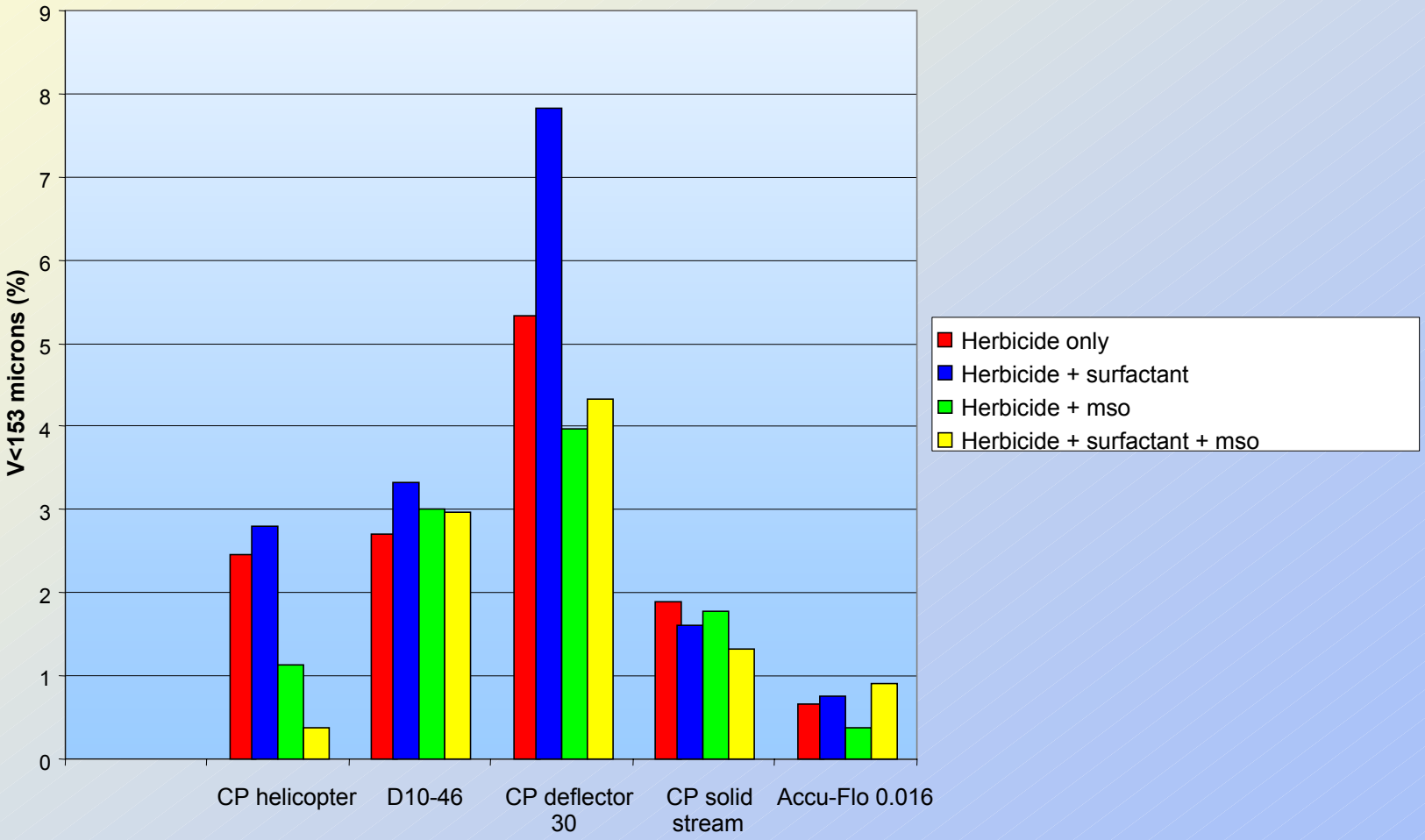
The effect of nozzle type on spray properties of tank mixes containing herbicide with different adjuvants

