2012 NAAA/ASABE Technical Session

Session Schedule

- AGDISP – Basics of Use and Applications
  - Hoffmann and Thomson
- Adjuvant and Active Product Effects
  - Wolf, Fritz and Stocker
- Development of New Pattern Testing System
  - Hoffmann
- Spray Quality and Efficacy
  - Kruger
- Low Rate Summary
  - Bretthauer

Speakers

- **Clint Hoffmann**
  – USDA ARS
- **Steve Thomson**
  – USDA ARS
- **Brad Fritz**
  – USDA ARS
- **Bob Wolf**
  – Wolf Consulting & Research LLC
- **Russ Stocker**
  – Pilot, Bob's Flying Service
- **Greg Kruger**
  – University of Nebraska – Lincoln
- **Scott Bretthauer**
  – University of Illinois

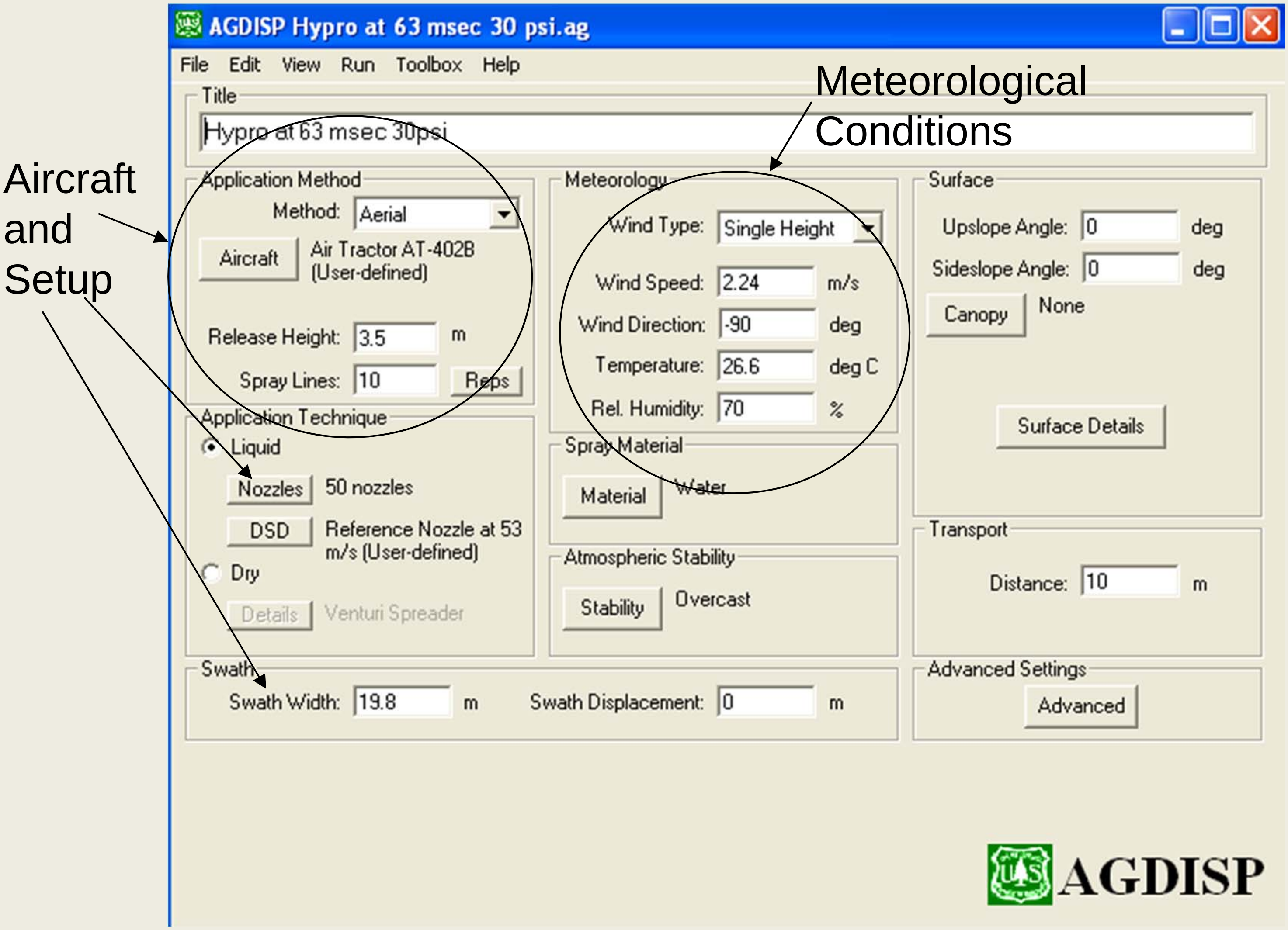
Basics of AGDISP and How It Can Be Used in Your Operation

Hoffmann and Thomson

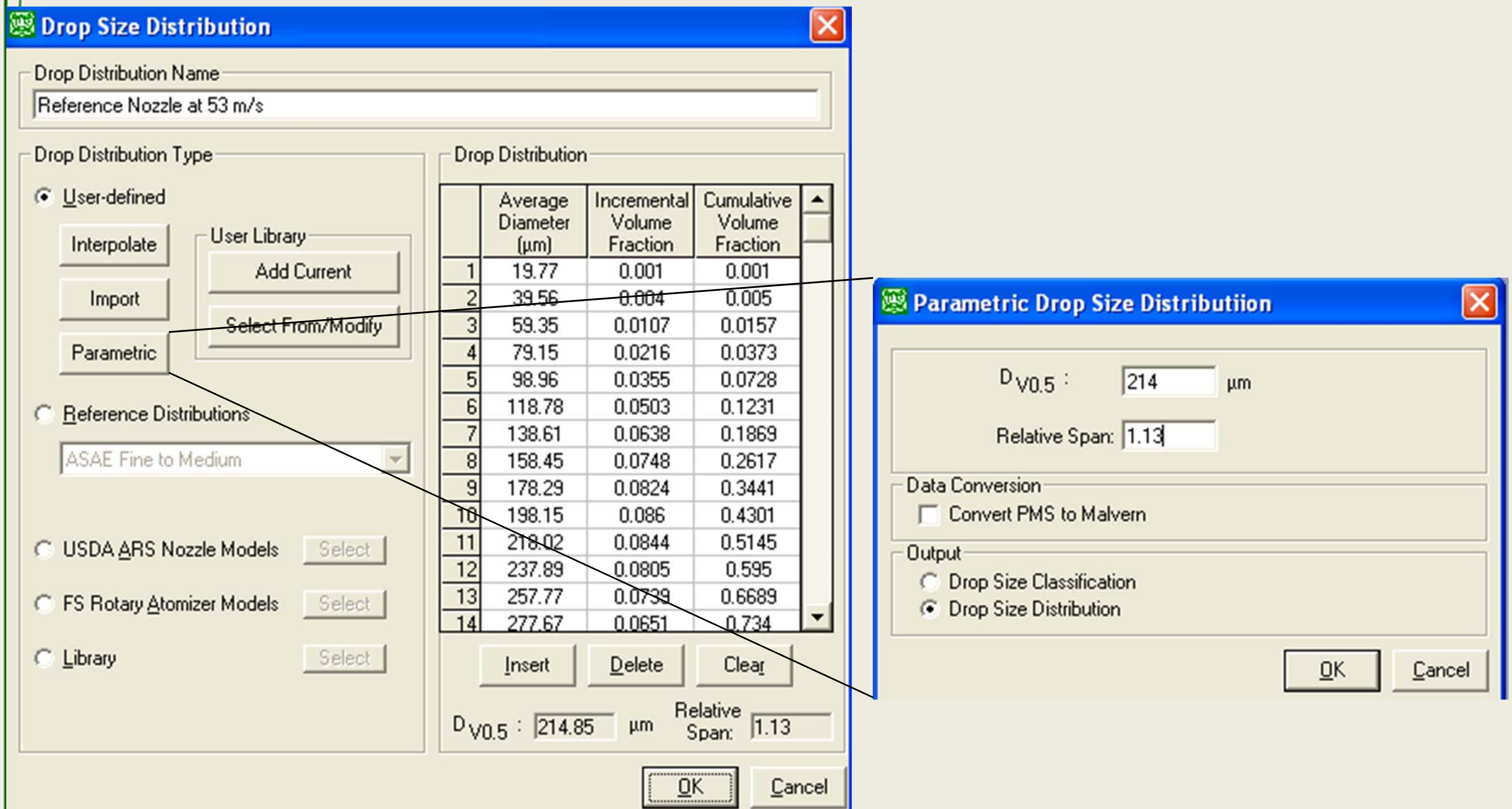
Intro

- Basic inputs to AGDISP;
- How to run a basic model in 15 mins
- Looking at wind and droplet size effects
  - Drift and droplet trajectories
- Pattern Offset
- Droplet Trajectory

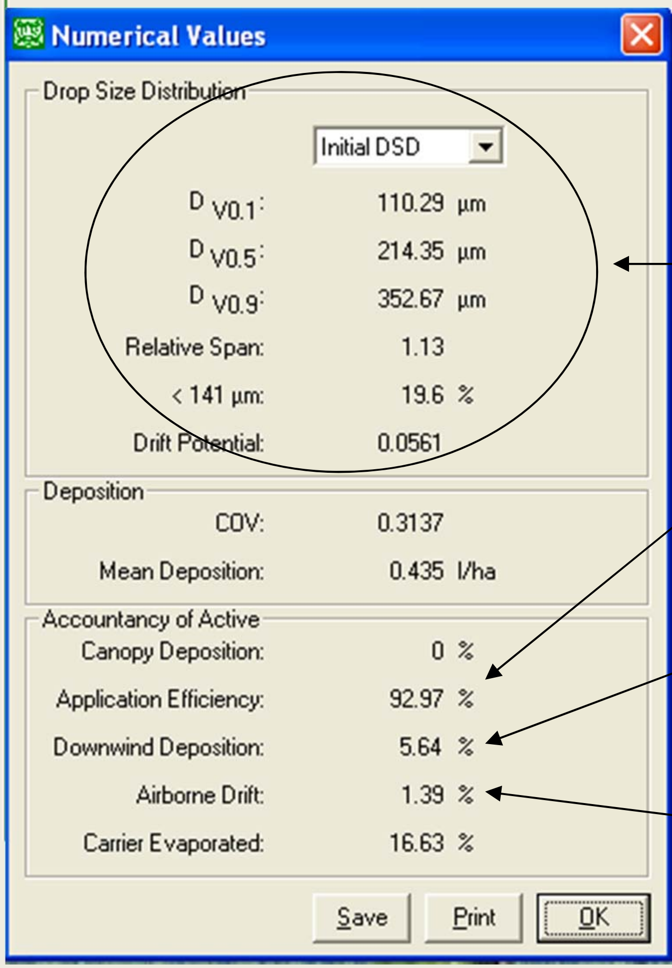
AGDISP Modeling (Ver. 8.21): Standard Conditions



Droplet Size Data Input



AGDISP Output



Droplet Size Statistics

Application Efficiency: Amount of material deposited in the target area

Downwind Deposition: Amount of material deposition on ground 0-10 m from field edge

Airborne Drift: Portion of spray in air after 10 m

These sum to 100%.

Time to Run a Model
Modeling scenarios

- 2, 5, and 10 mph winds
- Medium and Coarse droplets

Results
53 m/sec (120 mph)

Nozzle	Pressure	Application Efficiency	Downwind Deposition	Airborne Drift
Reference	43	86.74	11.75	1.51
N1	60	90.76	8.97	0.267
N2	60	90.67	9.03	0.297
N3	40	91.16	8.61	0.237

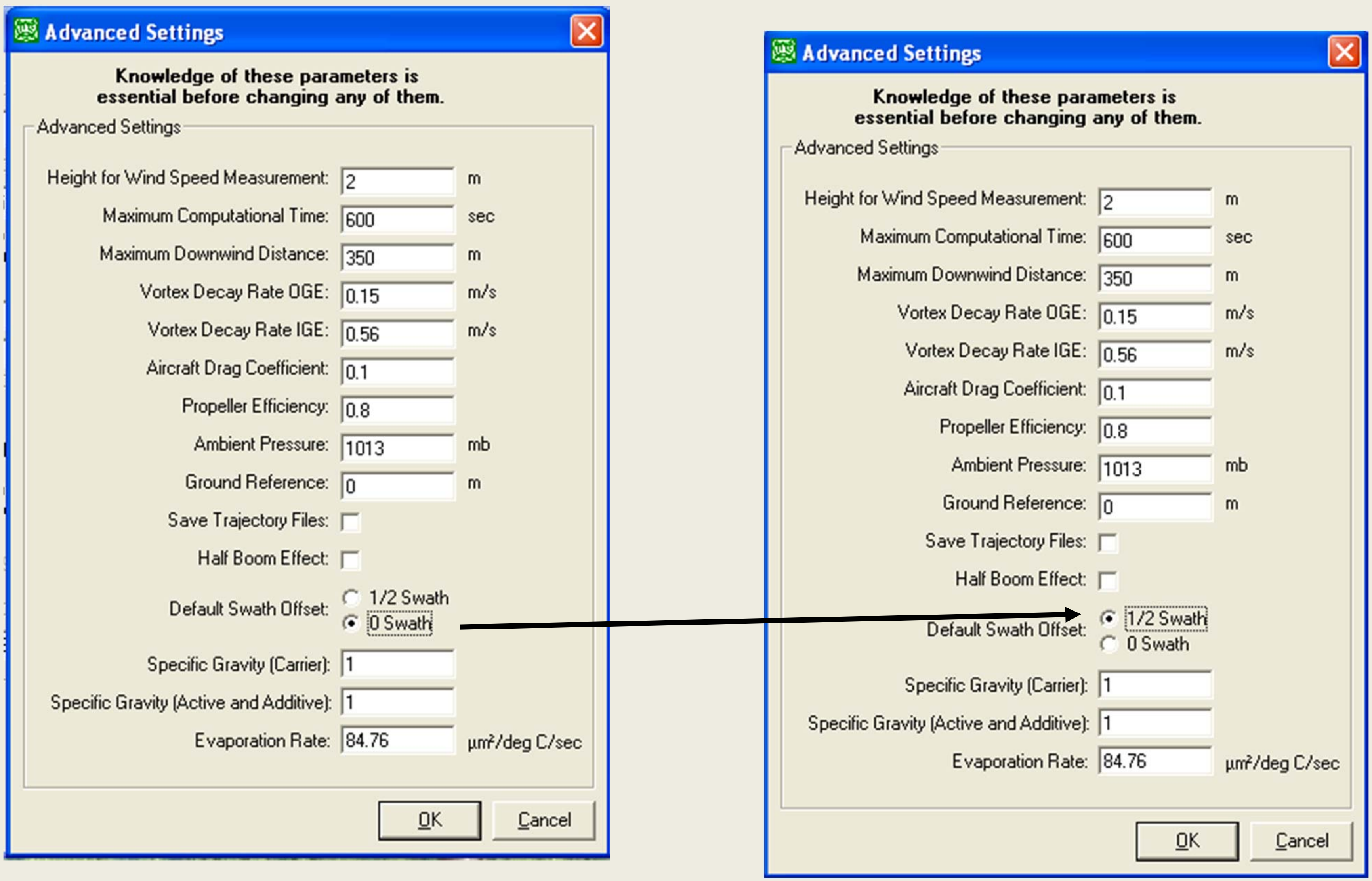
Results
63 m/sec (140 mph)

Nozzle	Pressure	Application Efficiency	Downwind Deposition	Airborne Drift
Reference	43	84.63	12.91	2.45
N1	60	88.13	10.7	1.18
N2	60	88.58	10.47	0.952
N3	40	89.7	9.67	0.629

Drift Reduction with Nozzle

Nozzle	Pressure	% Reduction 120 mph	% Reduction 140 mph
Reference	43		
N1	60	**73.0**	**62.0**
N2	60	**72.4**	**63.9**
N3	40	**76.0**	**70.3**

Aerial Application Industry BMP: ½ to 1 swath offset



Drift Reduction from Nozzles + BMP

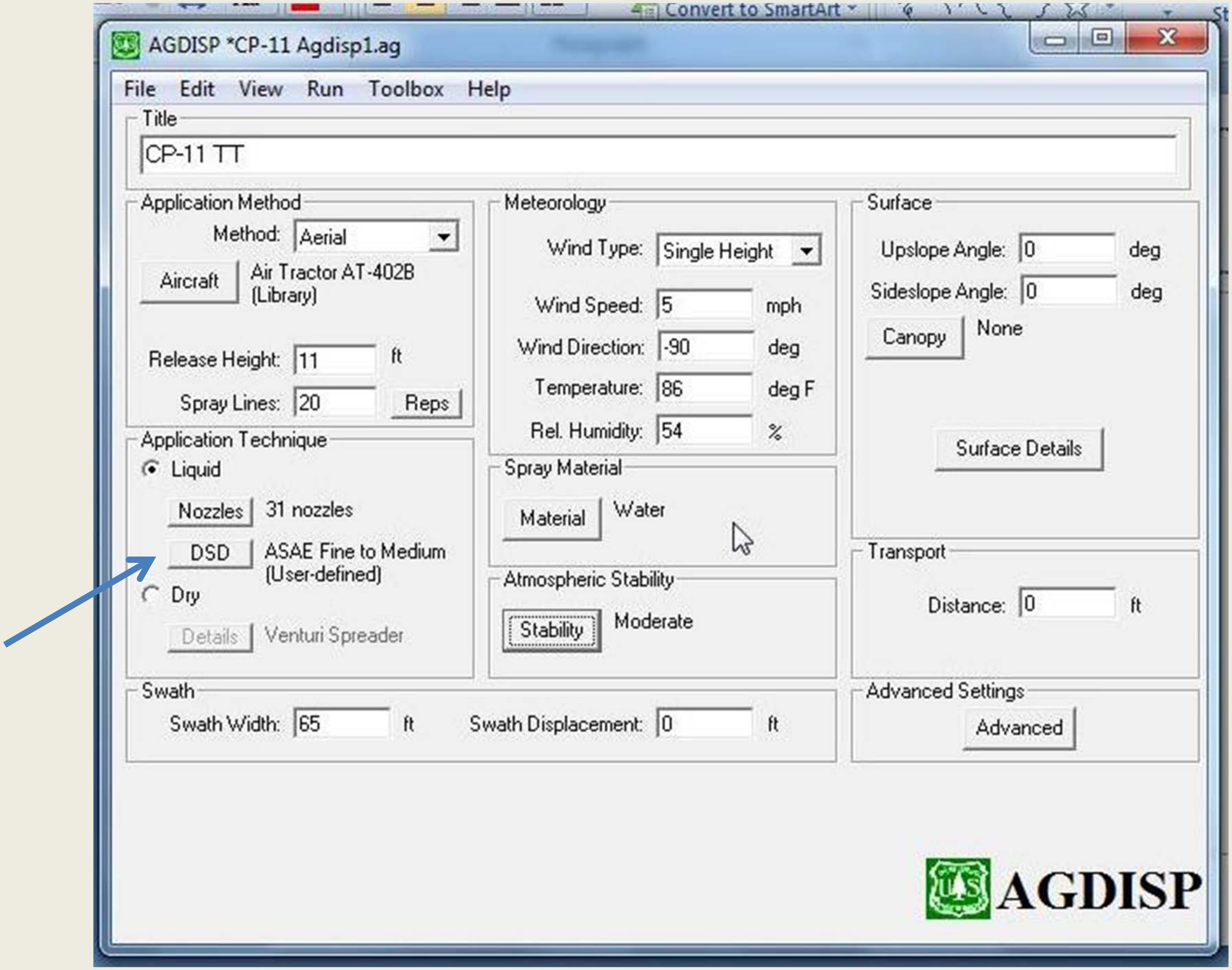
Nozzle	Pressure	% Reduction 120 mph	% Reduction 140 mph
Reference	43		
N1	60	**82.3**	**51.8**
N2	60	**80.3**	**61.1**
N3	40	**84.3**	**74.3**

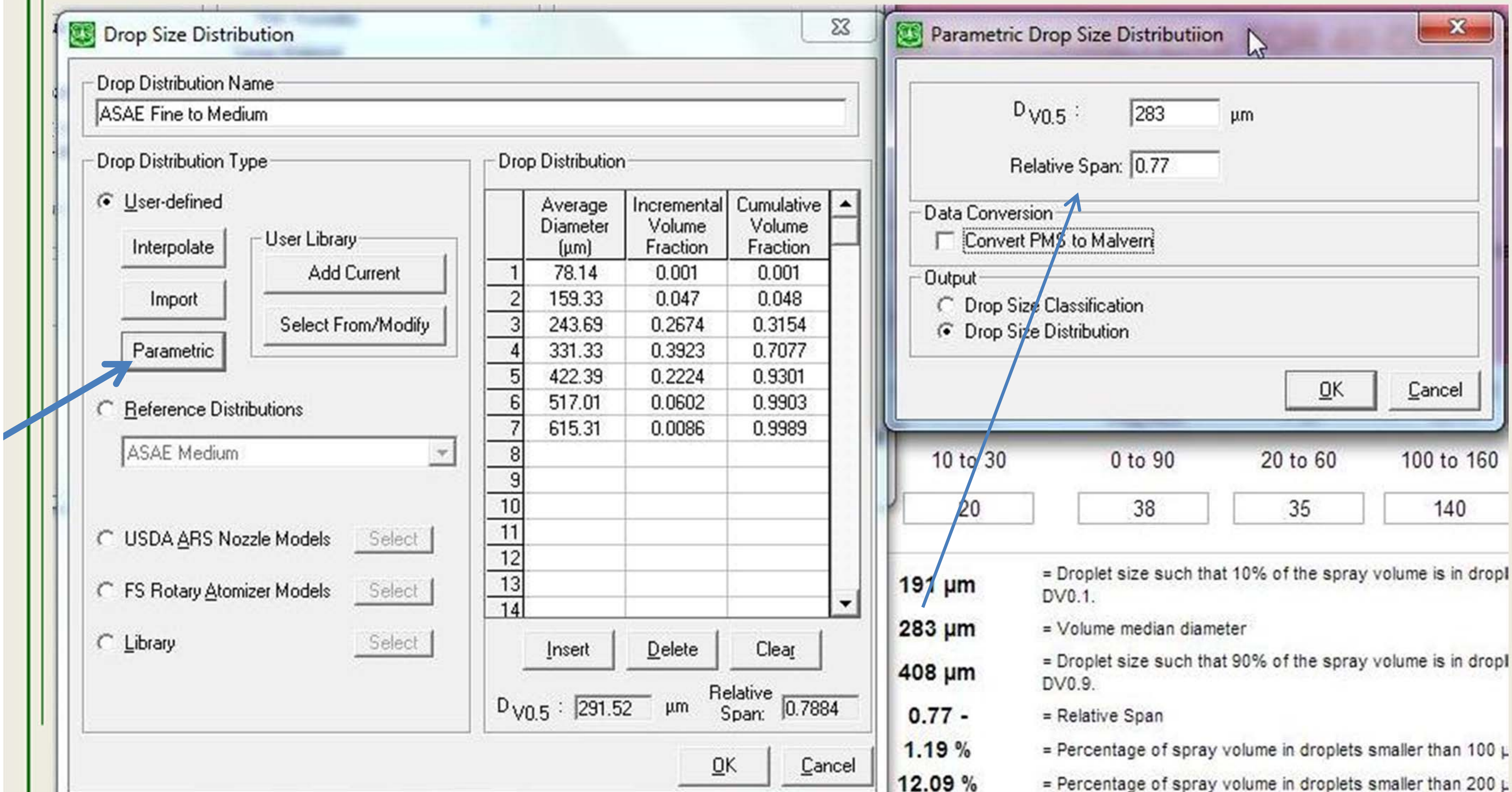
More model runs

- The effect of application height on downwind deposition and airborne drift: CP-11TT flat fan
- The effect of nozzle angle on downwind deposition and airborne drift: CP-09
- Comparison of both nozzles under aircraft similar setup

CP-11 First

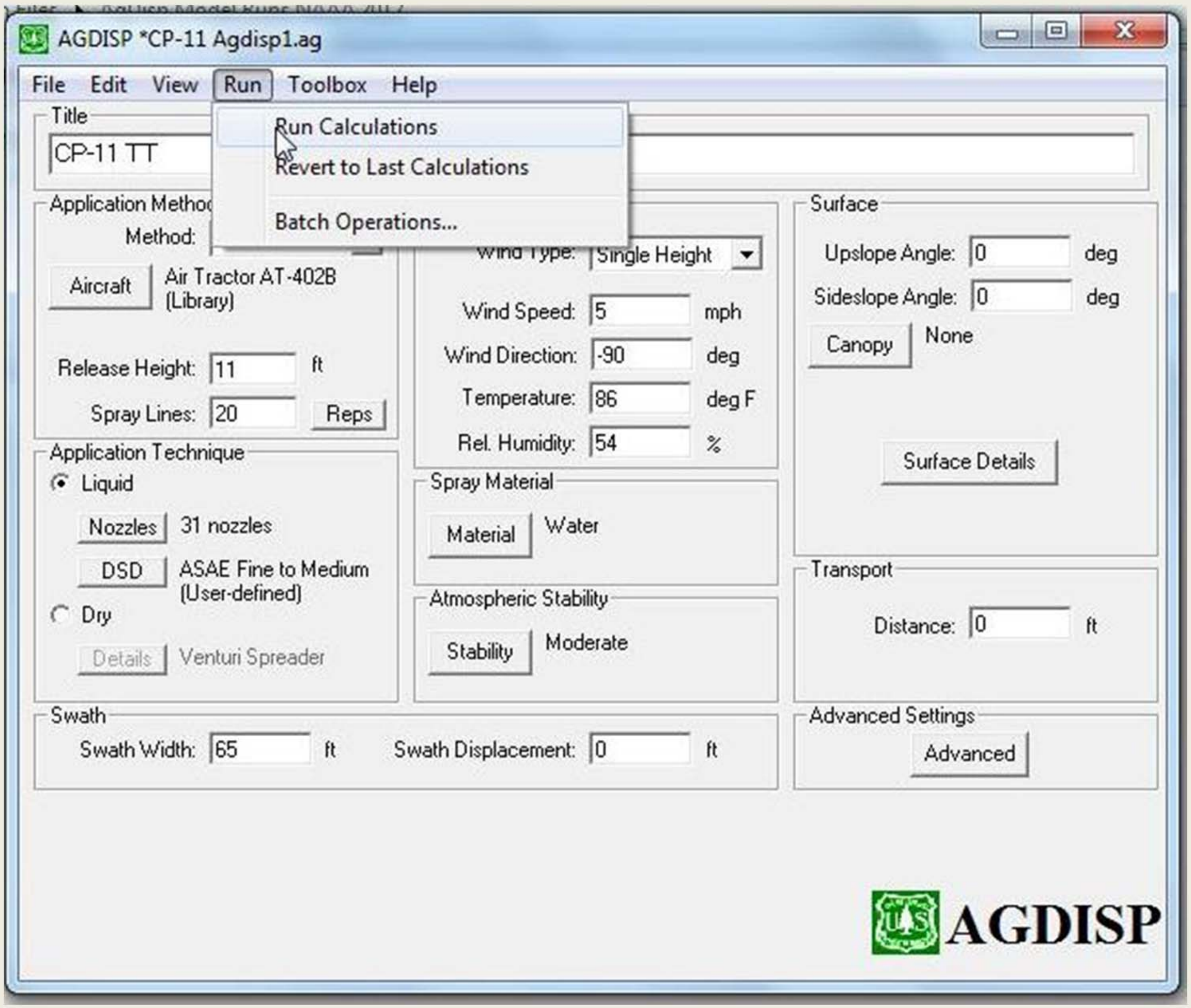
- Parameters are entered from a typical experiment