	Herbicide		+ Surfactant 1%		+ MSO 1%	
Nozzle types	Fine droplets %<153 microns	VMD microns	Fine droplets %<153 microns	VMD microns	Fine droplets %<153 microns	VMD microns
CP helicopter	2.46	597	2.8	574	1.13	633
D10-46 hollow cone	2.70	633	3.33	594	3.0	581
CP 30 deg deflector	5.33	451	7.83	417	3.97	463
CP solid stream	1.90	678	1.6	664	1.77	690
Accuflo 0.016	0.67	588	0.76	554	0.37	606

Effect of adjuvants on VMD from different nozzle types:



Effect of Adjuvants on Fine Droplets from Various Nozzle Types



Effect of Nozzle Type on Spray Properties

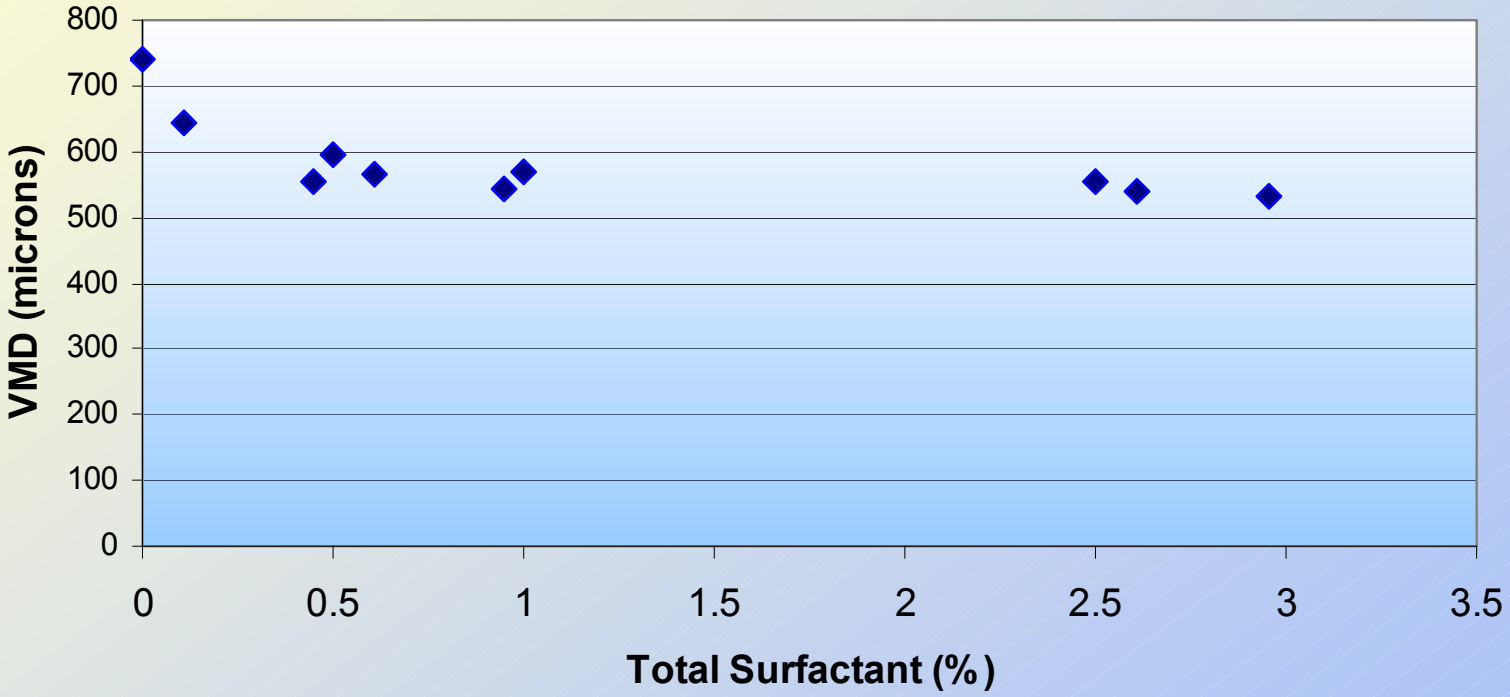
Nozzle type and application methods are more important than tank mix composition