Convert to SmartArt
AGDISP *CP-11 Agdisp1.ag
File Edit View Run Toolbox Help
Title
CP-11 TT
Application Method
Method: Aerial
Aircraft
Air Tractor AT-402B
(Library)
Release Height: 11 ft
Spray Lines: 20
Reps
Application Technique
Liquid
Nozzles
31 nozzles
DSD
ASAE Fine to Medium
(User-defined)
Dry
Details
Venturi Spreader
Meteorology
Wind Type: Single Height
Wind Speed: 5 mph
Wind Direction: -90 deg
Temperature: 86 deg F
Rel. Humidity: 54 %
Spray Material
Material
Water
Atmospheric Stability
Stability
Moderate
Surface
Upslope Angle: 0 deg
Sideslope Angle: 0 deg
Canopy
None
Surface Details
Transport
Distance: 0 ft
Swath
Swath Width: 65 ft
Swath Displacement: 0 ft
Advanced Settings
Advanced
AGDISP

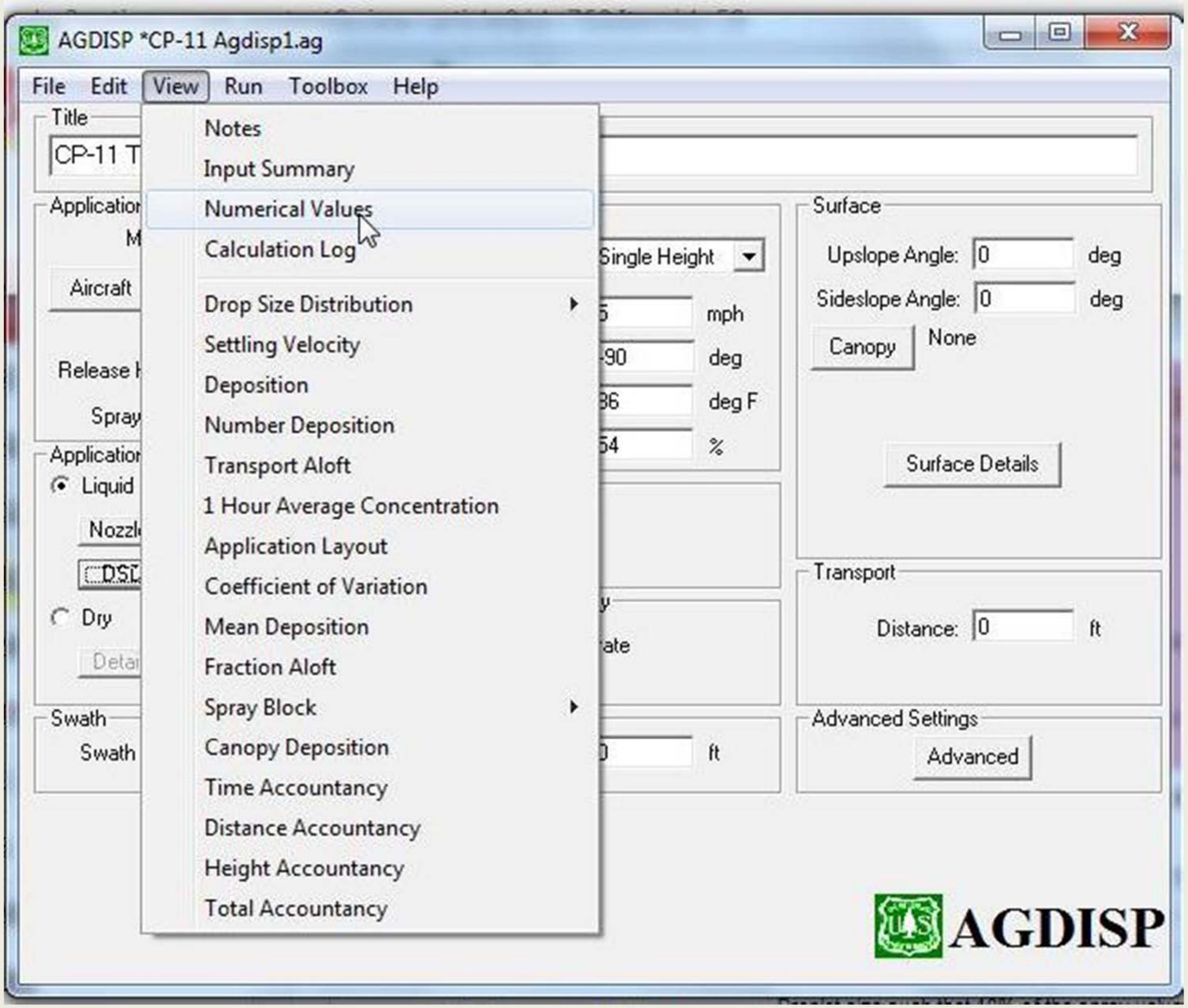


Nozzle model outputs entered above

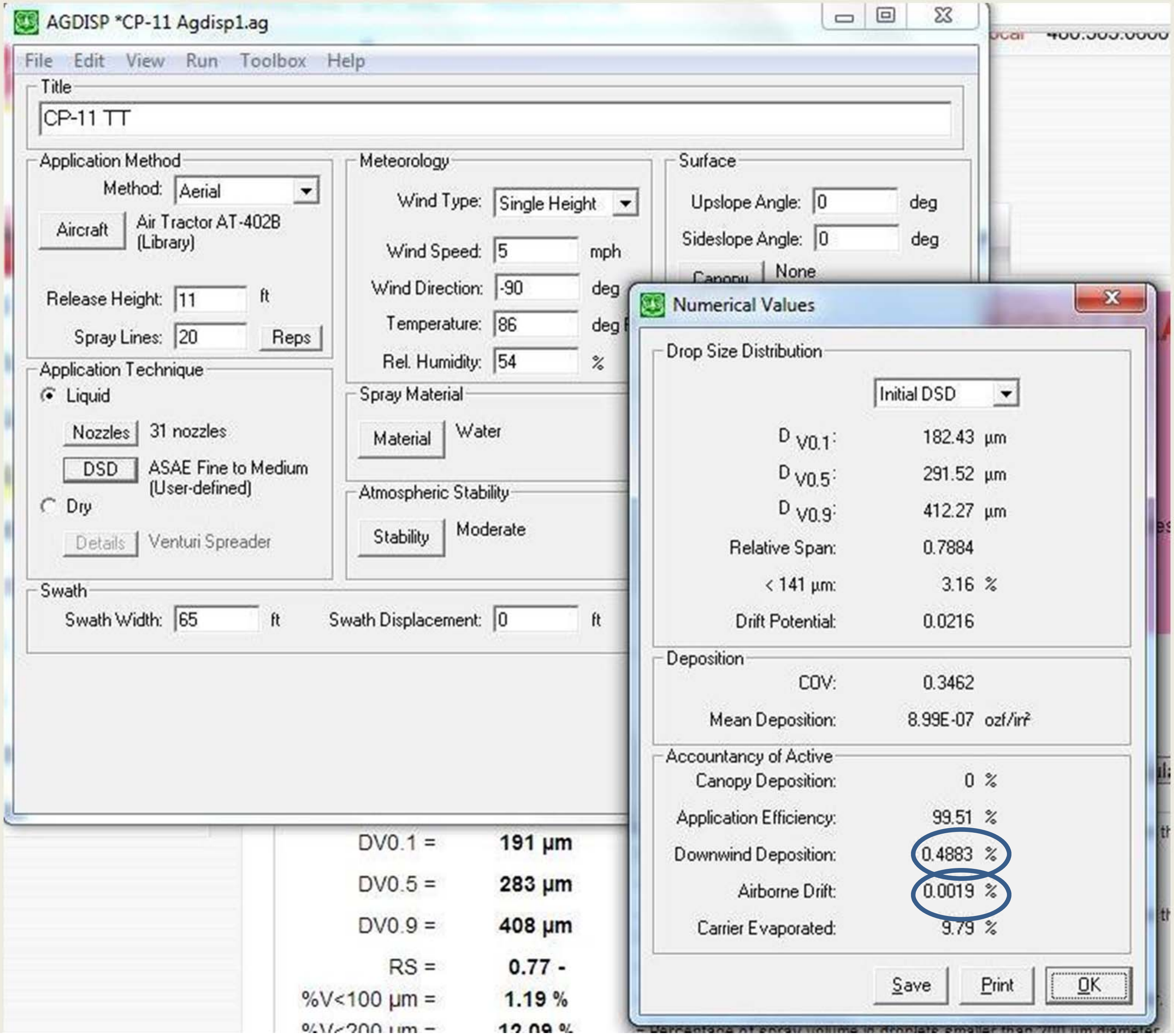
Run Model


AGDISP *CP-11 Agdisp1.ag
File Edit View Run Toolbox Help
Run Calculations
Revert to Last Calculations
Batch Operations...
Title
CP-11 TT
Application Method
Method:
Aircraft
Air Tractor AT-402B (Library)
Release Height: 11 ft
Spray Lines: 20
Reps
Application Technique
Liquid
Nozzles
31 nozzles
DSD
ASAE Fine to Medium (User-defined)
Dry
Details
Venturi Spreader
Wind Type: Single Height
Wind Speed: 5 mph
Wind Direction: -90 deg
Temperature: 86 deg F
Rel. Humidity: 54 %
Spray Material
Material
Water
Atmospheric Stability
Stability
Moderate
Surface
Upslope Angle: 0 deg
Sideslope Angle: 0 deg
Canopy
None
Surface Details
Transport
Distance: 0 ft
Swath
Swath Width: 65 ft
Swath Displacement: 0 ft
Advanced Settings
Advanced
AGDISP

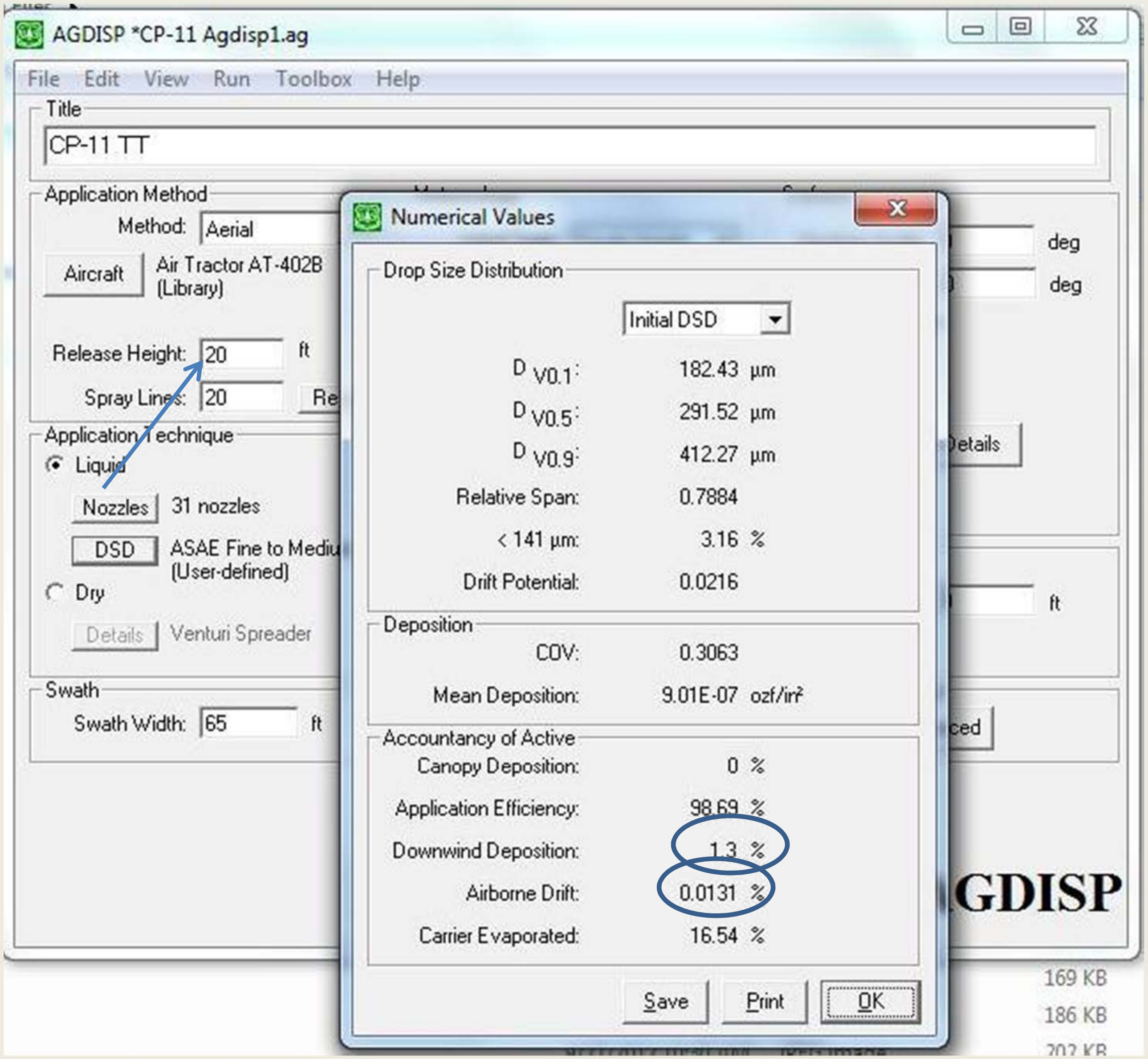
See numerical results



Result – 11 ft altitude



Result – 20 ft altitude

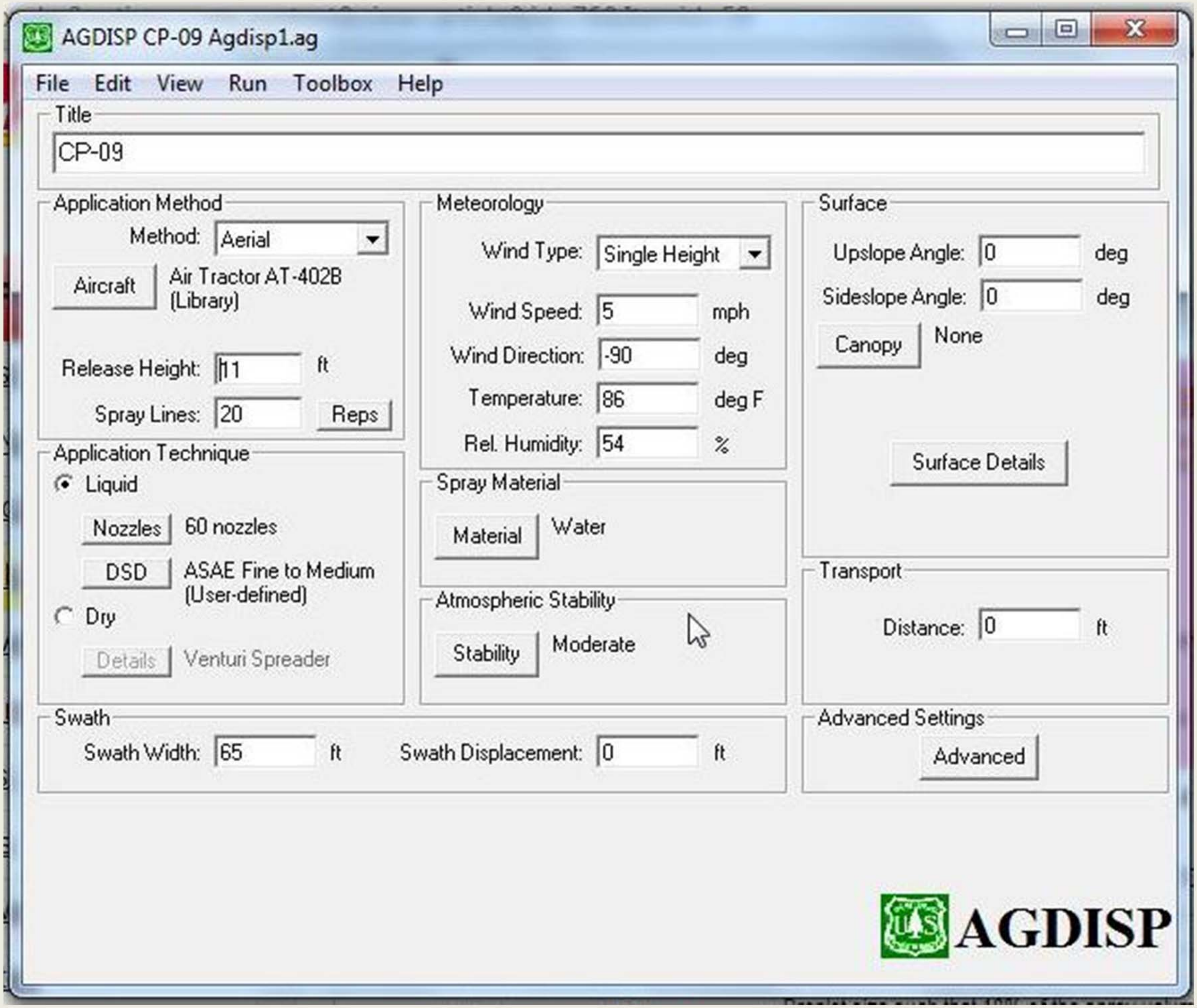


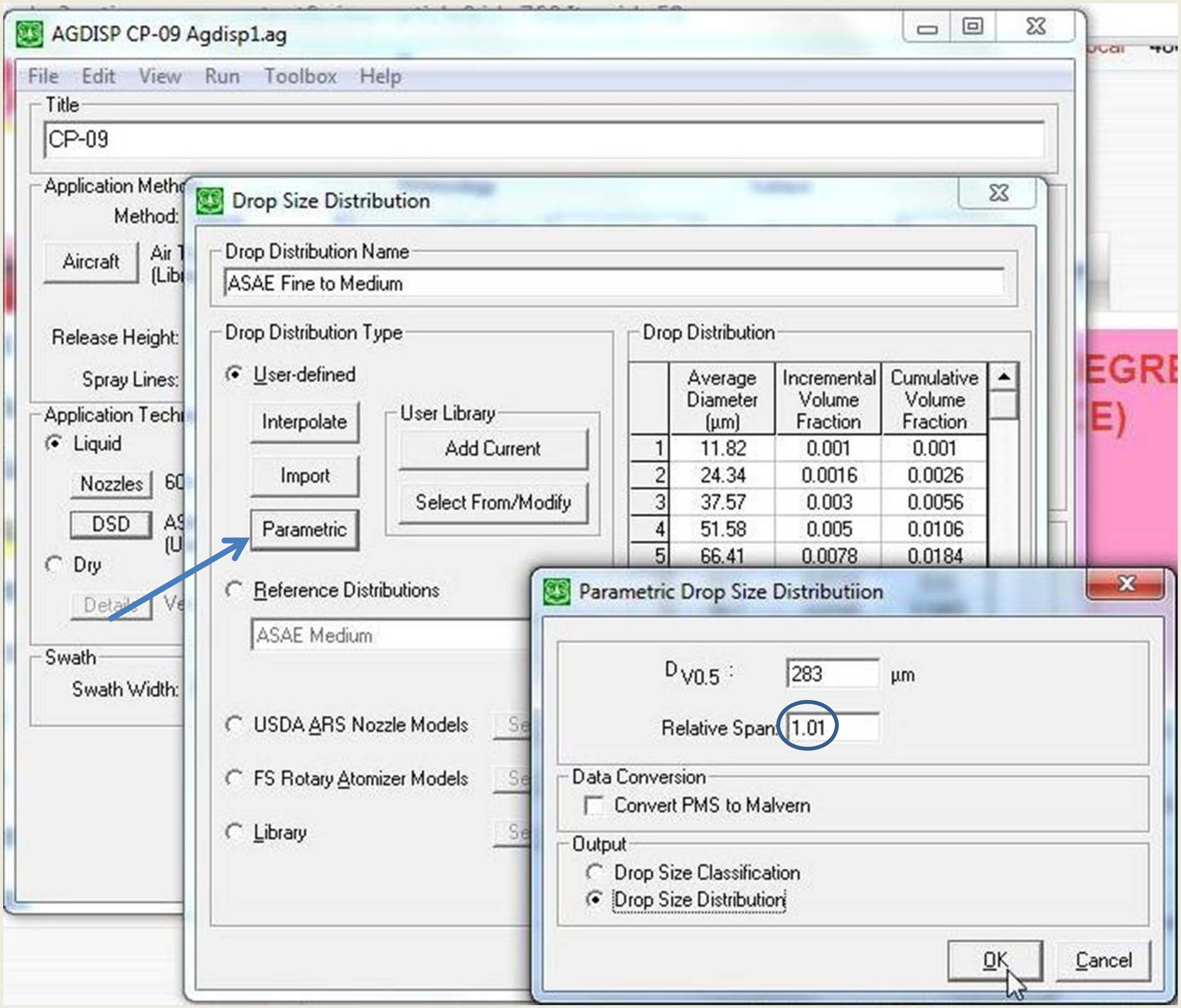
Summary – CP11-TT

Altitude	Angle	DV 0.5	R.S.	Deposition	Airborne Drift
11 ft	38°	283 µm	0.77	0.49%	0.002%
20 ft	38°	283 µm	0.77	1.30%	0.013%
Difference				2.6X	6.5X

Now CP-09

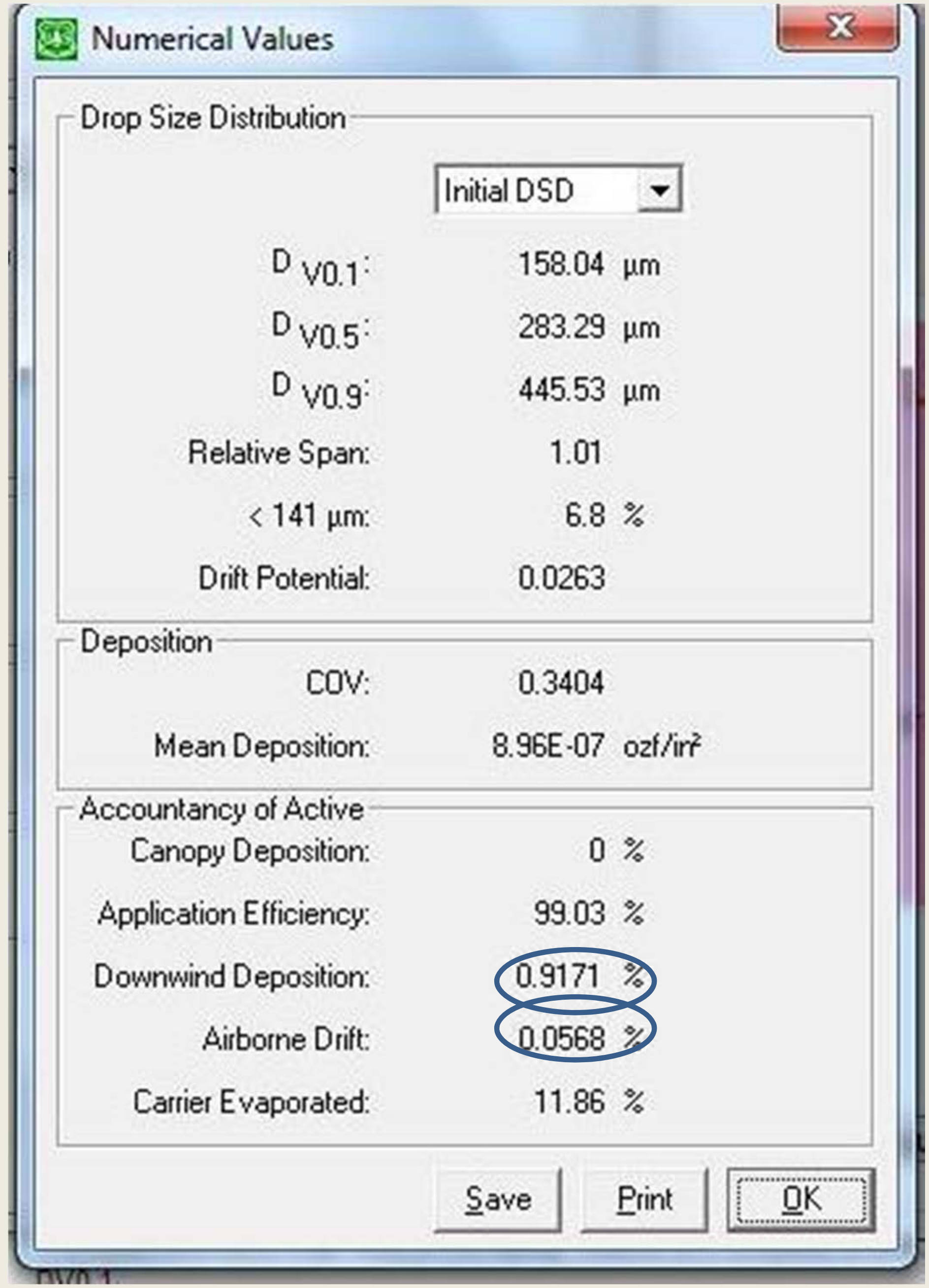
- Effect of nozzle angle


AGDISP CP-09 Agdisp1.ag
File Edit View Run Toolbox Help
Title
CP-09
Application Method
Method: Aerial
Aircraft
Air Tractor AT-402B (Library)
Release Height: 11 ft
Spray Lines: 20
Reps
Meteorology
Wind Type: Single Height
Wind Speed: 5 mph
Wind Direction: -90 deg
Temperature: 86 deg F
Rel. Humidity: 54 %
Surface
Upslope Angle: 0 deg
Sideslope Angle: 0 deg
Canopy
None
Surface Details
Application Technique
Liquid
Nozzles
60 nozzles
DSD
ASAE Fine to Medium (User-defined)
Dry
Details
Venturi Spreader
Spray Material
Material
Water
Atmospheric Stability
Stability
Moderate
Transport
Distance: 0 ft
Swath
Swath Width: 65 ft
Swath Displacement: 0 ft
Advanced Settings
Advanced
AGDISP