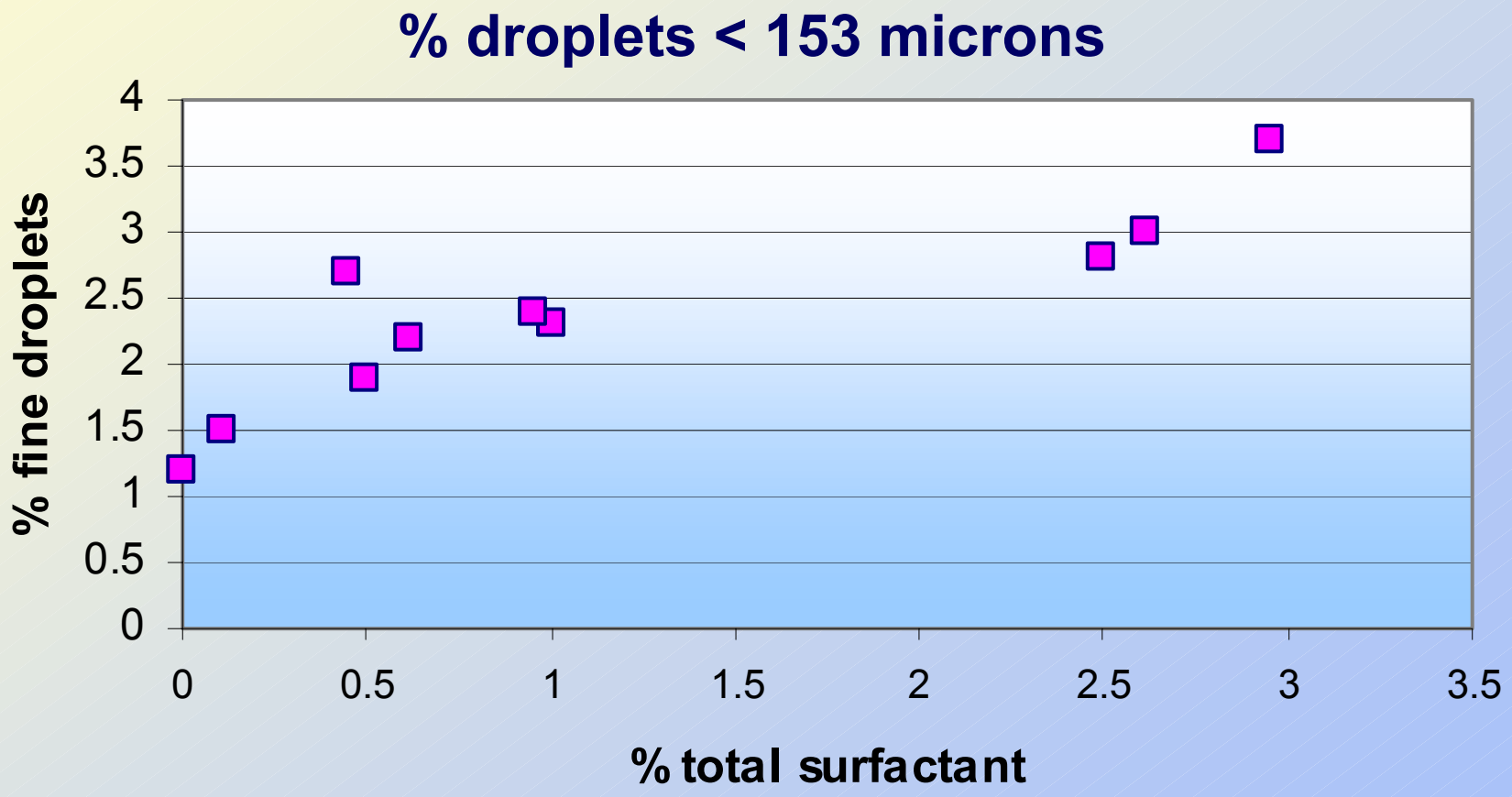
- Nozzle selection controls VMD and amount of fine droplets
- Select nozzles which produce fewer fines
  - example: Accu-flo
- Avoid nozzles which produce many fines
  - examples: Deflector, hollow cone