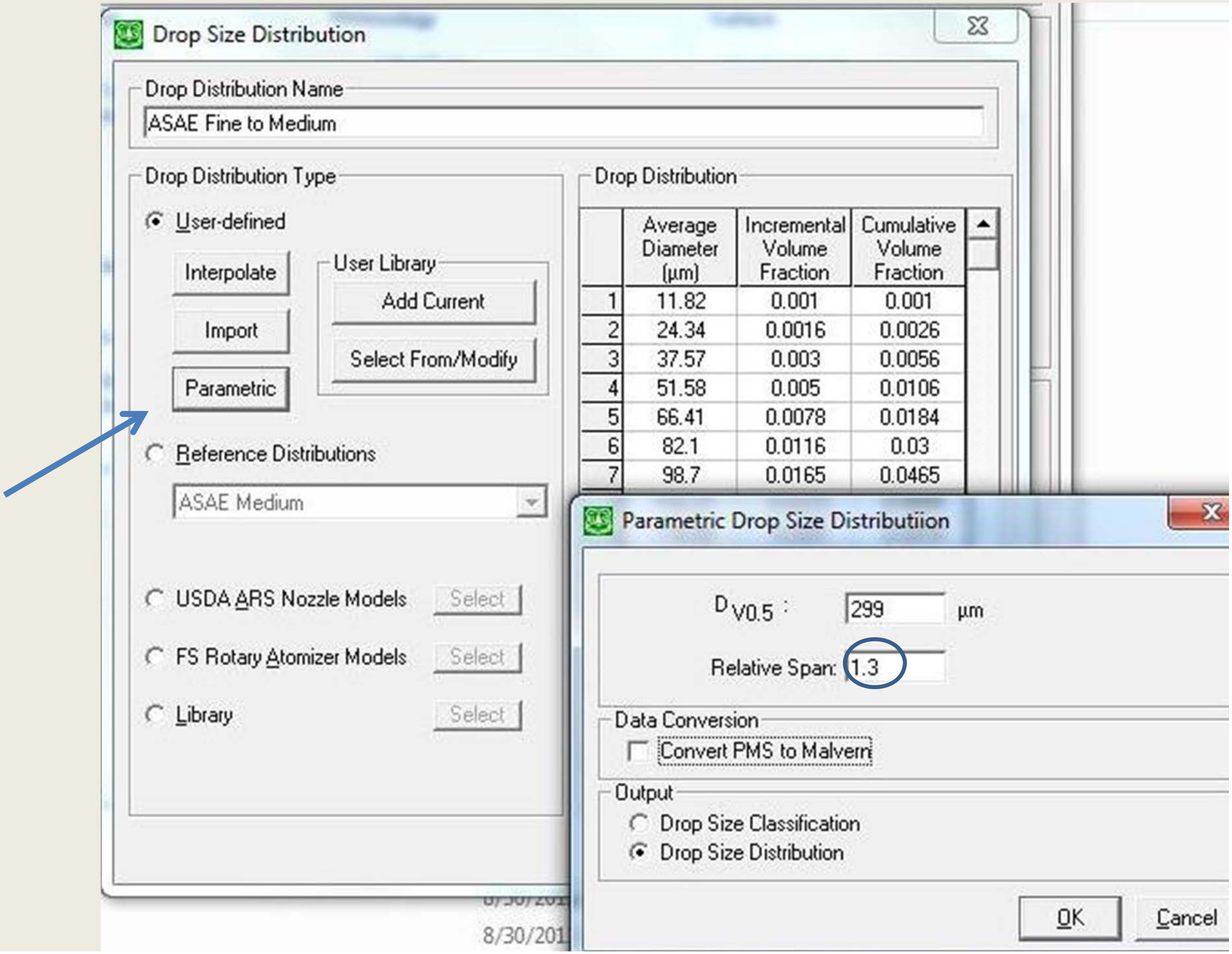

AGDISP CP-09 Agdisp1.ag
File Edit View Run Toolbox Help
Title
CP-09
Application Metho
Method:
Aircraft
Release Height:
Spray Lines:
Application Techn
Liquid
Nozzles
DSD
Dry
Details
Swath
Swath Width:
Drop Size Distribution
Drop Distribution Name
ASAE Fine to Medium
Drop Distribution Type
User-defined
Interpolate
Import
Parametric
User Library
Add Current
Select From/Modify
Reference Distributions
ASAE Medium
USDA ARS Nozzle Models
FS Rotary Atomizer Models
Library
Drop Distribution
Average Diameter (µm)
Incremental Volume Fraction
Cumulative Volume Fraction
1 11.82 0.001 0.001
2 24.34 0.0016 0.0026
3 37.57 0.003 0.0056
4 51.58 0.005 0.0106
5 66.41 0.0078 0.0184
Parametric Drop Size Distributiion
DV0.5 : 283 µm
Relative Span: 1.01
Data Conversion
Convert PMS to Malvern
Output
Drop Size Classification
Drop Size Distribution
OK
Cancel

Result:

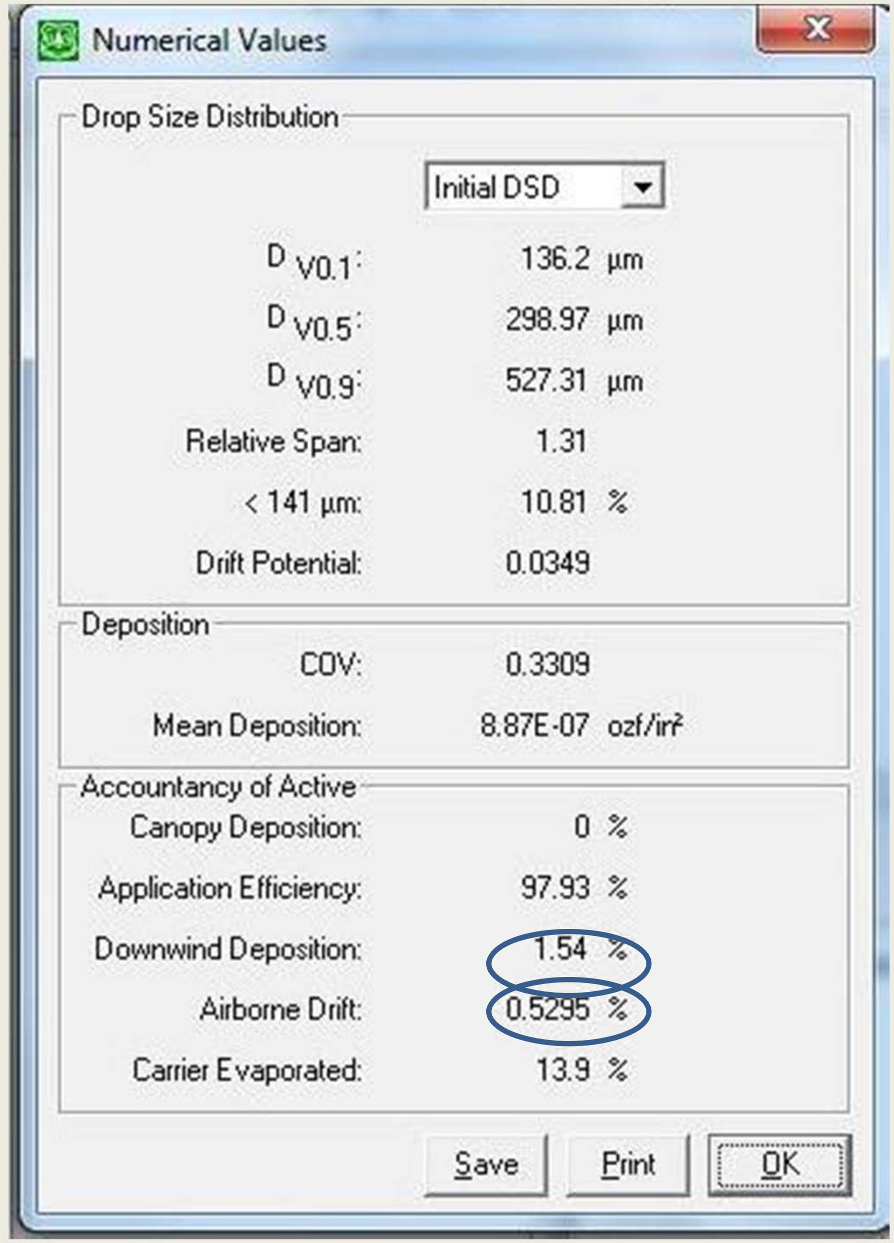
CP-09, 30° down angle



Now…let's do 5° down angle



Result:
CP-09, 5° down angle



Summary – CP-09

Altitude	Angle	DV 0.5	R.S.	Deposition	Airborne Drift
11 ft	30°	283 µm	1.01	0.92%	0.057%
11 ft	5°	299 µm	1.3	1.54%	0.530%
Difference				1.6X	9X

Conclusions

- CP-11 flat fan
  - increase in height of application from 10 to 20 ft. resulted in 2.6X percentage increase in downwind deposition; 6.5X percentage increase in airborne drift.

Conclusions

- CP-09
  - Changing down angle from 30° to 5° increased downwind deposition by 1.6 X percent; increased airborne drift by almost 9X percent.

Conclusions

- CP-09 (30°) and CP-11TT (38°) comparison
  - At same pressure and gal/acre, CP-09 showed 2X higher percent downwind deposition and 30X higher percent airborne drift than CP-11TT flat fan.
  - From nozzle models and AgDisp run
    - CP-09 : 6.8% of droplets < 141μm size
    - CP-11TT: 3.16% of droplets < 141μm size

The Influence of Adjuvants on Aerial Spray Droplet Size

Robert E. Wolf

DATA SUMMARY
3 TRIALS
2003, 2008, 2011

Drift Study #1 - 2003

Companies

1. United Suppliers
2. Helena Chemical
3. Garrco
4. Loveland
5. Wilber-Ellis
6. Rosen's
7. Precision Labs
8. SanAg

Products

1. 41-A
2. Formula One
3. AMS 20/10
4. Border EG 250
5. Control
6. INT VWZ
7. Inplace
8. Garrco Exp-3
9. INT YAR
10. Border XTRA 8L
11. HM2005-C
12. HM0226
13. Liberate
14. Target LC
15. HM2052
16. INT HLA
17. HM 0230
18. Valid
19. Double Down

20 & 21. water

Some worked & some didn't!!!

Materials and Methods:

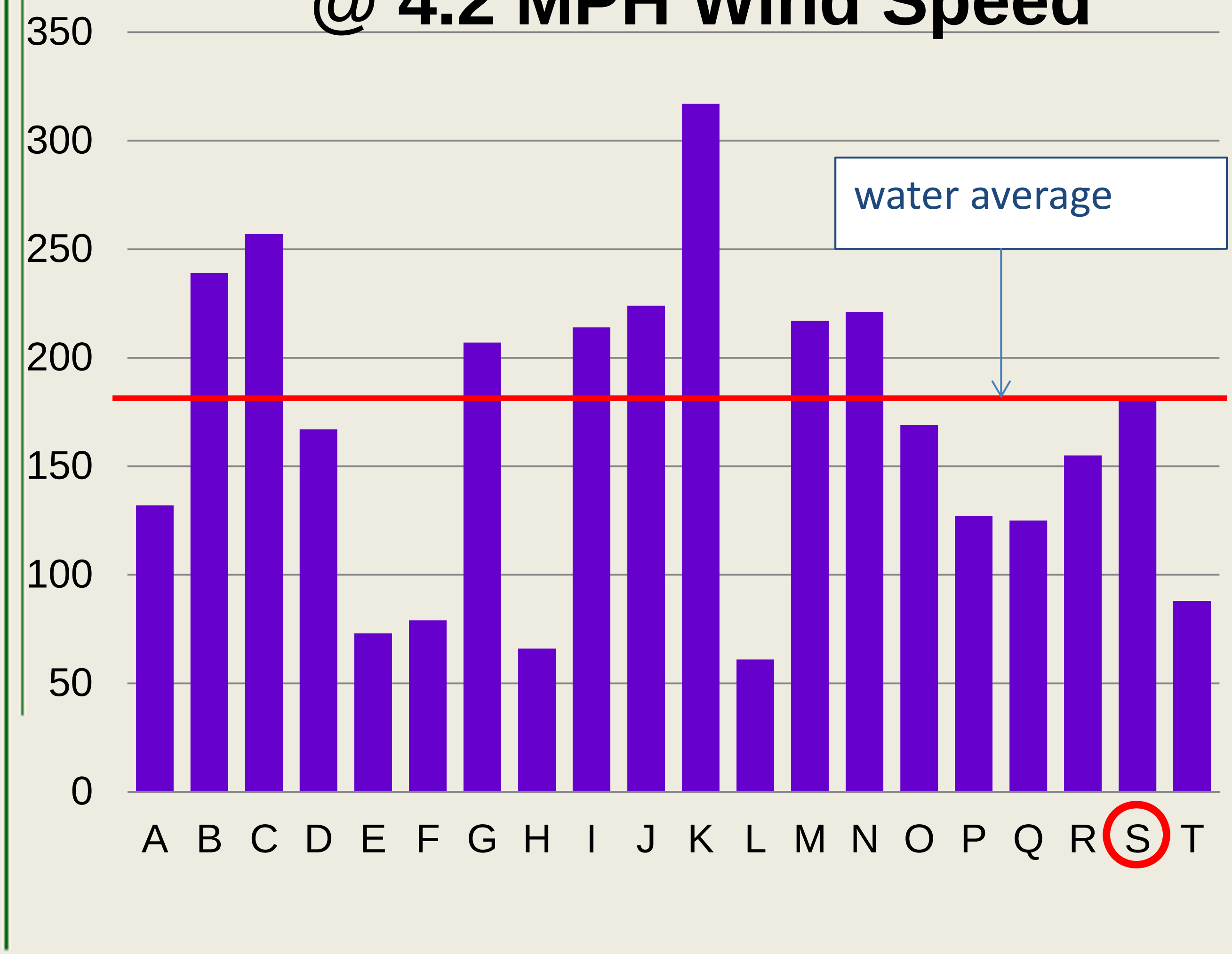
- AT 502A (Hawkeye Flying Service)
  - Drop booms
  - CP-09 nozzles w/5° deflection
  - Combination of .078 and .125 orifice settings
  - 40 psi
  - 150 mph ground speed by radar

- Cessna 188 Ag Husky (Rucker Flying Service)
  - Ag Tips
  - CP-03 w/30 degree deflection
  - Combination of .078 and .125 orifice settings
  - 26 psi
  - 115 mph ground speed by radar

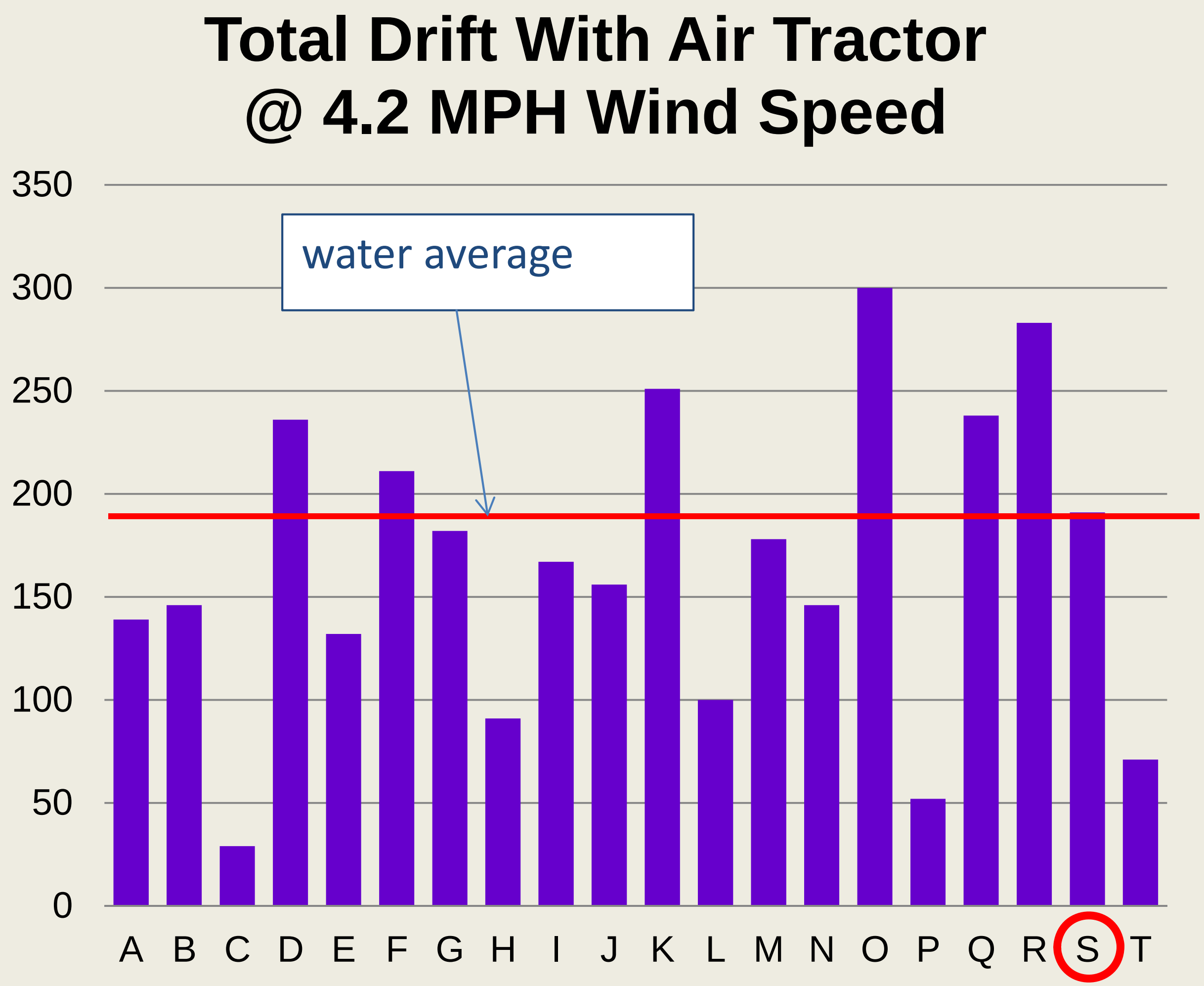
- Aircraft calibrated for 3 GPA

Collection Procedure for drift:

Total Drift With Cessna @ 4.2 MPH Wind Speed



FORMULA ONE	A
HM0226	B
AMS20/10	C
BORDER EG 250	D
CONTROL	E
INT VWX	F
INPLACE	G
GARCO #3	H
INT YAR	I
BORDER XTRA 8L	J
HM 2005C	K
DOUBLE DOWN	L
LIBERATE	M
TARGET LC	N
HM 2052	O
INT HLA	P
HM 0230	Q
VALID	R
TAP WATER	S
41-A	T



FORMULA ONE	A
HM0226	B
AMS20/10	C
BORDER EG 250	D
CONTROL	E
INT VWX	F
INPLACE	G
GARCO #3	H
INT YAR	I
BORDER XTRA 8L	J
HM 2005C	K
DOUBLE DOWN	L
LIBERATE	M
TARGET LC	N
HM 2052	O
INT HLA	P
HM 0230	Q
VALID	R
TAP WATER	S
41-A	T

DATA SUMMARY
2ND TRIAL
2008

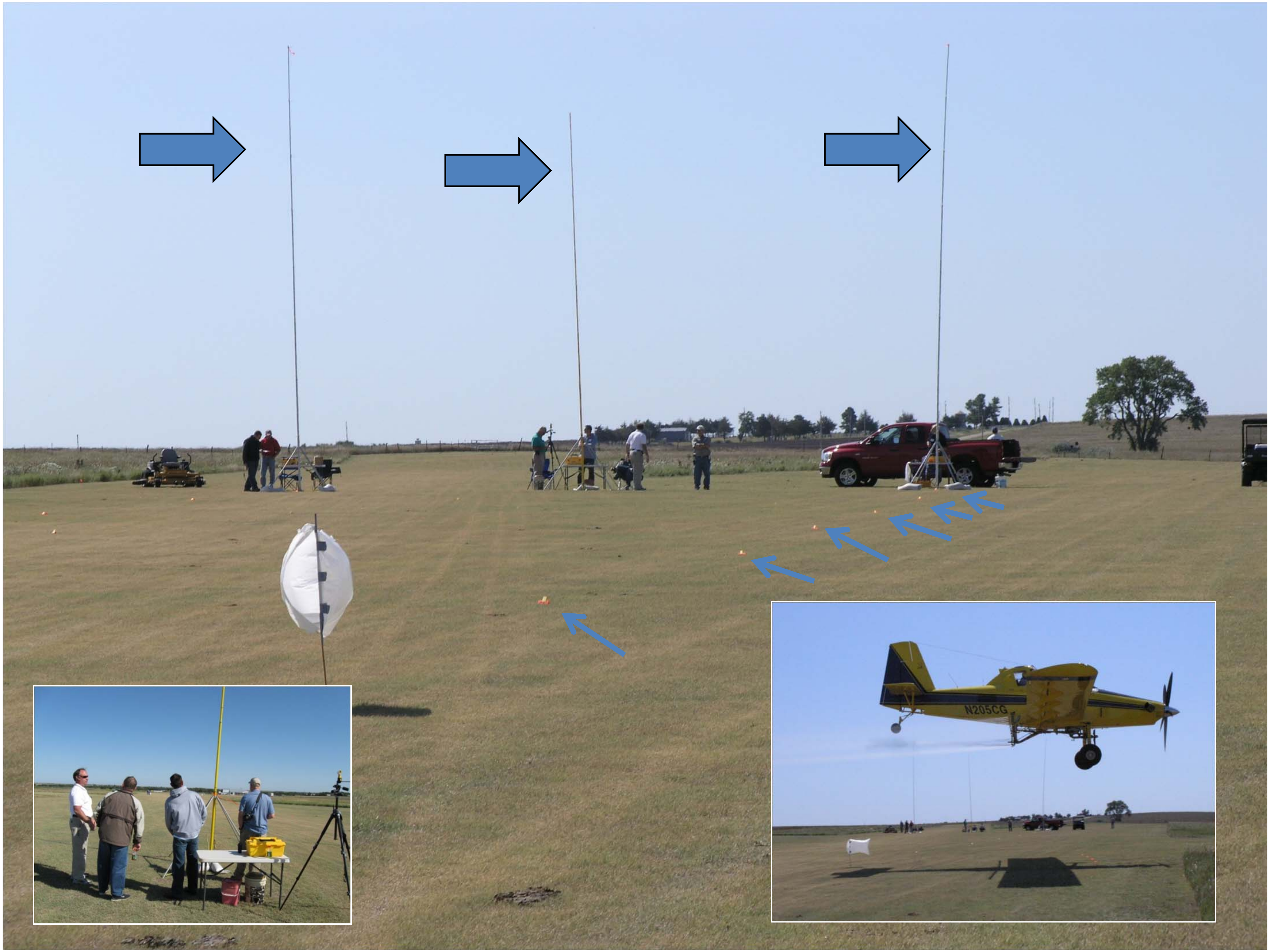
DRIFT STUDY # 2 - 2008

Product Name	Product Company	Mixing rate[a]
Tap water 1	Local supply	X-77 only
Superb HC + Interlock	Winfield Solutions	133 oz + 33 oz / 50 gal
Formula 1	United Suppliers	1.5 qt / 50 gal
#PX056-Z	Precision Labs, Inc	5 qt / 50 gal
Tap water 2	Local supply	X-77 only
Ag 06037	Winfield Solutions	64 oz / 50 gal
Ag 08050	Winfield Solutions	80 oz / 50 gal
Interlock 1.25	Winfield Solutions	80 oz / 50 gal
Control	GarrCo Products, Inc	2 oz /50 gal
Tap water 3	Local supply	X-77 only
INT 908	Rosen's	5 gal / 45 gal
Tap water + Prime Oil[b]	Local supply + Winfield Solutions	266 oz / 50 gal
Interlock 0.8	Winfield Solutions	50 oz / 50 gal

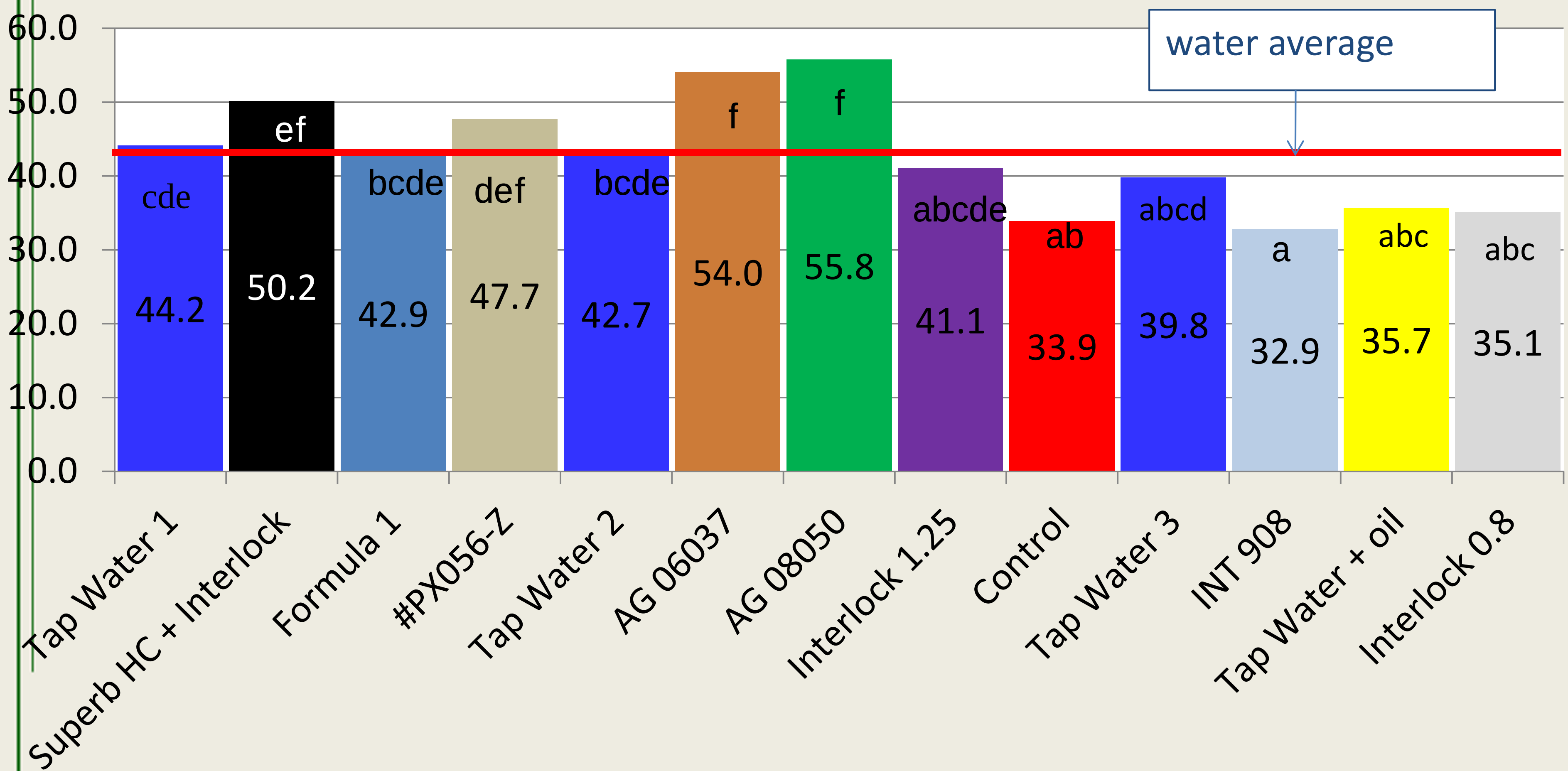
[a] All tank mixes included X-77 at .25% v/v (16 ounces per 50 gallon load).
[b]Oil to simulate a suggested tank mix with fungicide (Prime Oil @ 1 pint/acre).

Materials and Methods (2008):

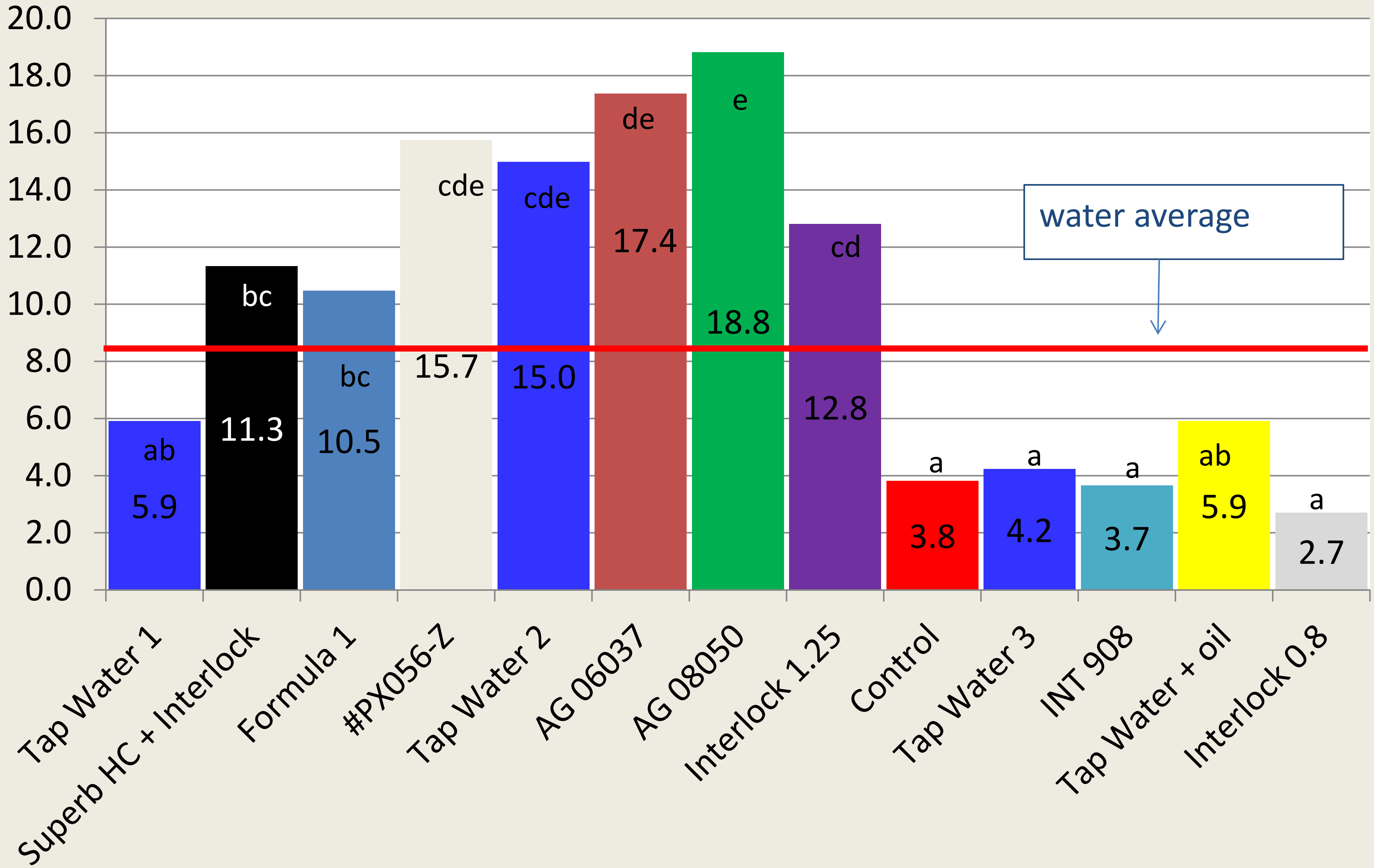
- AT 502A(Rucker Flying Service)
  - Drop booms
  - CP-11TT #15 straight stream nozzles w/8° deflection
  - 44 PSI
  - 156 mph ground speed by GPS
  - Droplet spectrum: Medium, %volume <200 = 7.65%
- Aircraft calibrated for 3 GPA


N205CG

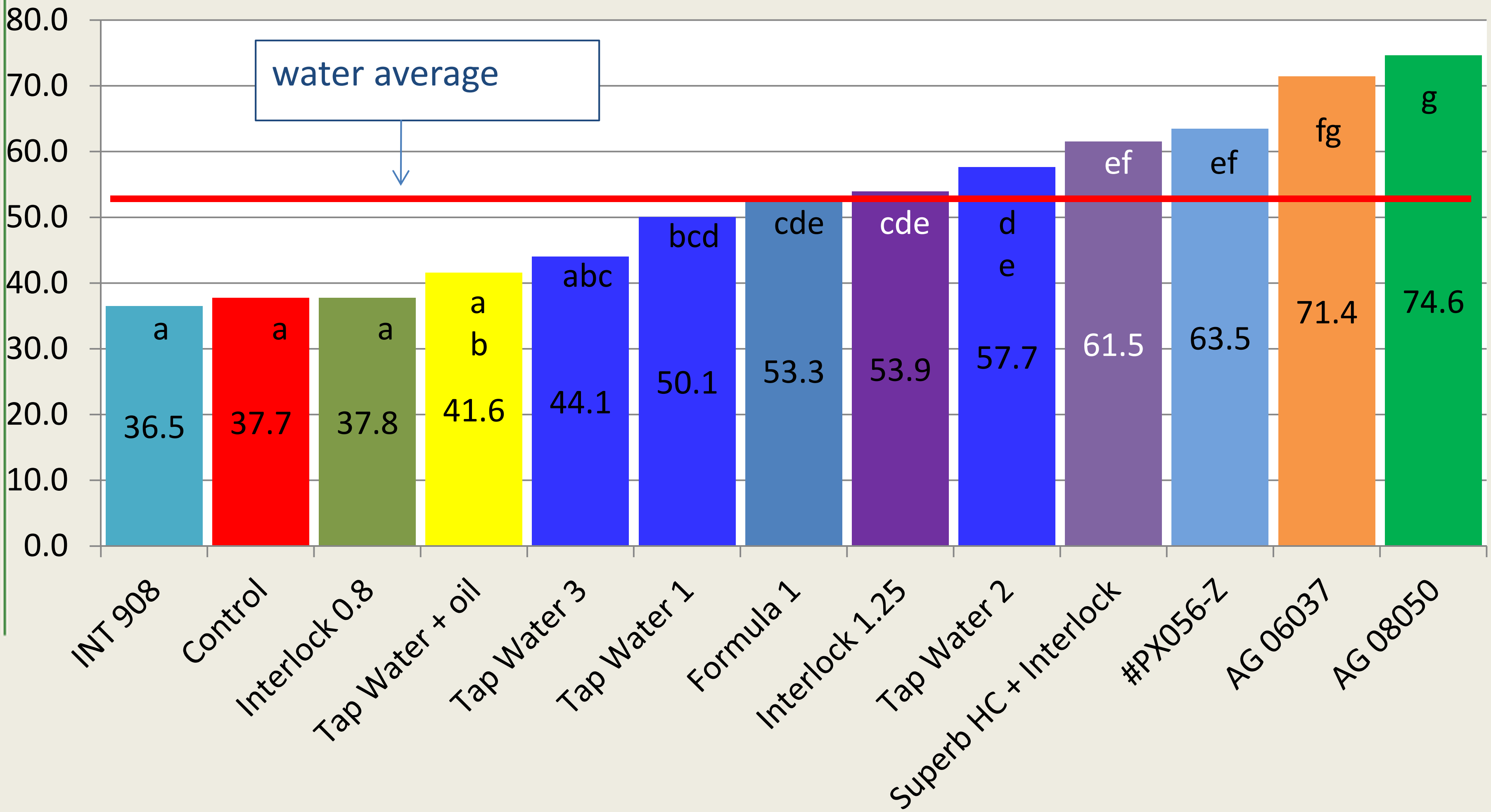
Horizontal Drift Summary:



Vertical Drift Summary:



Total Drift Ranked:



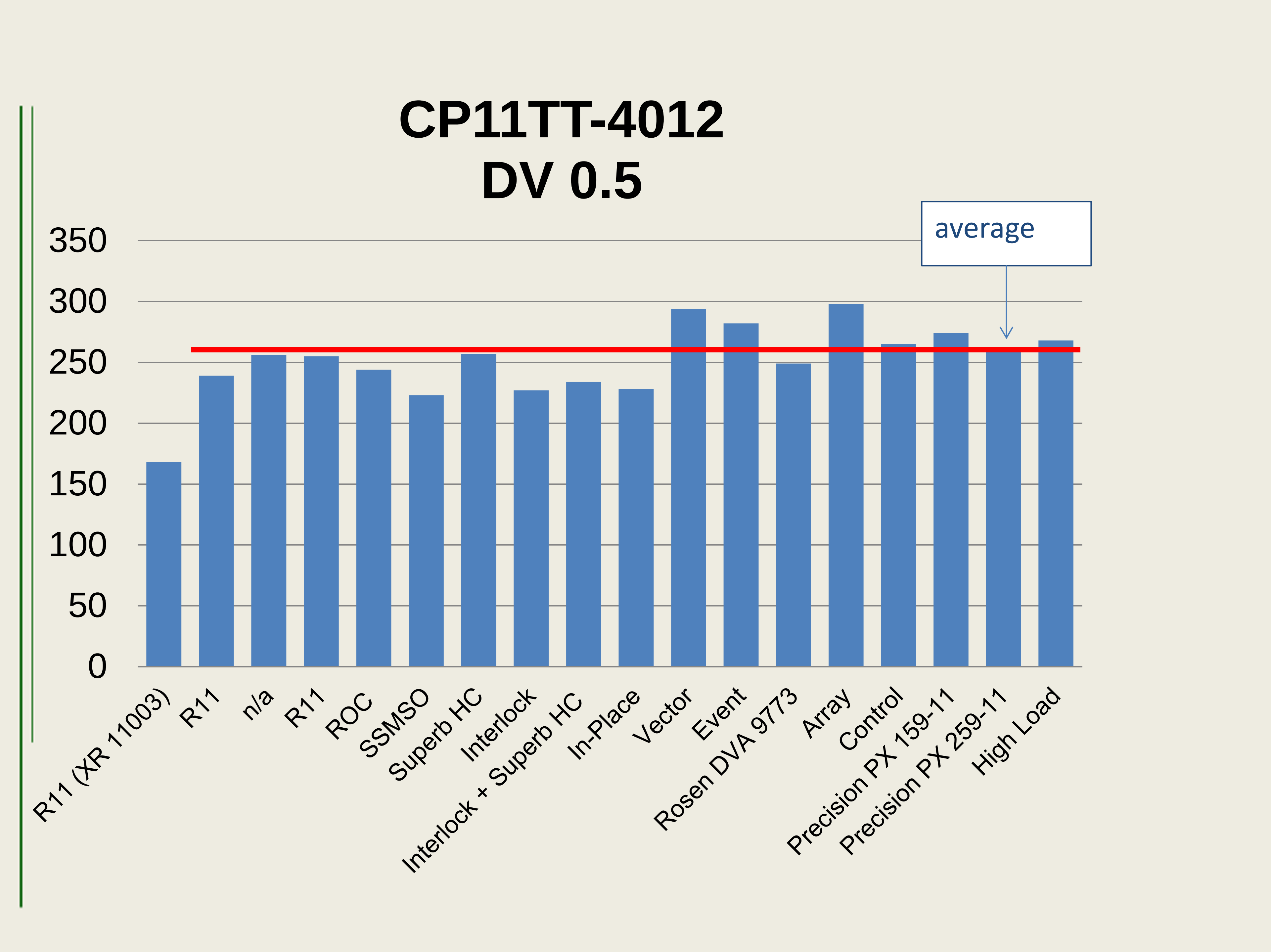
DATA SUMMARY
3RD TRIAL
2011

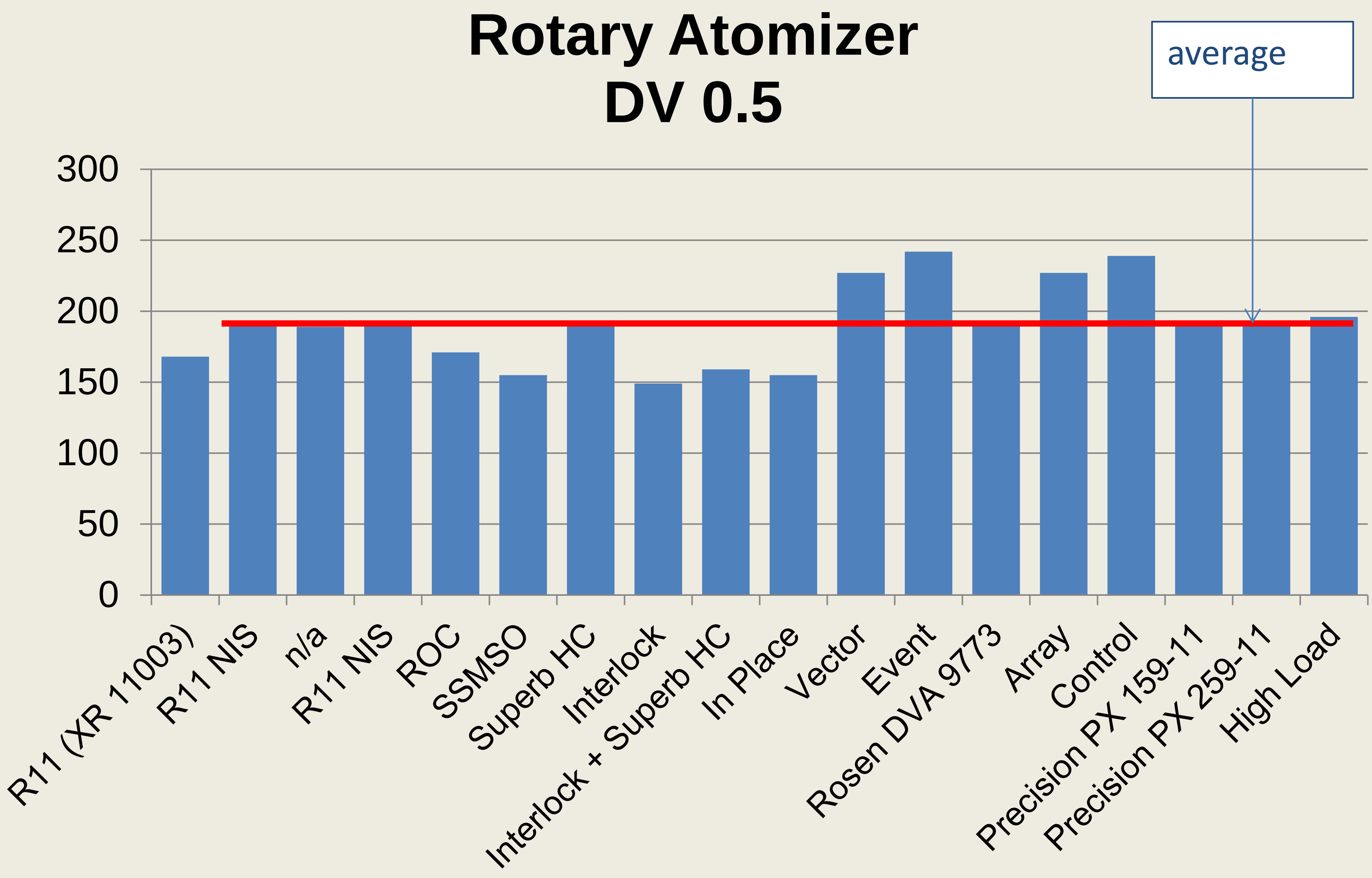
Companies and Products:

Wilbur-Ellis	Winfield Solutions	Rosen's	GarrCo	Precison Labs
SSMSO	Superb HC	Vector	Control	PX 159-11
InPlace	Interlock	Event		PX 259-11
High Load	Interlock + Superb HC	Array		
		DVA 9773		

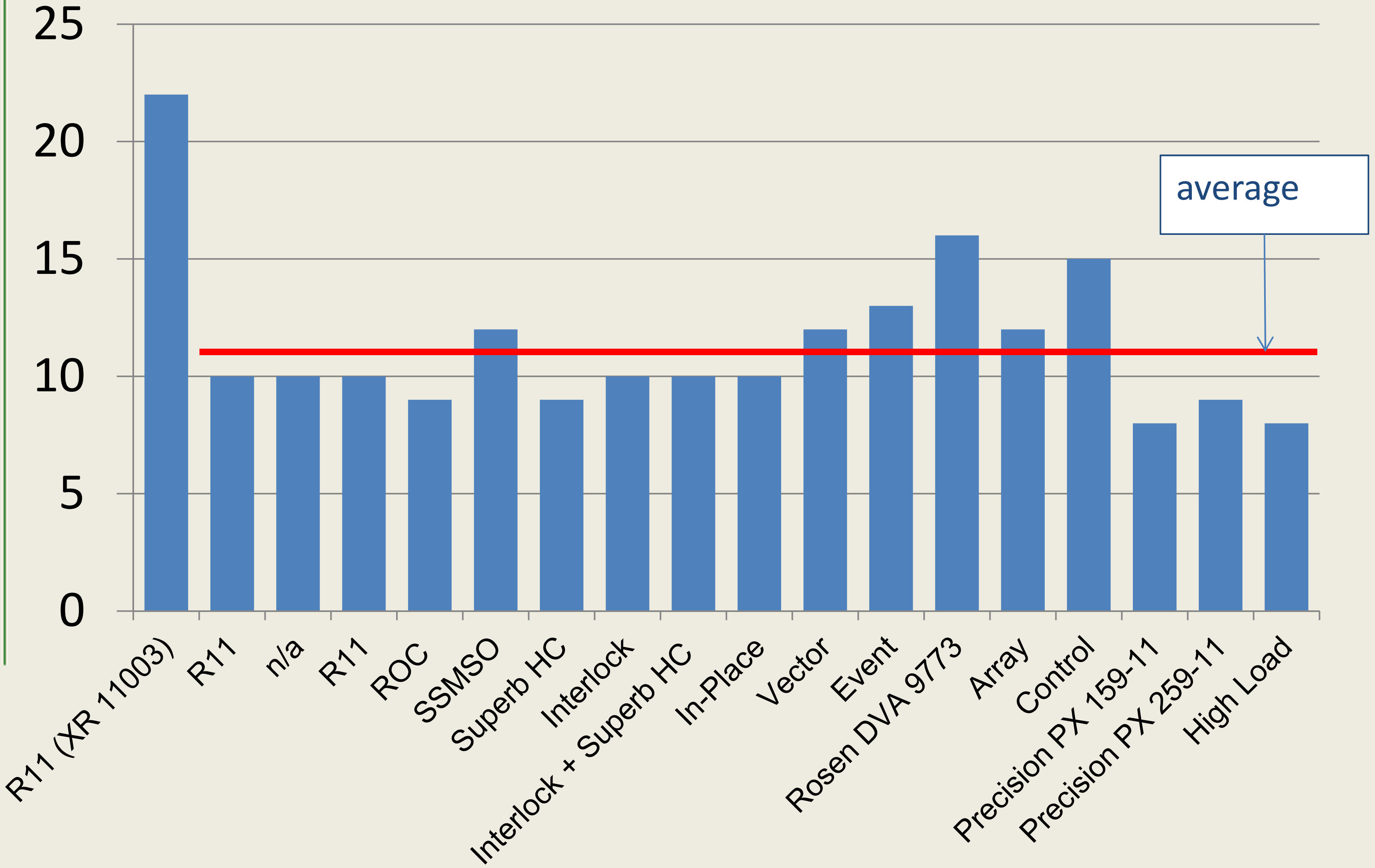
Materials and Methods Wind Tunnel:

- USDA ARS High Speed Wind Tunnel
  - 137 mph wind speed
- Flow calibrated for 2 GPA
- Nozzles tested:
  - CP-11TT 4012 Flat-fan nozzles w/23°deflection, 38 PSI
  - ASC Rotary Atomizer D-12 orifice and blade setting #2, 23 PSI
  - XR11003 (nozzle standard), 43 PSI, 0°deflection
- HELOS laser diffraction droplet sizing system

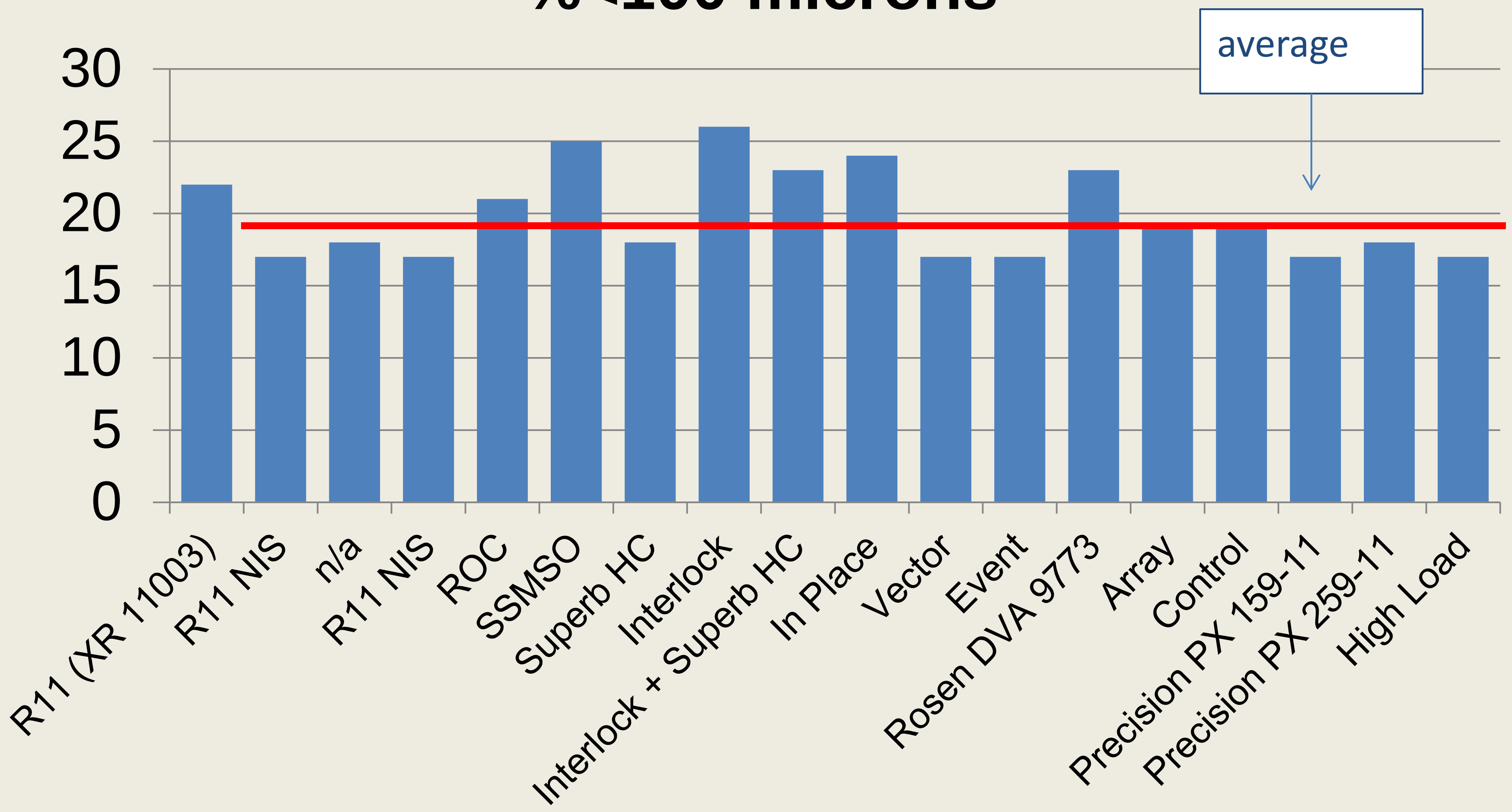

CP11TT-4012
DV 0.5
average
350
300
250
200
150
100
50
0
R11 (XR 11003)
R11
n/a
R11
ROC
SSMSO
Superb HC
Interlock
Interlock + Superb HC
In-Place
Vector
Event
Rosen DVA 9773
Array
Control
Precision PX 159-11
Precision PX 259-11
High Load


Rotary Atomizer
DV 0.5
average
300
250
200
150
100
50
0
R11 (XR 11003)
R11 NIS
n/a
R11 NIS
ROC
SSMSO
Superb HC
Interlock
Interlock + Superb HC
In Place
Vector
Event
Rosen DVA 9773
Array
Control
Precision PX 159-11
Precision PX 259-11
High Load

CP11TT-4012
% < 100 microns



Rotary Atomiser
%<100 microns



Droplet Size Classification System

Brad Fritz

Why use Droplet Size Classes?