Tank Mix Effects and Nozzle Type

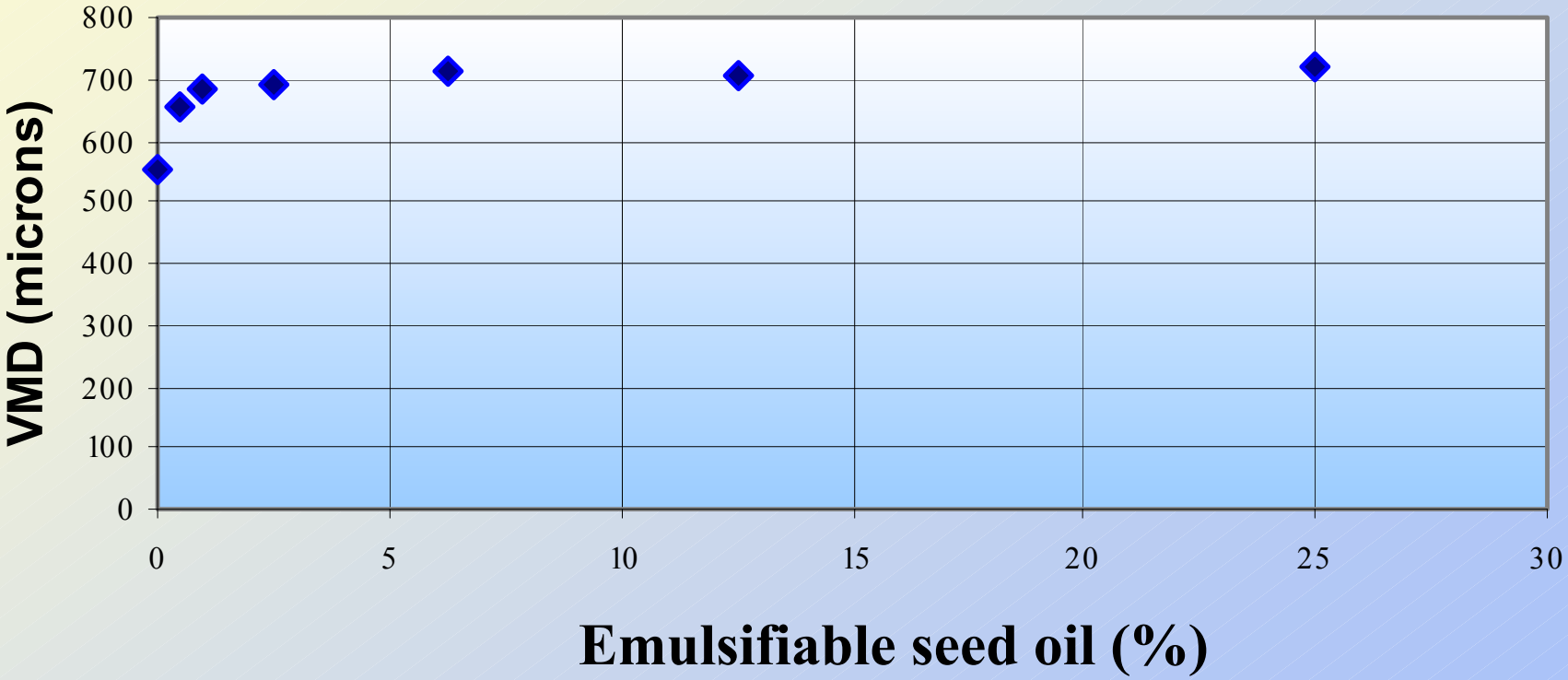
- **When surfactant added, VMD decreased and the amount of fine droplets increased for all nozzles except CP solid stream**
- **When emulsified oil used, VMD increased and amount of fine droplets decreased for all nozzles except D10-46.**
- Recommend use of emulsifiable seed oil to minimize fines
- Avoid excess surfactant

Herbicide/ Surfactant Tank Mixes




% droplets < 153 microns
% fine droplets
4
3.5
3
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
3
3.5
% total surfactant