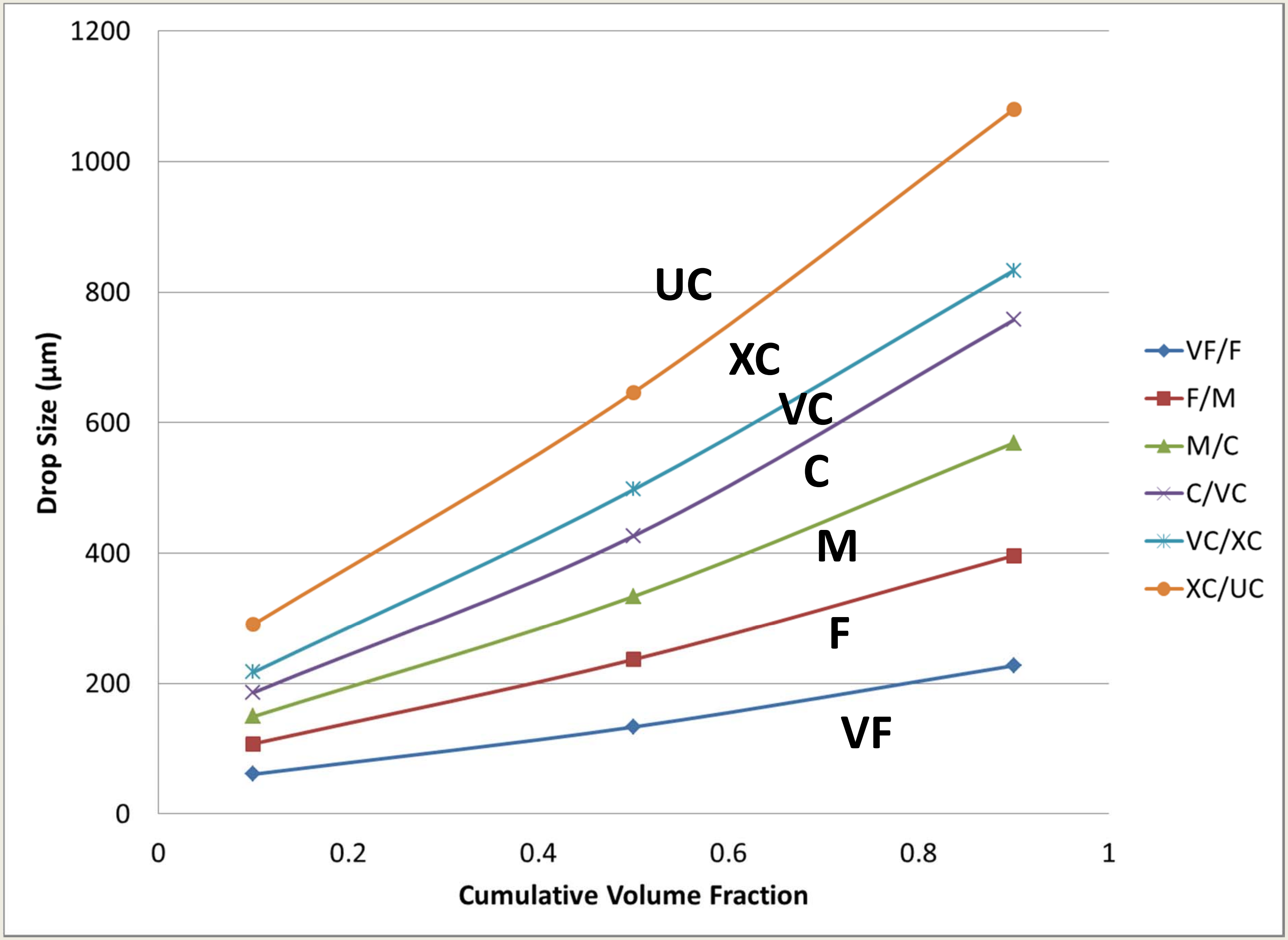
- To account for measurement differences between locations
  - Location and system differences = different numbers.
    - VMD of 250 µm from Lab 1 may be 275 µm at Lab 2
- ASABE standard classifies sprays by comparison to standardized nozzles
  - Classification between locations would be the same
    - MEDIUM spray at Lab 1 would also be MEDIUM at Lab 2

Reference Nozzles

- Series of flat fans and specified pressures.
- Measured droplet sizes defines class boundaries.
- Other systems tested by same lab and system are compared to Reference nozzle data.
  - Finest classification from $D_{V0.1}$ and $D_{V0.5}$ is given
    - i.e. $D_{V0.1}$ is FINE and $D_{V0.5}$ is MEDIUM – Spray is FINE

VF/F F/M M/C C/VC VC/XC XC/UC

Classification Curves



Droplet Size and the Effects of an Active Product and Adjuvants

Brad Fritz

Study

- Increasing air shear effect on formulation plus adjuvant atomization for aerial sprays

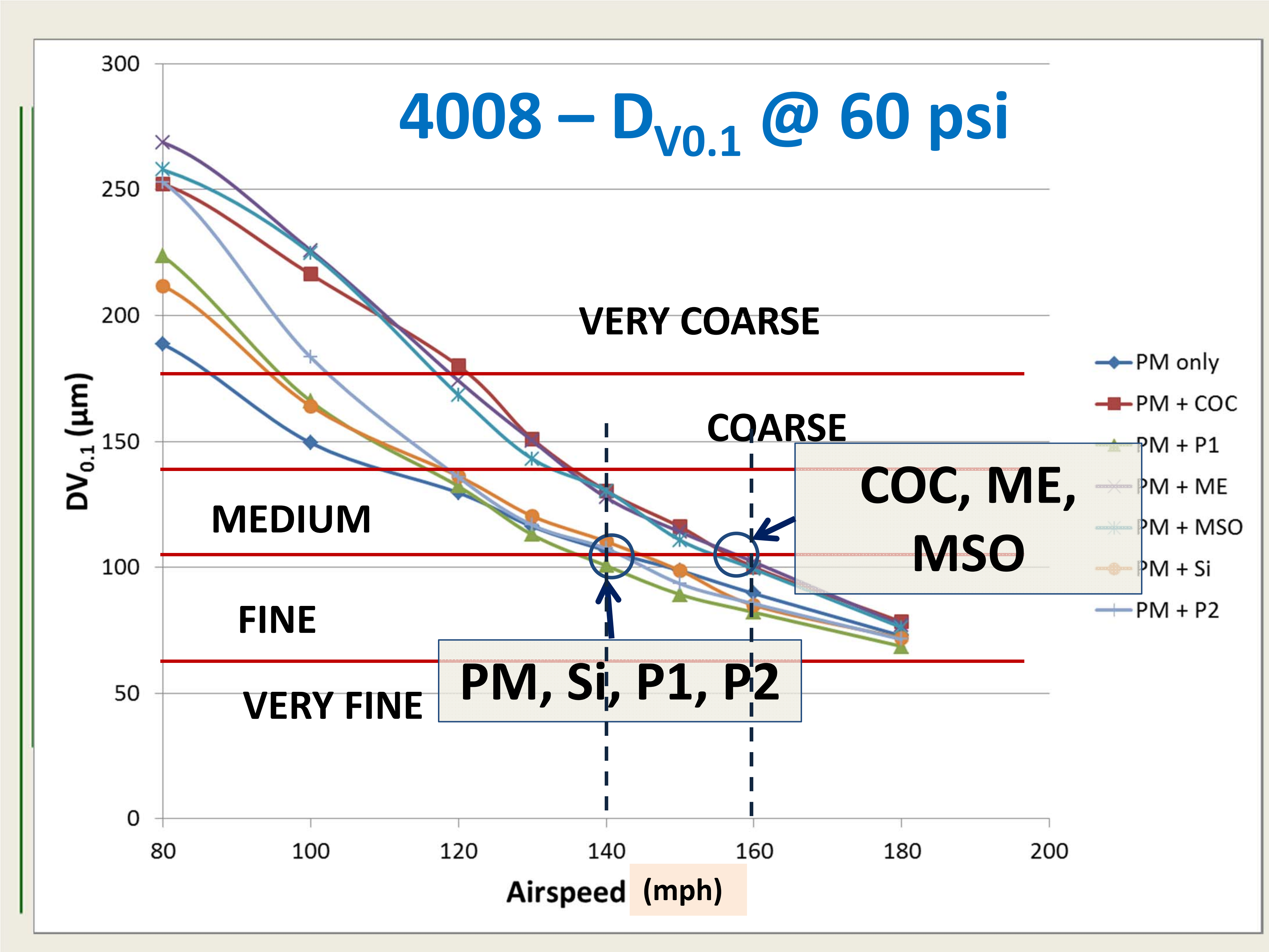
Solutions Tested

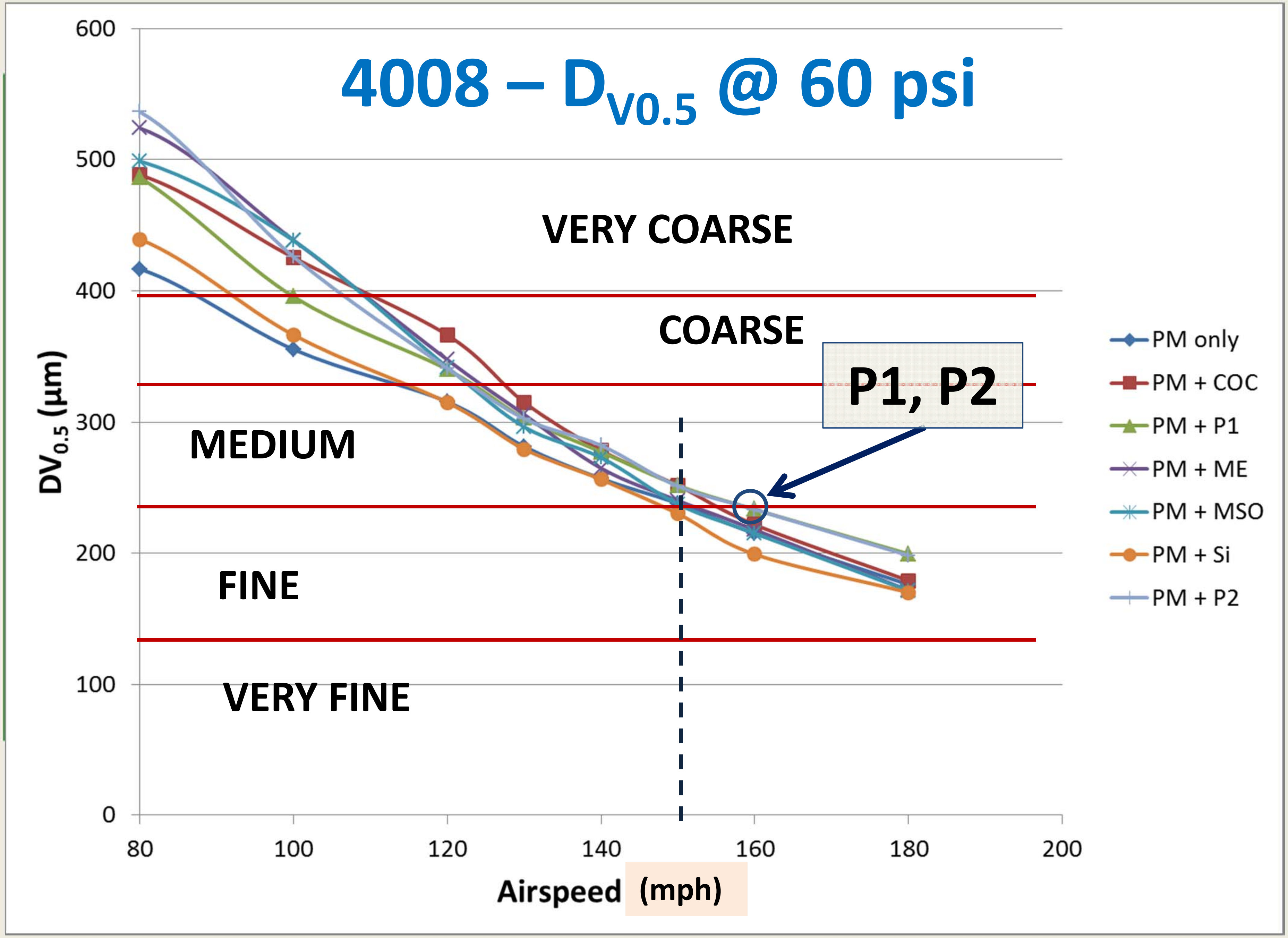
- Spray Solutions
  - PowerMax only (PM)
  - PM + crop oil concentrate (PM+COC)
  - PM + micro emulsion (PM+ME)
  - PM + methylated seed oil (PM+MSO)
  - PM + silicone surfactant (PM+Si)
  - PM + polymer 1 (PM+P1)
  - PM + polymer 2 (PM+P2)

Nozzles Tested

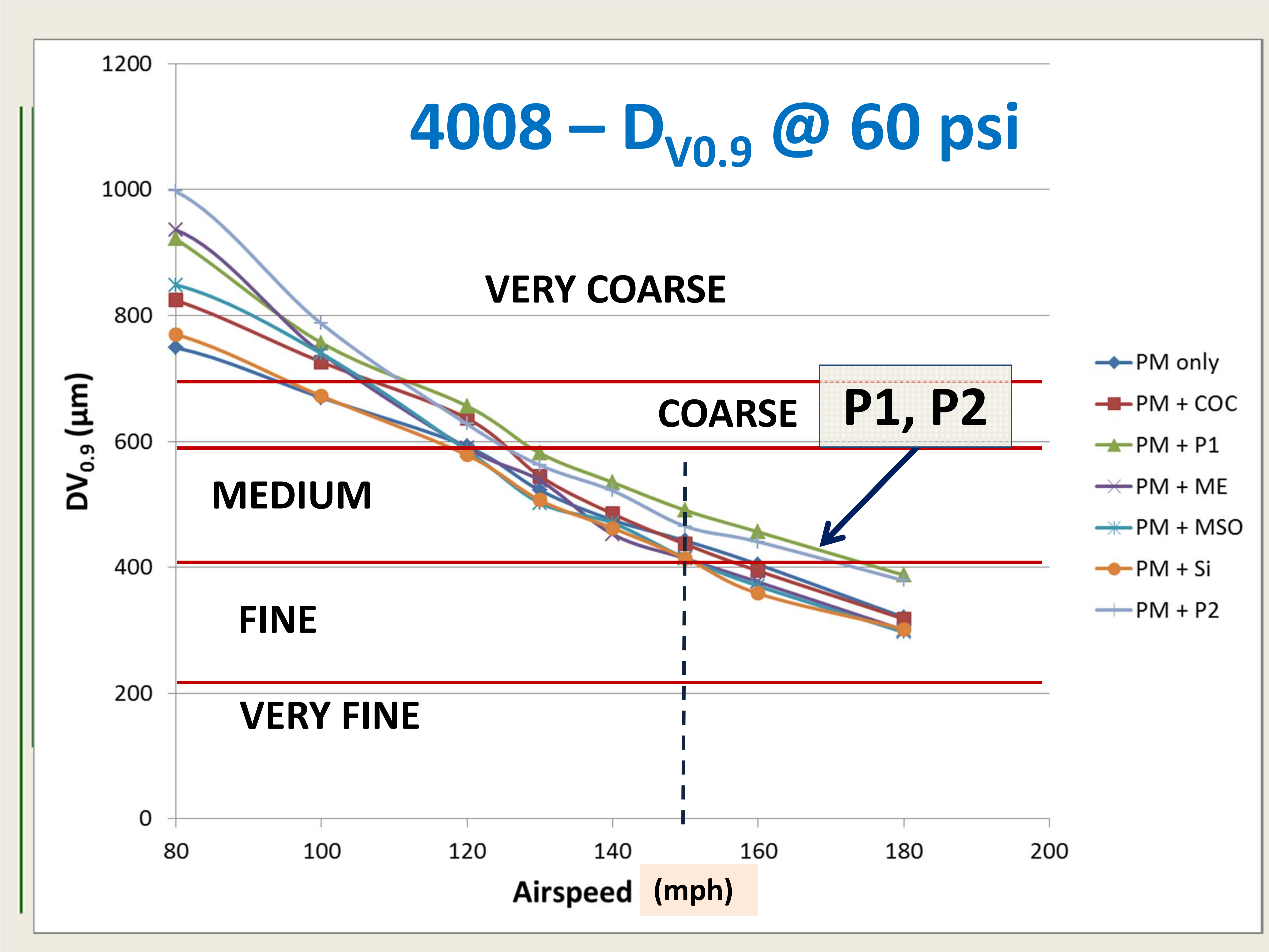
- Aerial Nozzles
  - CP11TT 4008 @ 8˚ deflection (Straight Back)
    - 40 and 60 psi
    - 15, 40, 60, 80, 100, 120, 130, 140, 150, 160, 180 mph
  - Micronair AU4000 #2 orifice and 6000 rpm
    - 40 psi
    - 120, 140, and 160 mph
      - Blade angles adjusted each airspeed to set at 6000 rpm

Wind Tunnel Testing

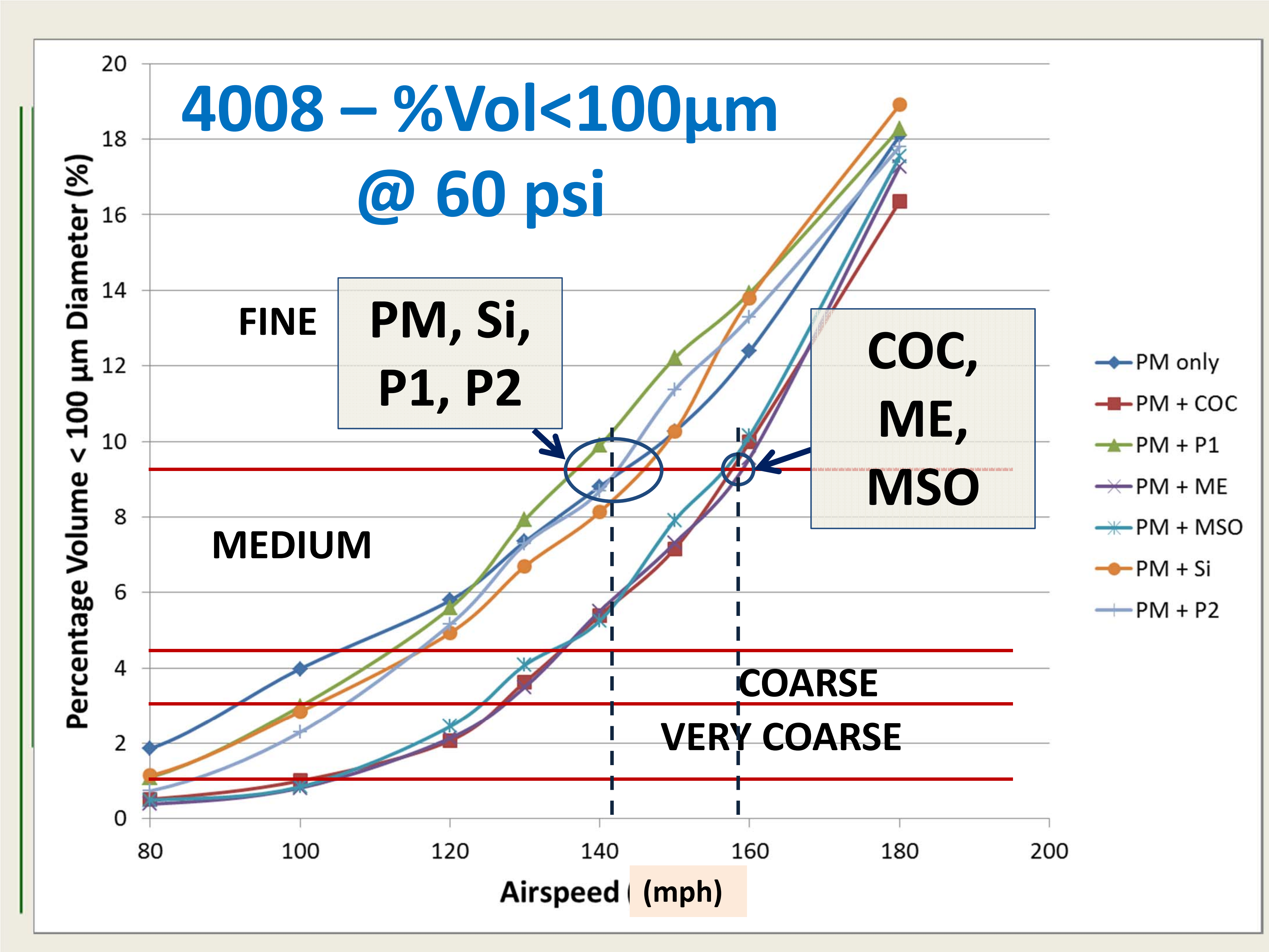

4008 – $D_{V0.1}$ @ 60 psi
300
250
200
150
100
50
0
$DV_{0.1}$ (µm)
VERY COARSE
COARSE
MEDIUM
FINE
VERY FINE
COC, ME, MSO
PM, Si, P1, P2
80
100
120
140
160
180
200
Airspeed (mph)
PM only
PM + COC
PM + P1
PM + ME
PM + MSO
PM + Si
PM + P2



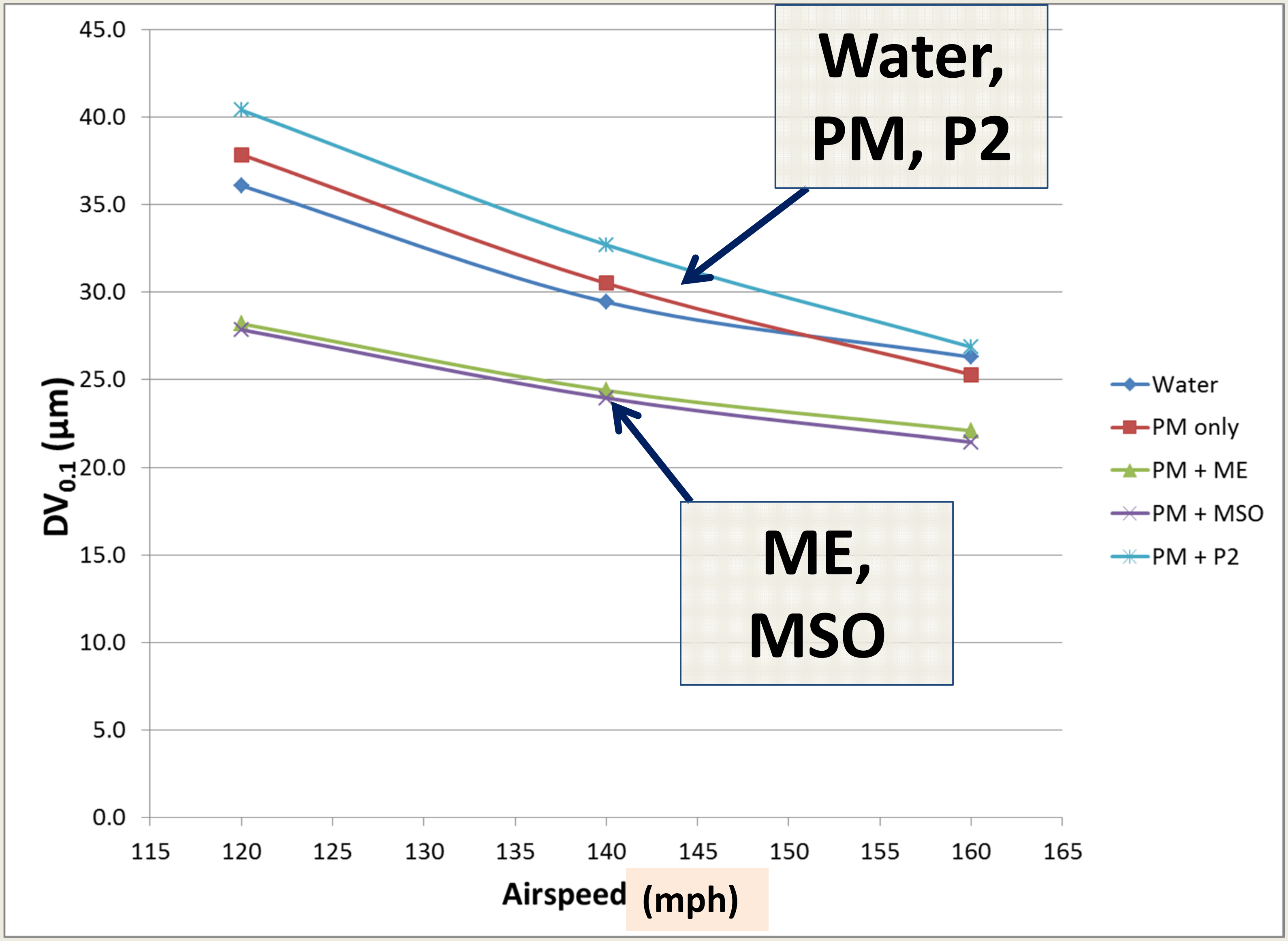
4008 – DV0.5 @ 60 psi
VERY COARSE
COARSE
MEDIUM
FINE
VERY FINE
P1, P2
DV0.5 (µm)
Airspeed (mph)
600
500
400
300
200
100
0
80
100
120
140
160
180
200
PM only
PM + COC
PM + P1
PM + ME
PM + MSO
PM + Si
PM + P2



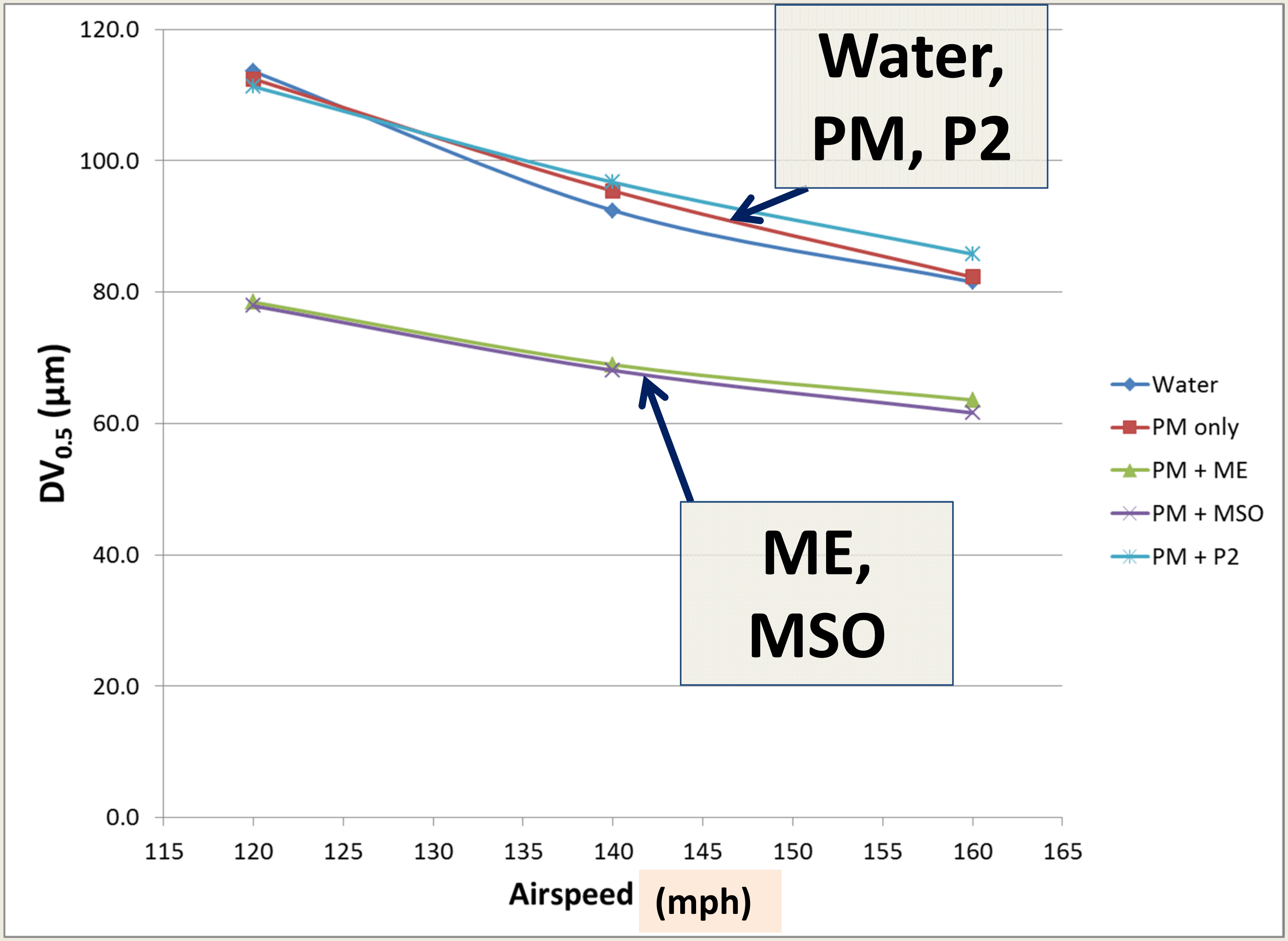
4008 – $D_{V0.9}$ @ 60 psi
$DV_{0.9}$ (µm)
Airspeed (mph)
VERY COARSE
COARSE
MEDIUM
FINE
VERY FINE
P1, P2
0
200
400
600
800
1000
1200
80
100
120
140
160
180
200
PM only
PM + COC
PM + P1
PM + ME
PM + MSO
PM + Si
PM + P2


4008 – %Vol<100µm @ 60 psi
Percentage Volume < 100 µm Diameter (%)
Airspeed (mph)
FINE
MEDIUM
COARSE
VERY COARSE
PM, Si, P1, P2
COC, ME, MSO
PM only
PM + COC
PM + P1
PM + ME
PM + MSO
PM + Si
PM + P2
0
2
4
6
8
10
12
14
16
18
20
80
100
120
140
160
180
200

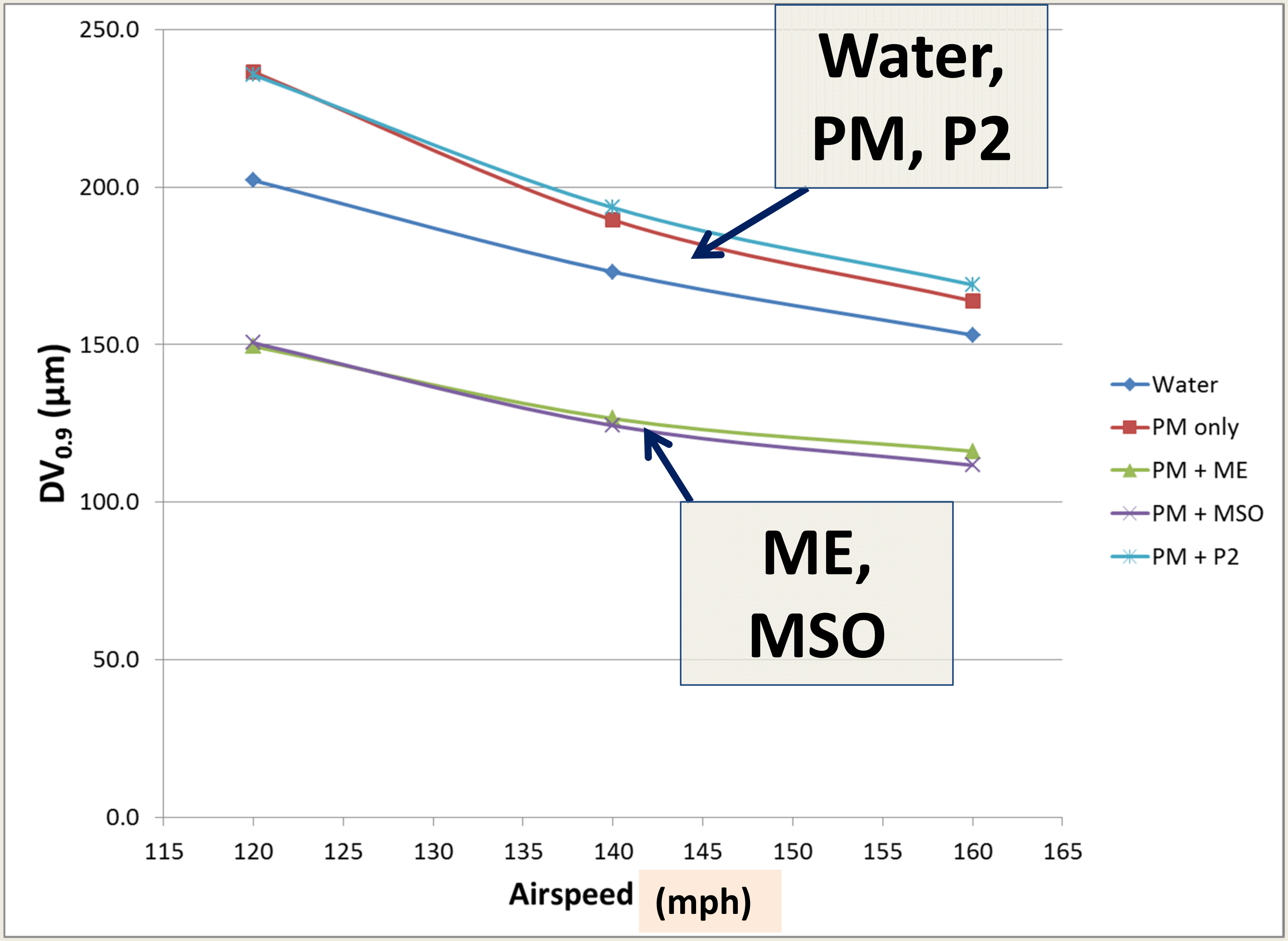
AU4000– $D_{V0.1}$ @ 40 psi



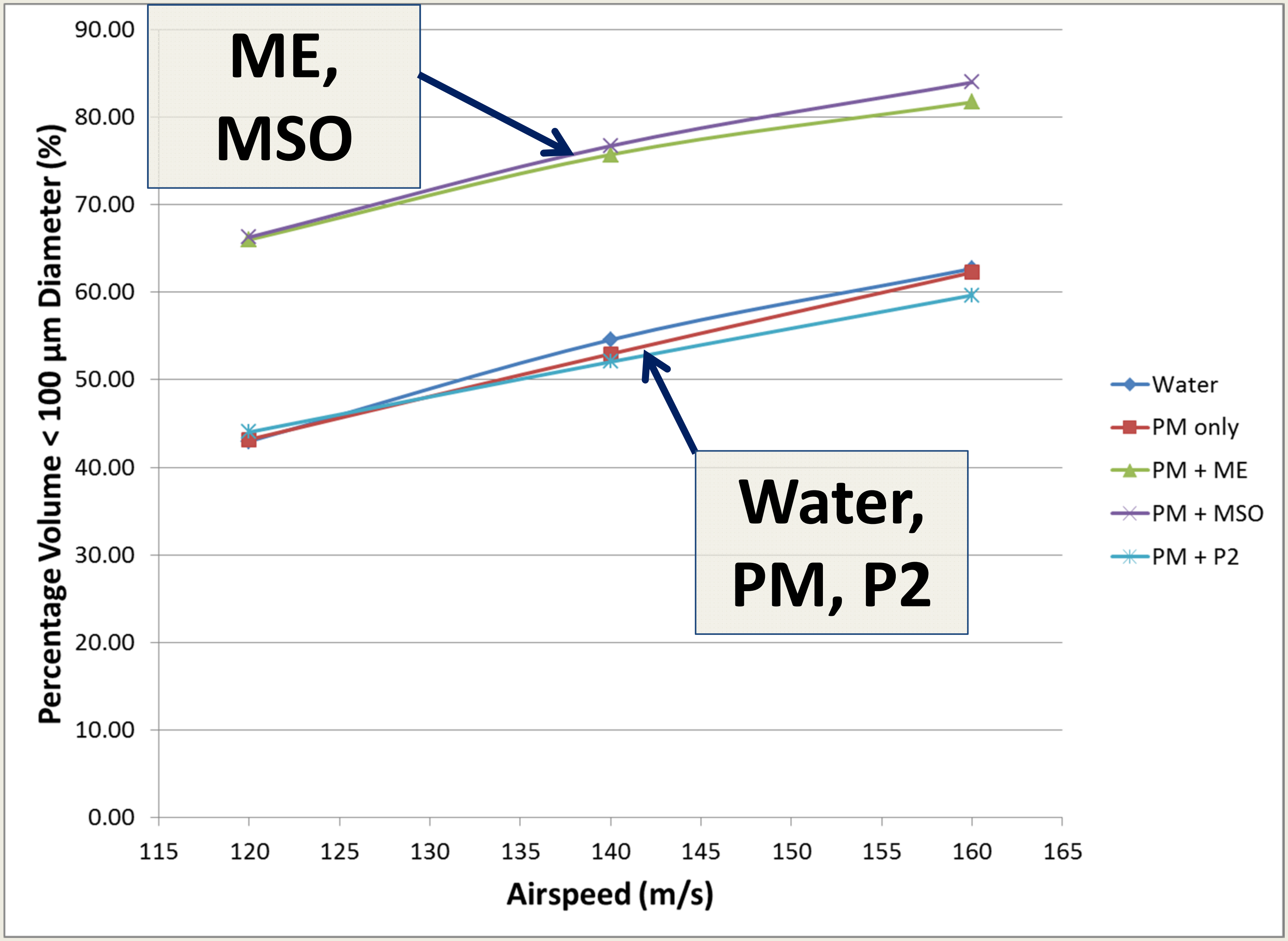
AU4000– $D_{V0.5}$ @ 40 psi



AU4000– $D_{V0.9}$ @ 40 psi



AU4000– %Vol<100µm @ 40 psi



Conclusions

- Airspeed effect
  - Past 160 mph
    - While solution effects were present, they were minimal – typically less than 3-4%
  - 4008 versus AU4000
    - Different response to the adjuvants
    - Coupled with ground nozzle (not presented here)
      - Whole system effects (nozzle + a.i. + adjuvant + other) have to be considered together.

Conclusions

- Flat Fan Nozzles
  - For the solutions tested:
    - Oil based adjuvants reduced volume of fine droplets (larger $D_{V0.1}$ values)
    - The silicone and two polymers had little effect on $D_{V0.1}$ compared to PM alone.
    - The oil based adjuvants (COC, ME, MSO) resulted in FINE spray above 160 mph
    - The remaining solutions (PM, Si, P1, P2) resulted in FINE sprays above 140-145 mph
      - Spray quality was driven by the $D_{V0.1}$ values
    - The two polymers increased both the $D_{V0.5}$ and $D_{V0.9}$
    - Little difference between remaining solutions' $D_{V0.5}$ and $D_{V0.9}$

Conclusions

- Rotary Nozzles
  - The setup used in testing would not be typical of a herbicide application.
    - Was setup for this work only
  - Saw a reversing of trends with adjuvants tested.
    - The ME and MSO created more fines (smaller $D_{V0.1}$ values) compared to PM and ploymer.

Conclusions

- Adjuvant effect likely not consistent across different nozzle types, formulated products and tank mixes.
  - Talk to your local distributor
  - Adjuvants have their place and should be considered on a case by case basis.
- Everything you add to your tank potentially affects droplet size.
- **>160 mph = FINE spray (in most cases)**

Variation in Tank Mix Atomization

Russ Stocker

Droplet size
is the most important factor
in spray management

Droplet size is
the most important factor
in spray management -
that we have control over

Elements of Control

- Nozzle selection
- Nozzle orifice size
- Nozzle (fluid) pressure
- Nozzle orientation
- Air speed
- Tank mix

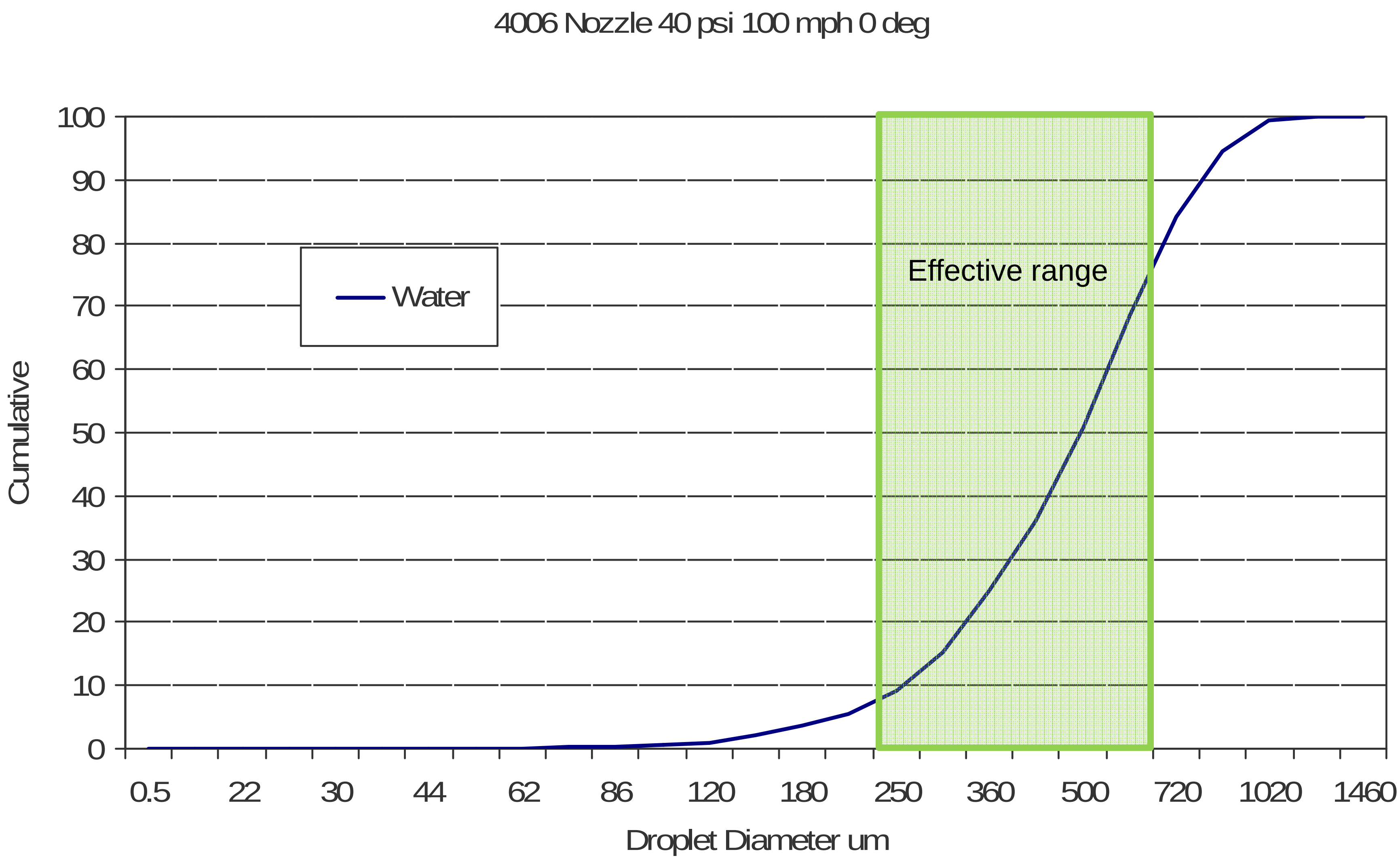
Tank mix elements include

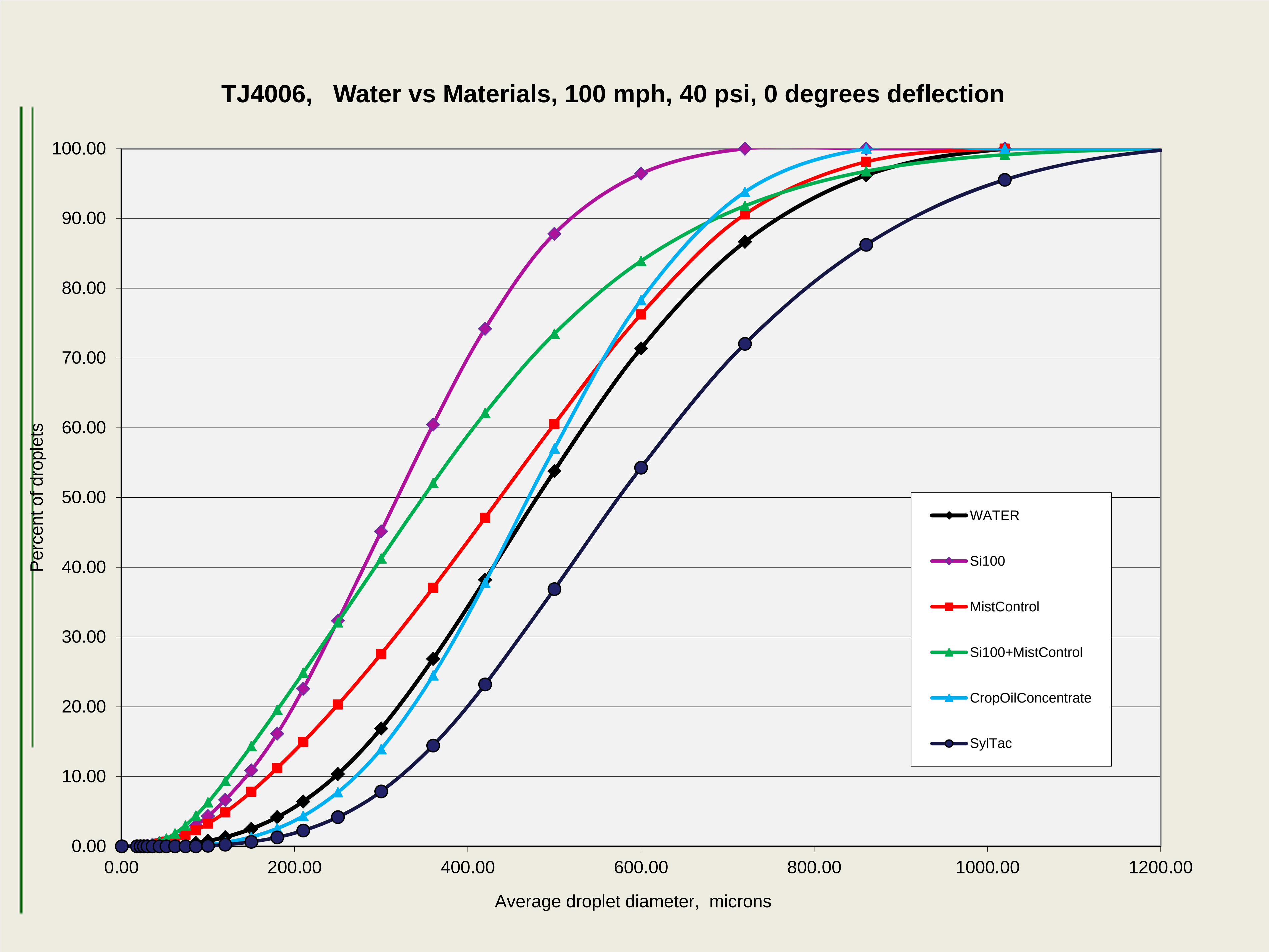
- Water
- Product to be used
- Added adjuvants
  - stickers
  - spreaders
  - drift control agents

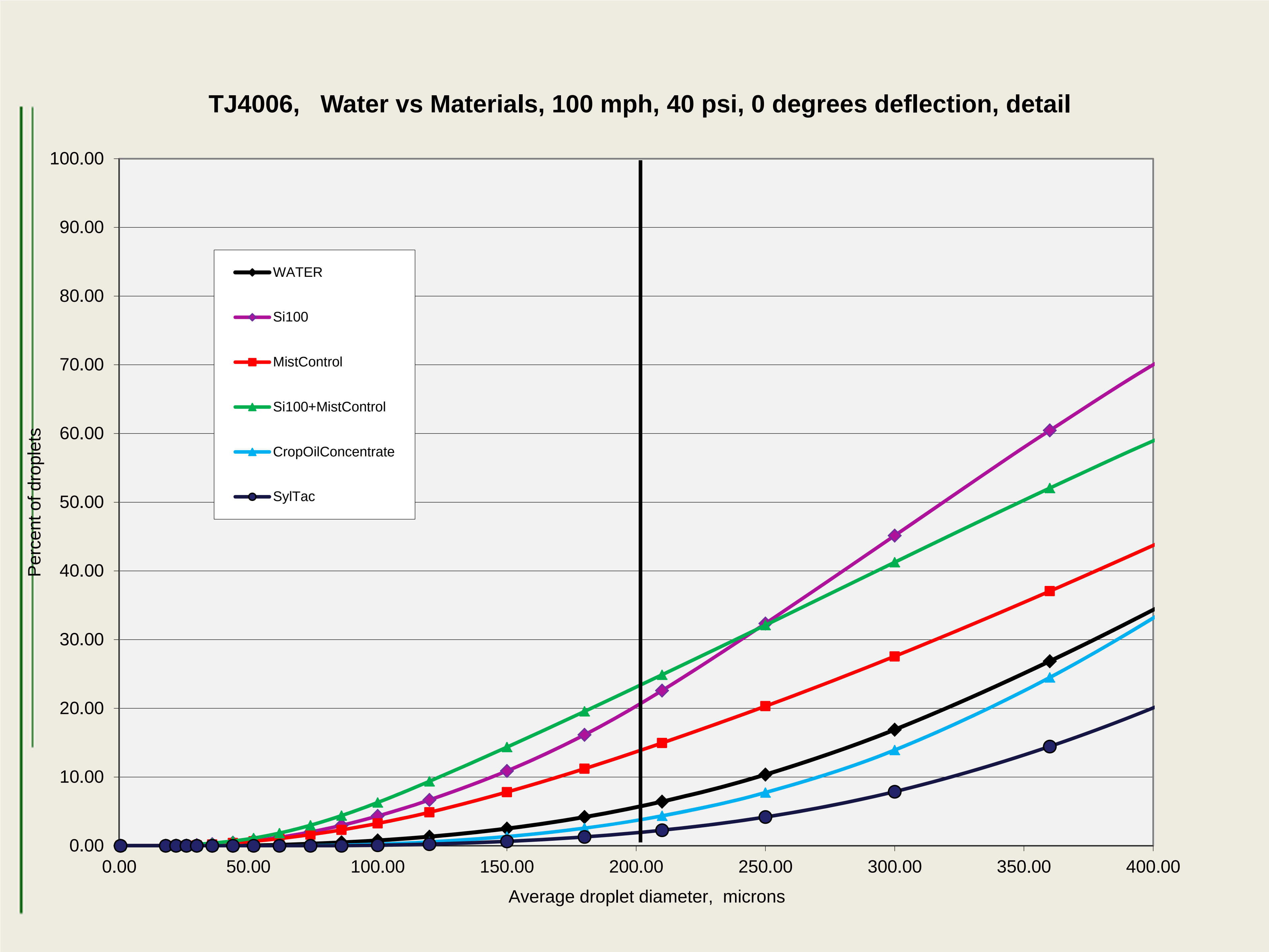
Elements of tank mix effecting atomization