Herbicide/ Modified Seed Oil Tank Mixes



% droplets < 153 microns

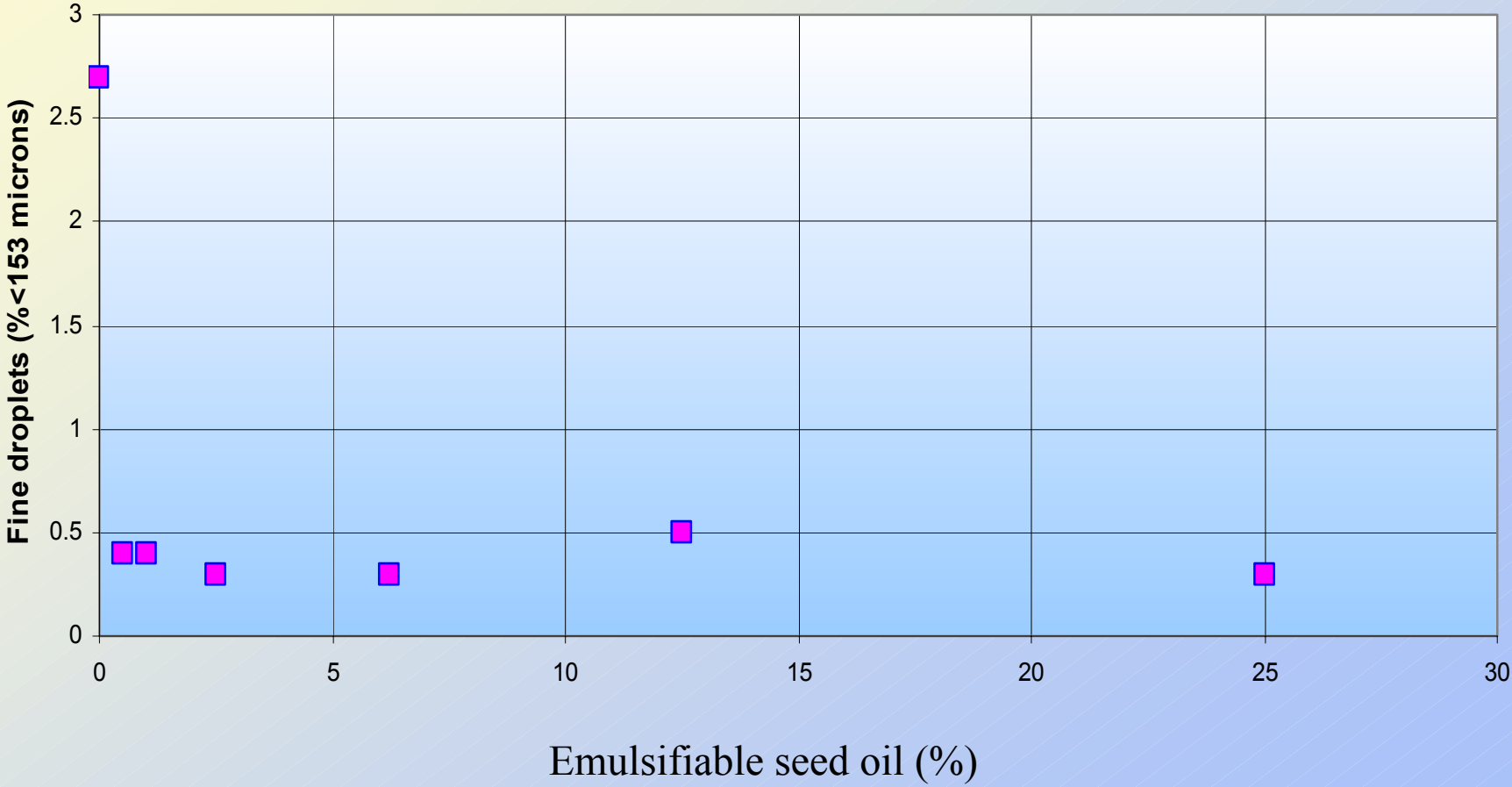
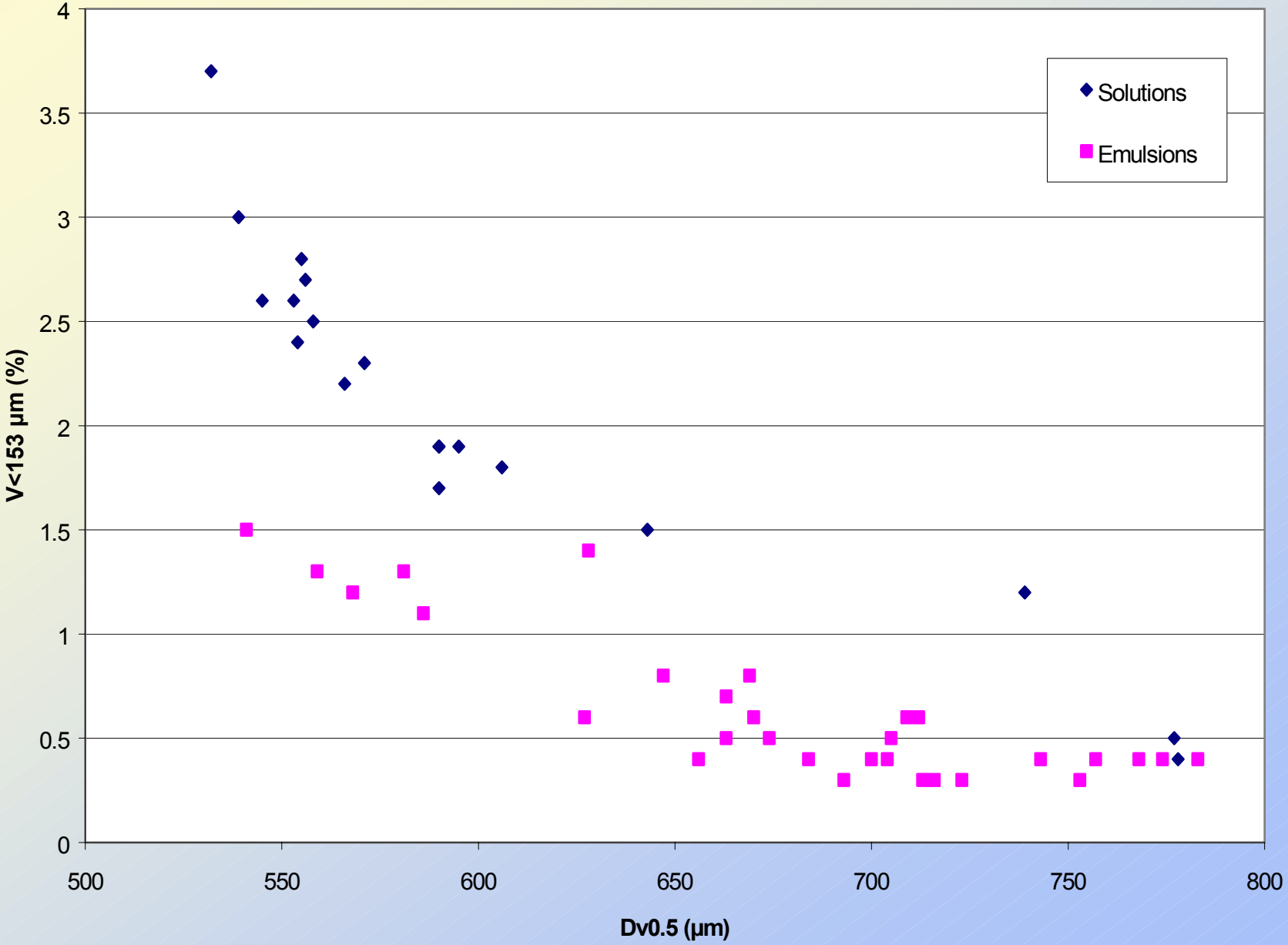


Figure 5. V<153µm Versus Dv0.5 Values for Different Tank Mix Chemistry Groups



Conclusions

- **Select nozzle type to avoid fine droplets**
- **Carefully consider application methods and conditions**
- **Avoid use of (NIS) surfactant**
- **Select co-herbicide with low NIS content**
- **Use emulsion carrier (emulsifiable seed oil) to reduce fines**

Ongoing and Future Work

- **Refinements to modeling atomization - need to consider emulsion and other effects (current models only consider DST and viscosity)**
- **Possible refinements to modeling drift if particle sphericity can be determined - current modeling usually assumes spherical droplets. Extremely coarse sprays may not be spherical, increasing drag and drift potential**
- **Comprehensive evaluations of diverse adjuvant types with real tank mixes and representative application conditions (ASTM standards being developed) - lab and field testing**
- **Evaporation rate testing and modeling**
- **Recommendation to fit aircraft with ASAE reference nozzles to compare wind tunnel and field droplet size data**