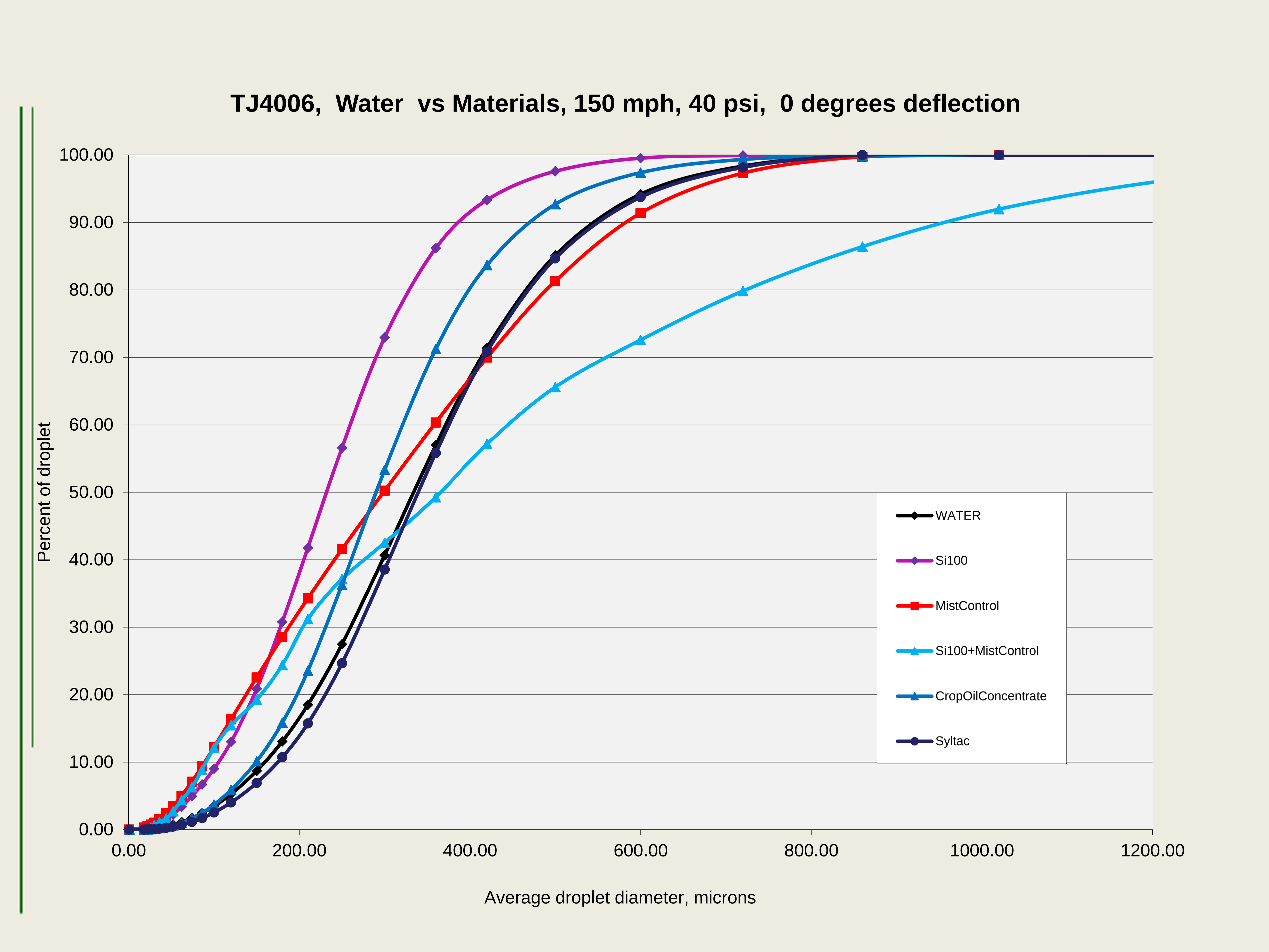
- Dynamic surface tension
- Equilibrium surface tension
- Extensional viscosity
- Shear viscosity

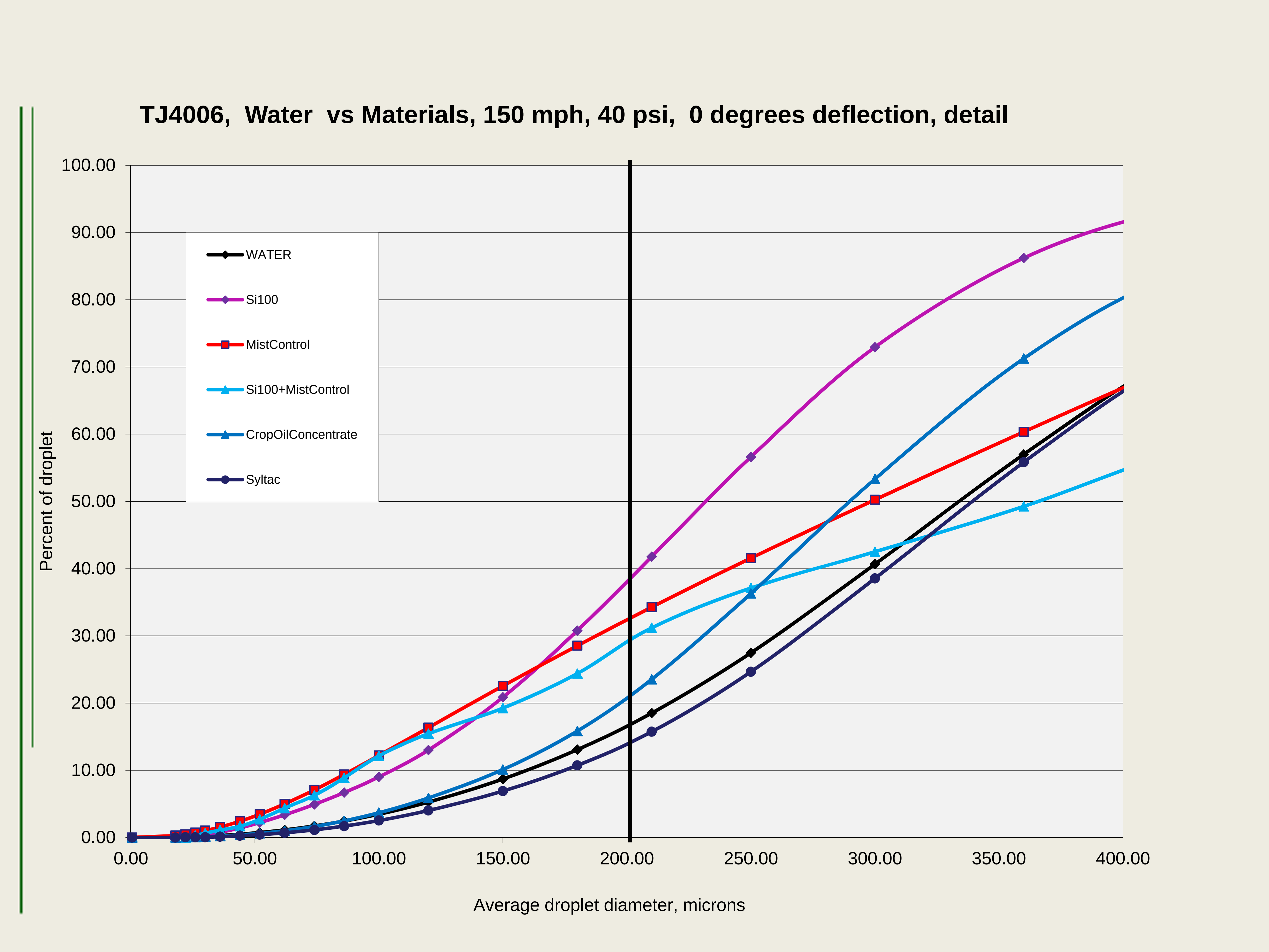
Effective droplet range



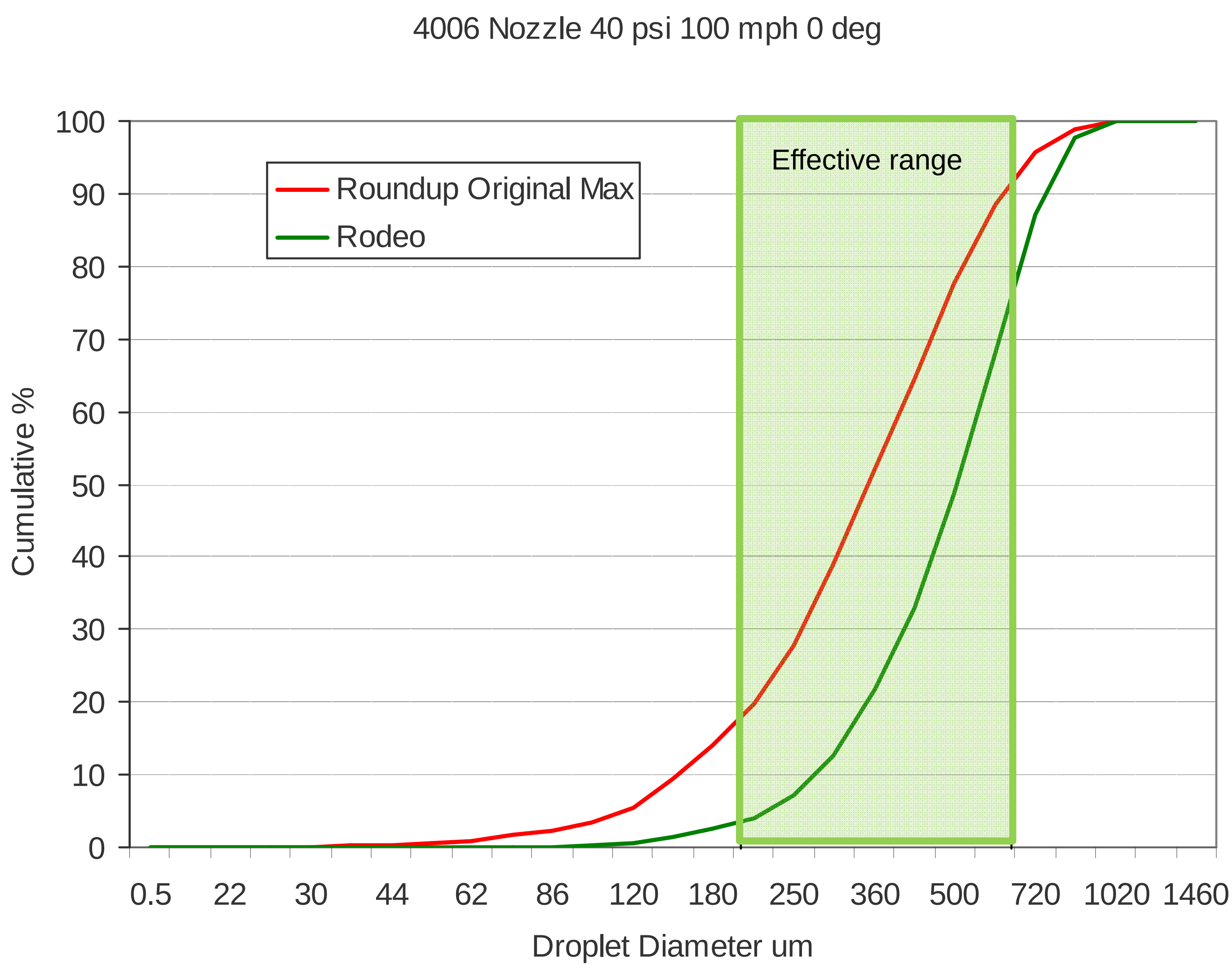

TJ4006, Water vs Materials, 100 mph, 40 psi, 0 degrees deflection
Percent of droplets
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.00
200.00
400.00
600.00
800.00
1000.00
1200.00
Average droplet diameter, microns
WATER
Si100
MistControl
Si100+MistControl
CropOilConcentrate
SylTac


TJ4006, Water vs Materials, 100 mph, 40 psi, 0 degrees deflection, detail
Percent of droplets
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
Average droplet diameter, microns
WATER
Si100
MistControl
Si100+MistControl
CropOilConcentrate
SylTac


TJ4006, Water vs Materials, 150 mph, 40 psi, 0 degrees deflection
Percent of droplet
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.00
200.00
400.00
600.00
800.00
1000.00
1200.00
Average droplet diameter, microns
WATER
Si100
MistControl
Si100+MistControl
CropOilConcentrate
Syltac


TJ4006, Water vs Materials, 150 mph, 40 psi, 0 degrees deflection, detail
Percent of droplet
Average droplet diameter, microns
WATER
Si100
MistControl
Si100+MistControl
CropOilConcentrate
Syltac
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00

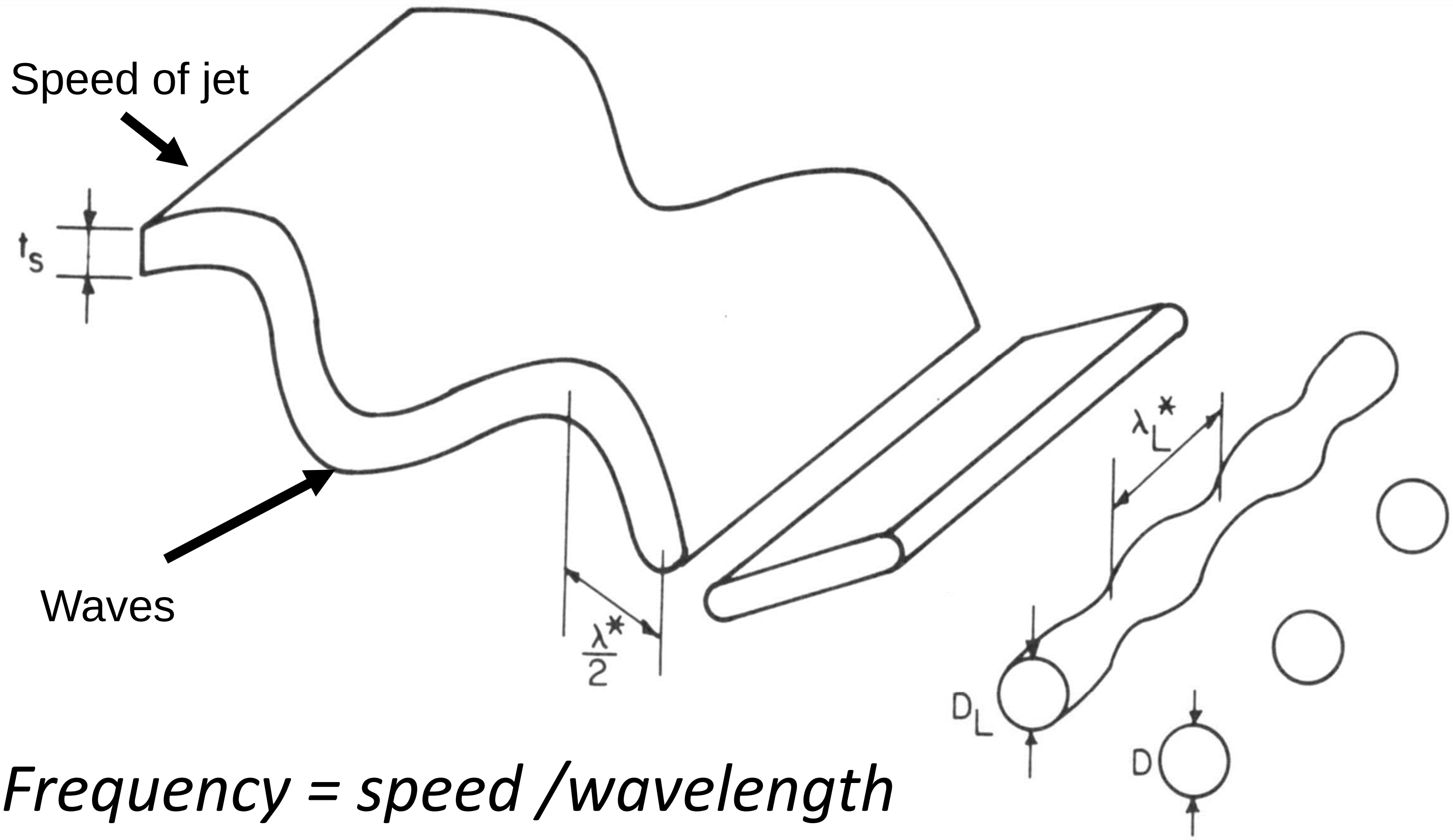
Effective droplet range



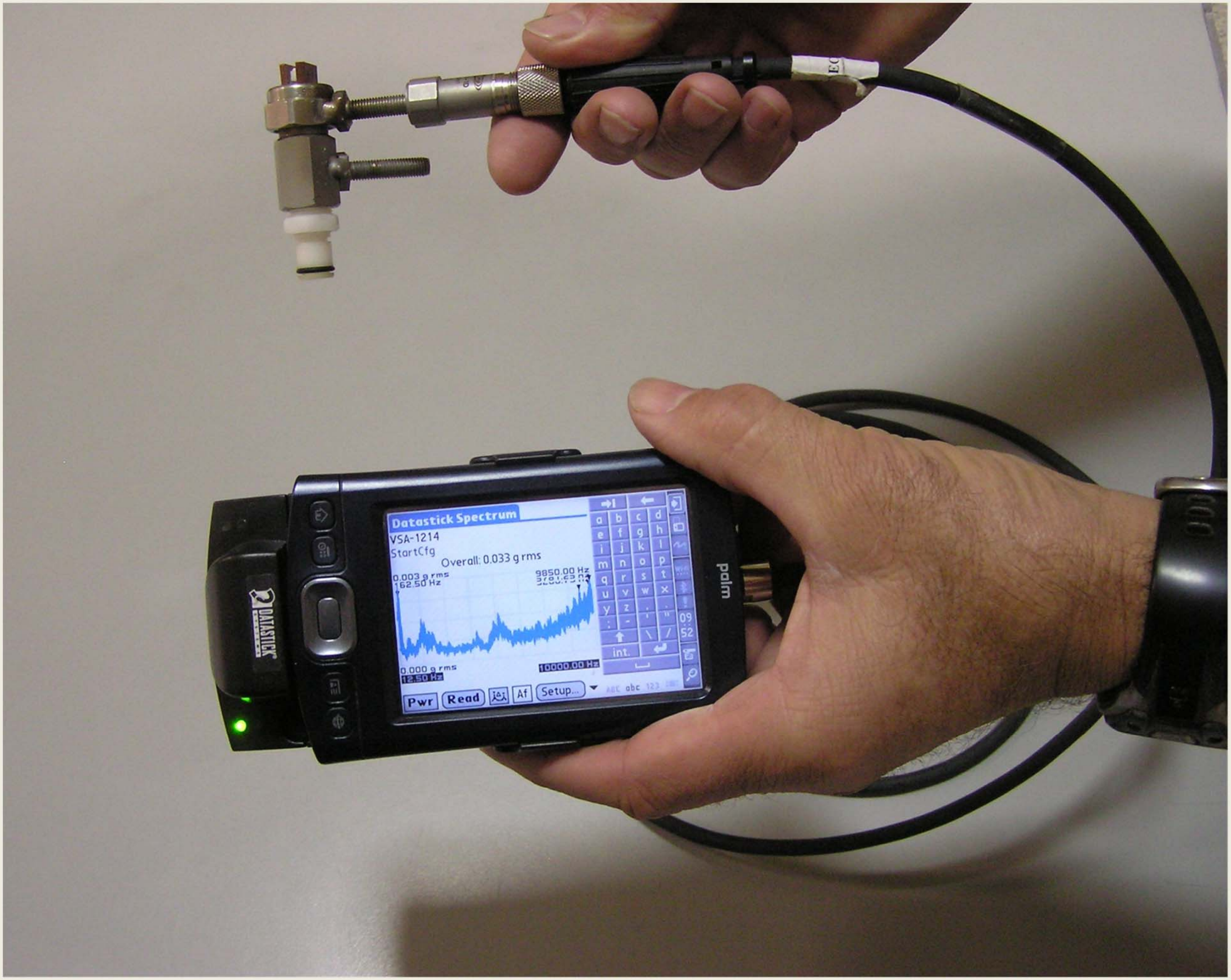
How do we evaluate a tank mix?

- Currently, we can’t
- New technology developments
- Evaluation of fluid vibration

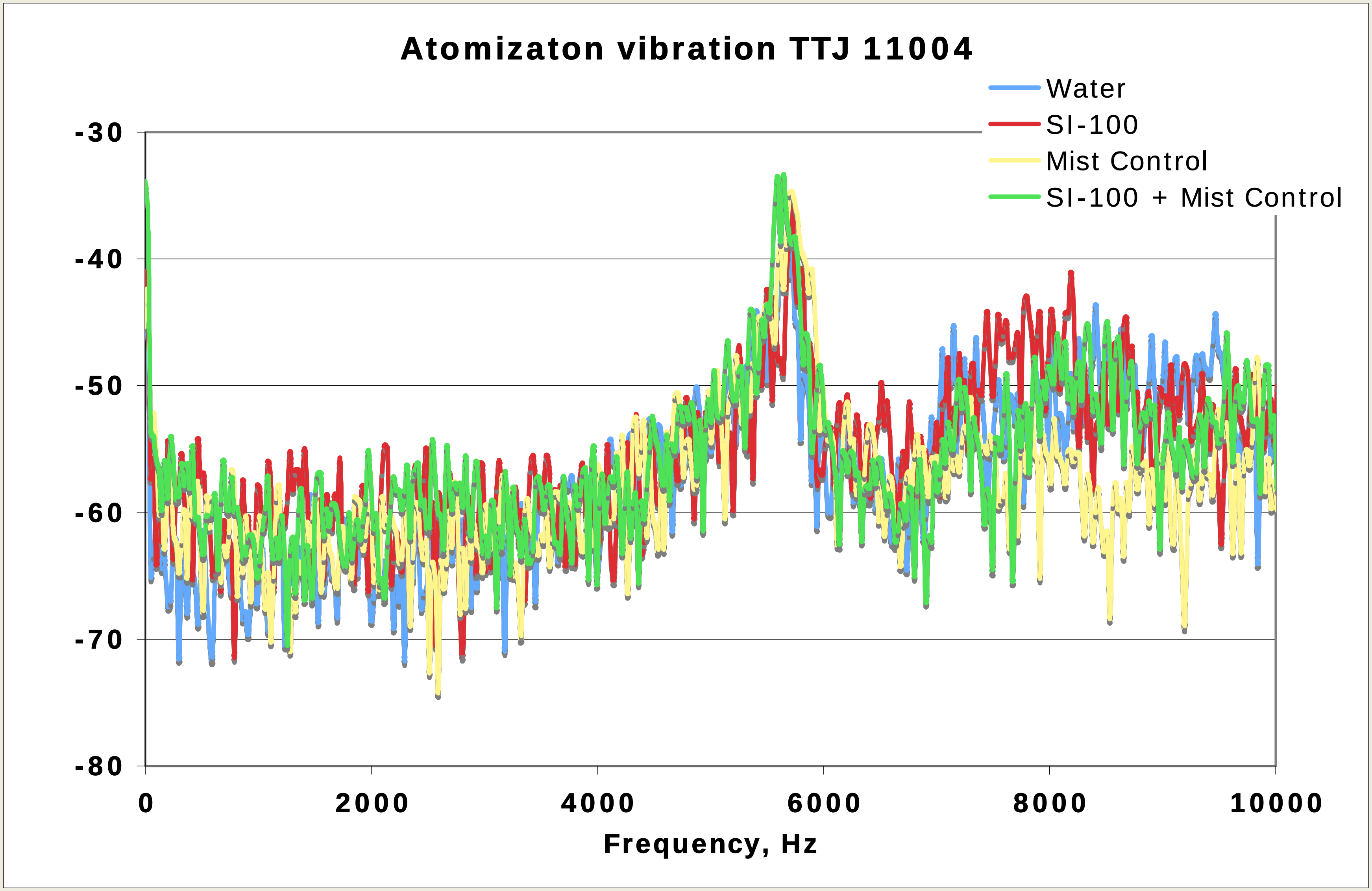
Spray droplet formation



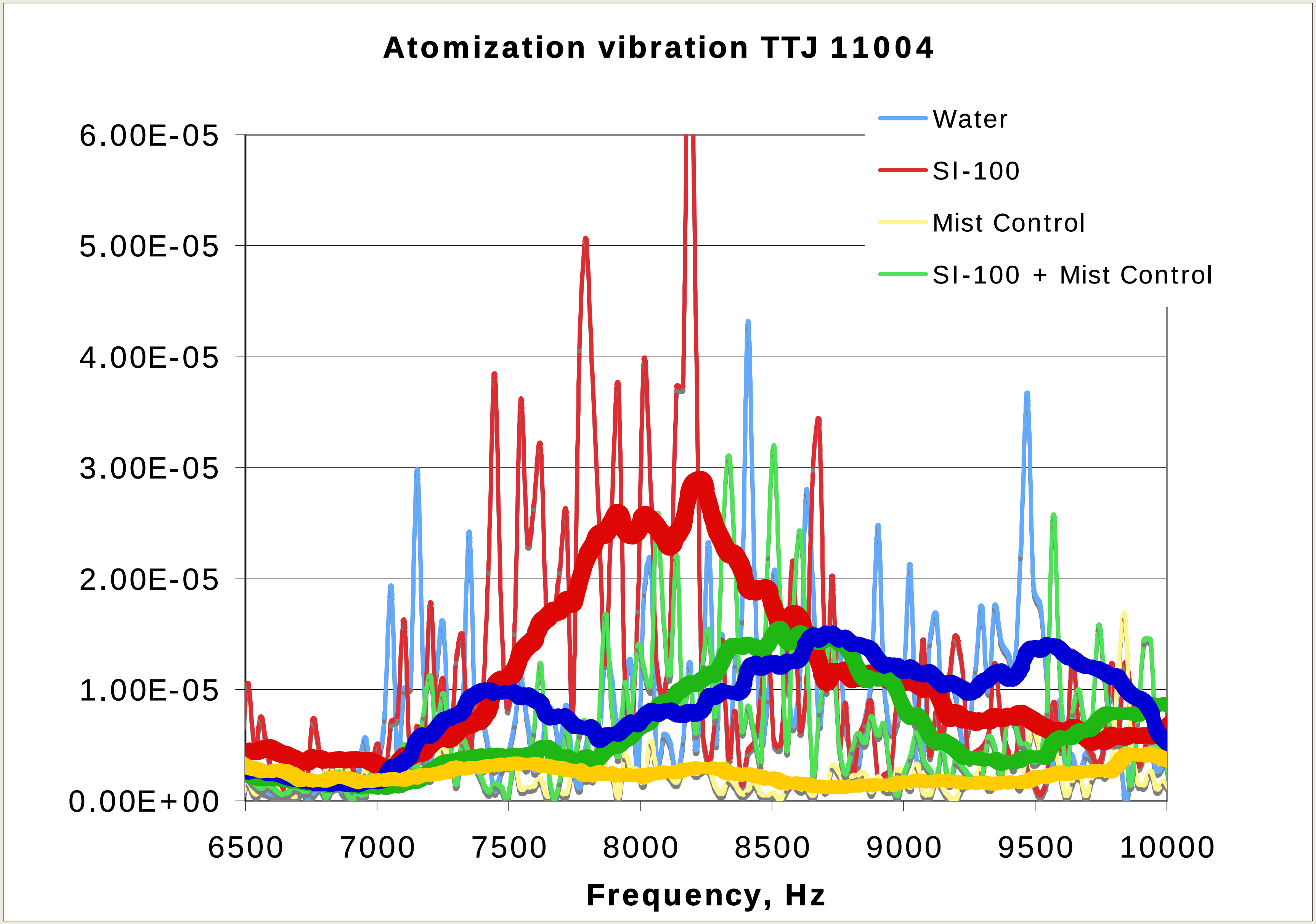
Frequency = speed /wavelength


Datastick Spectrum
VSA-1214
StartCfg
Overall: 0.033 g rms
0.003 g rms
162.50 Hz
9850.00 Hz
0.000 g rms
12.50 Hz
10000.00 Hz
Pwr
Read
Af
Setup...
palm

Nozzle vibration



Nozzle vibration



Conclusion

- Tank mix properties affect the droplet formation
- Currently there is no valid way to determine the atomization of a particular tank mix
- There are repeatable trends between vibration measurements and droplet size profiles produced by tank mixes

Conclusion

- As already known, tank mix properties affect the droplet size spectra produced by ag spray nozzles
- Currently there is no valid way to determine the atomization properties of a particular tank mix
- There are repeatable trends between vibration measurements and droplet size profiles produced by tank mixes

String System for Swath Uniformity Testing

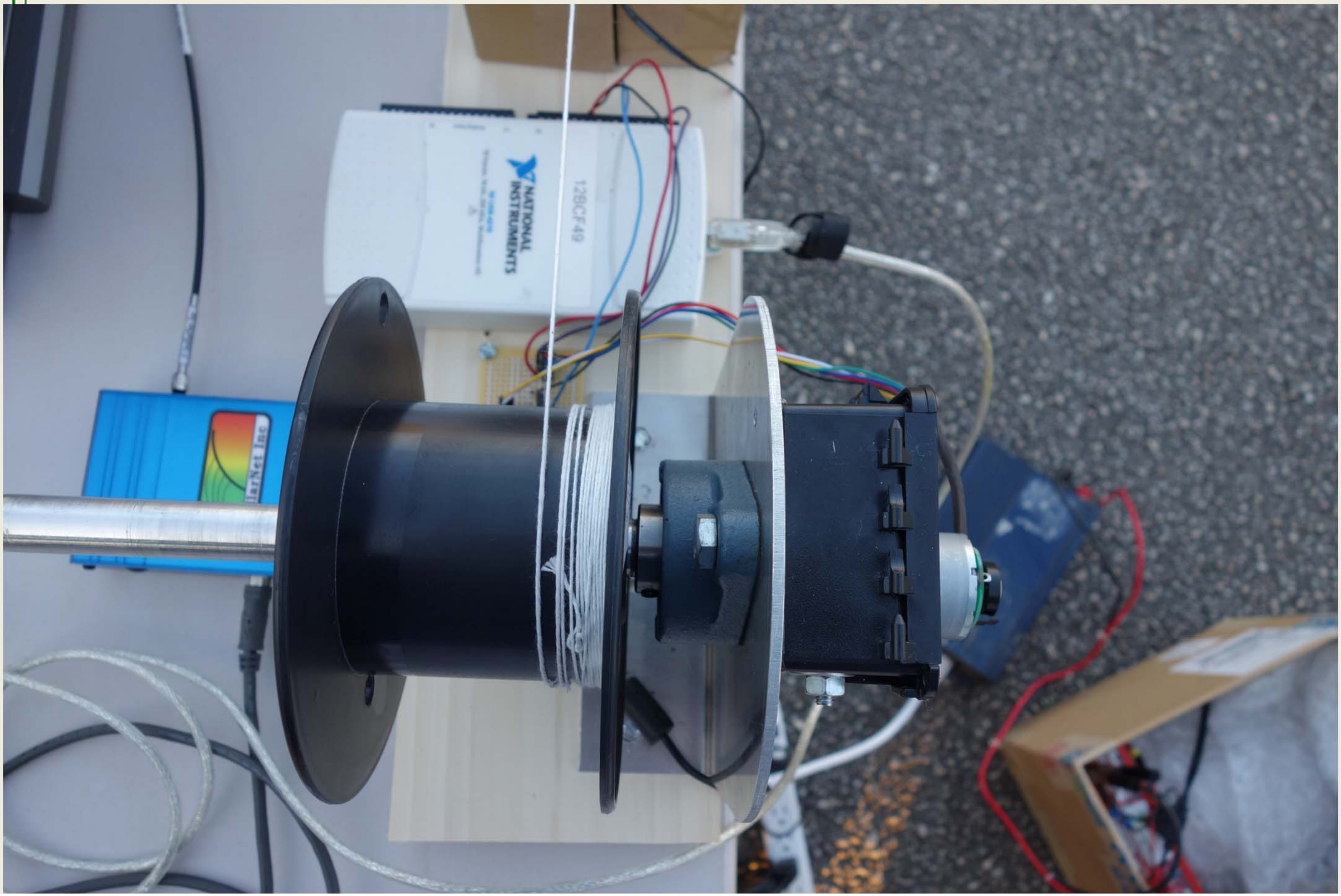
Clint Hoffmann

Introduction

- WRK String System has made and continues to make significant contributions to the aerial application industry;
- The weak link in this system is the Turner fluorometer;
- Our goal is to design a complimentary system using more modern components.

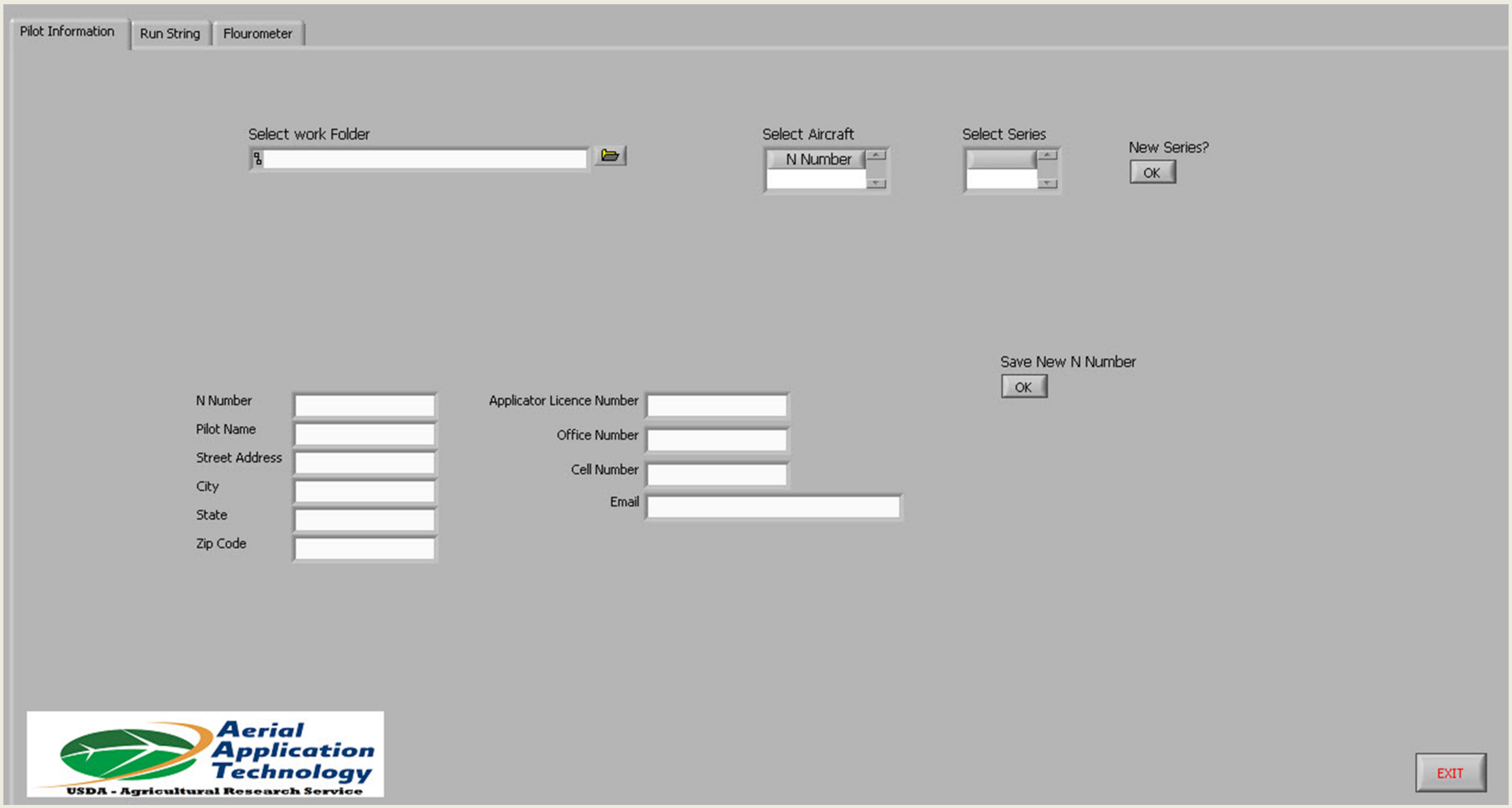
Design Features

- Similar to the existing equipment and easy to operate;
- String is analyzed as is brought in so that the turn around time is about 2 mins;
- Allow greater flexibility in data collection so that you can run 2 airplanes at the same time;
- Allow analyst to move swath patterns to account for shifting winds.

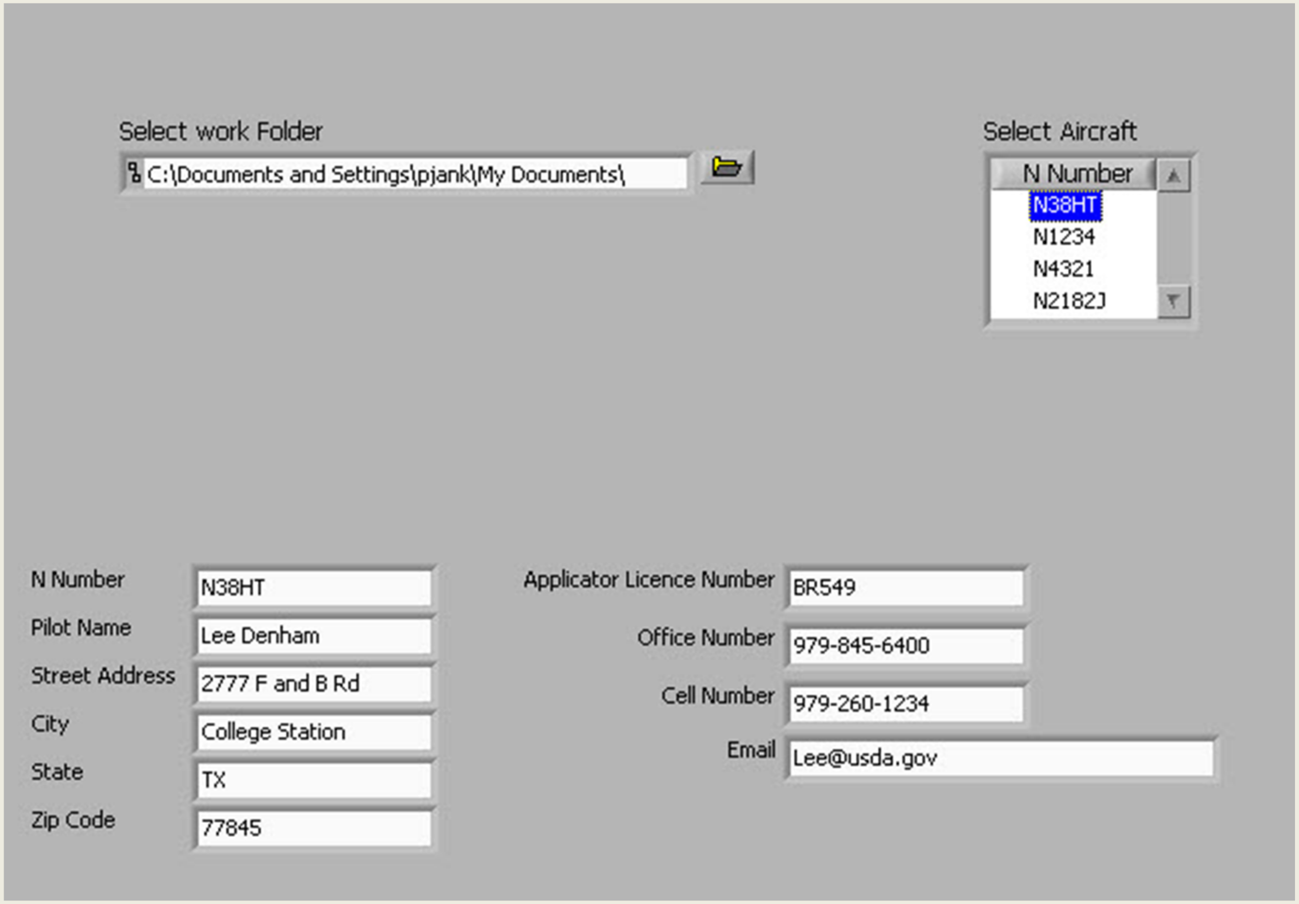

NATIONAL INSTRUMENTS
128CF49


USDA

Opening screen

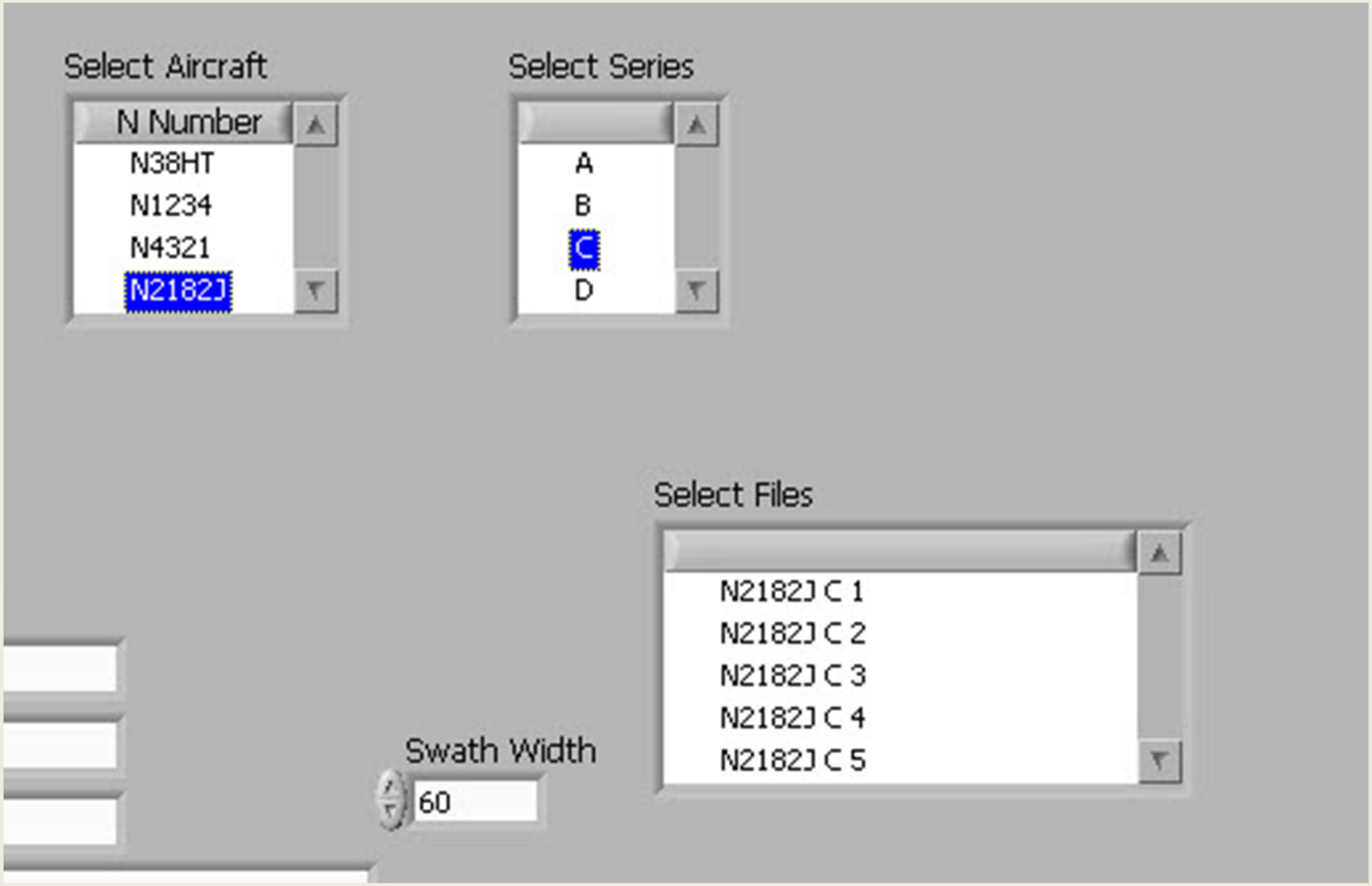


Auto data fill based on aircraft



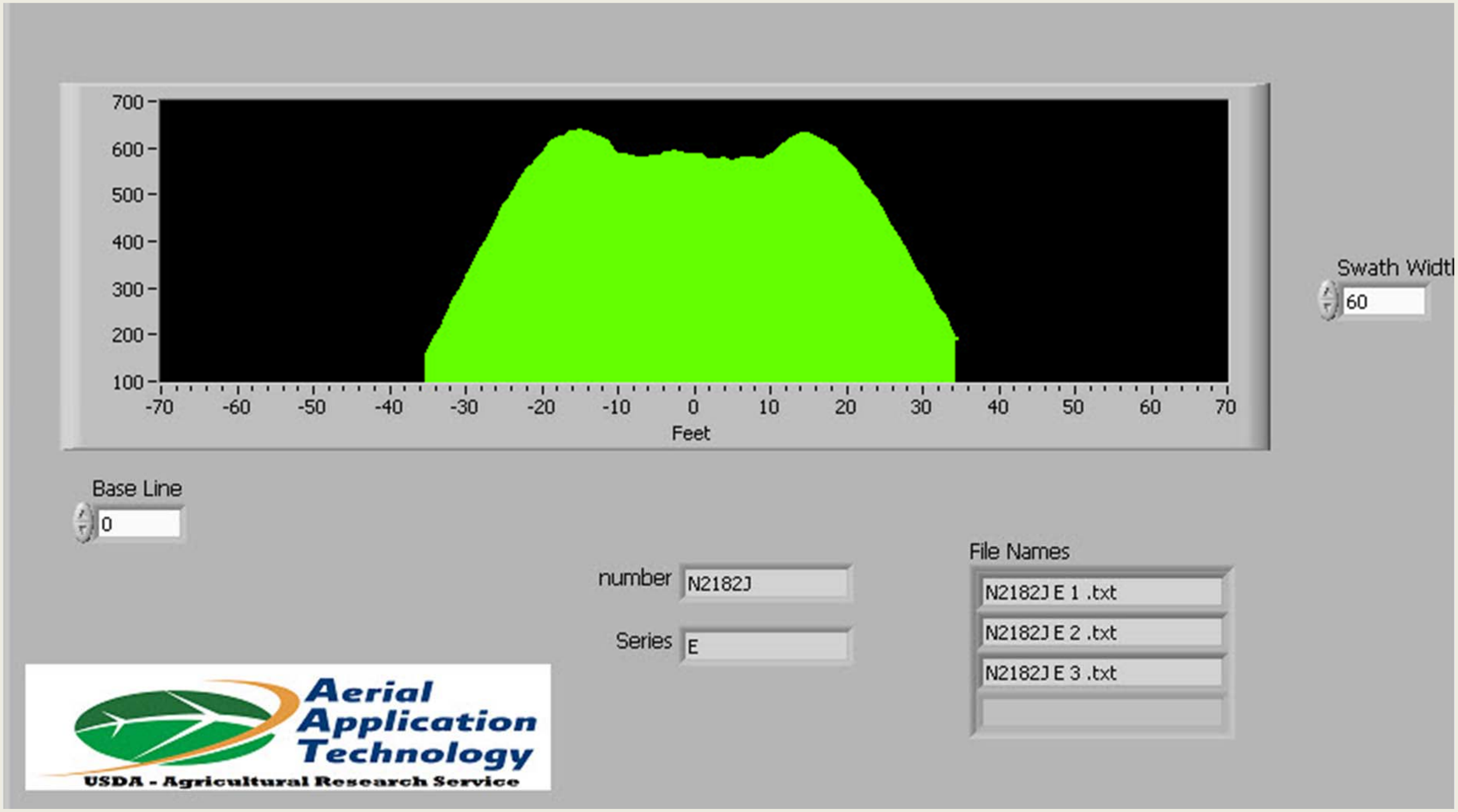
Bring in the data

Select the Spray Runs



Move the swaths to account for shifting winds

Processed Data



Cost

- ~$2500 right now for components
- $1000 for software license from LabView

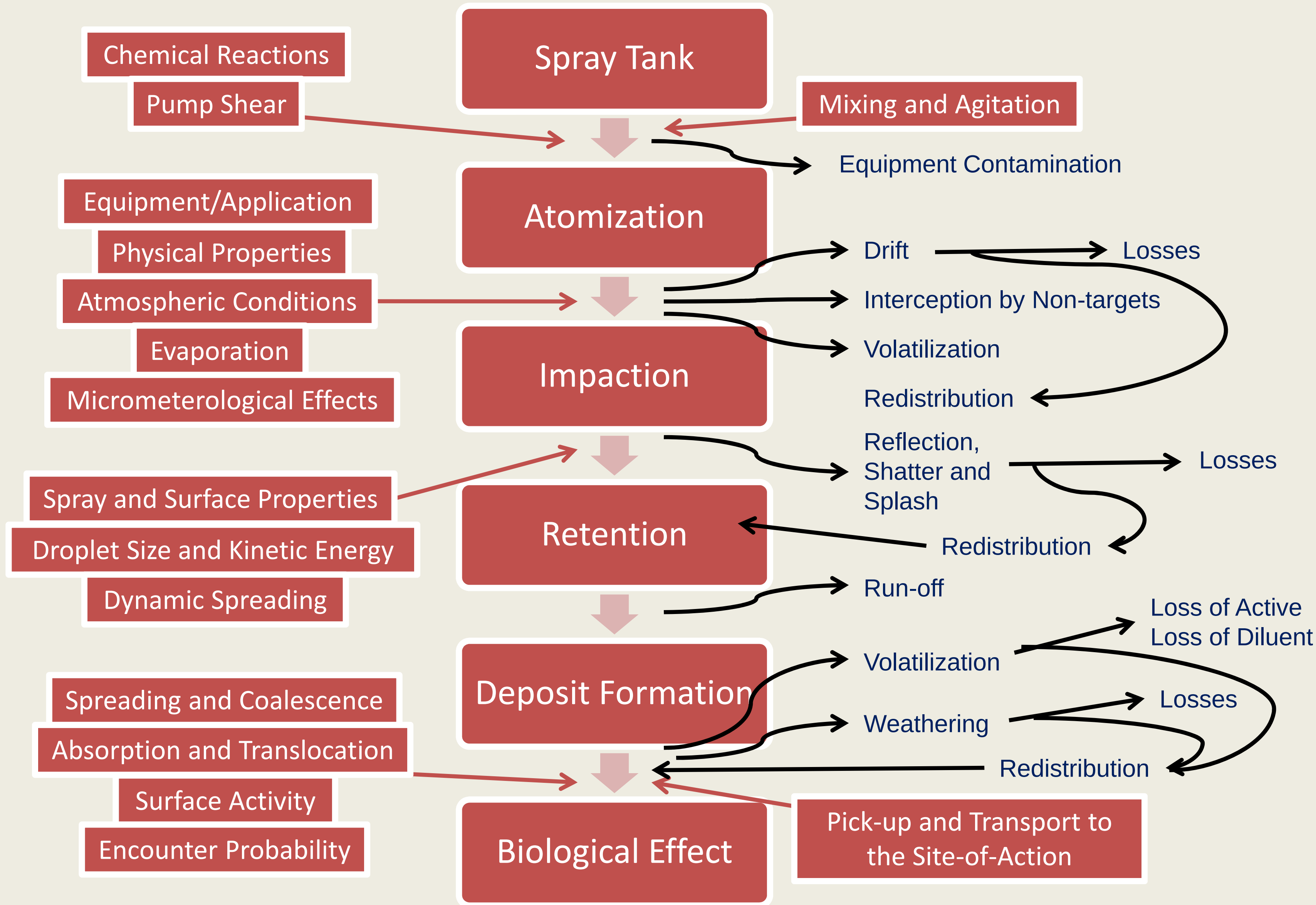
Conclusion

- Plan to have 2 systems in the field this spring with some SAFE analyst;
- Stay turned for future updates in Agricultural Aviation magazine.

Spray Quality and Efficacy

Kruger

Process for Pesticide Efficacy

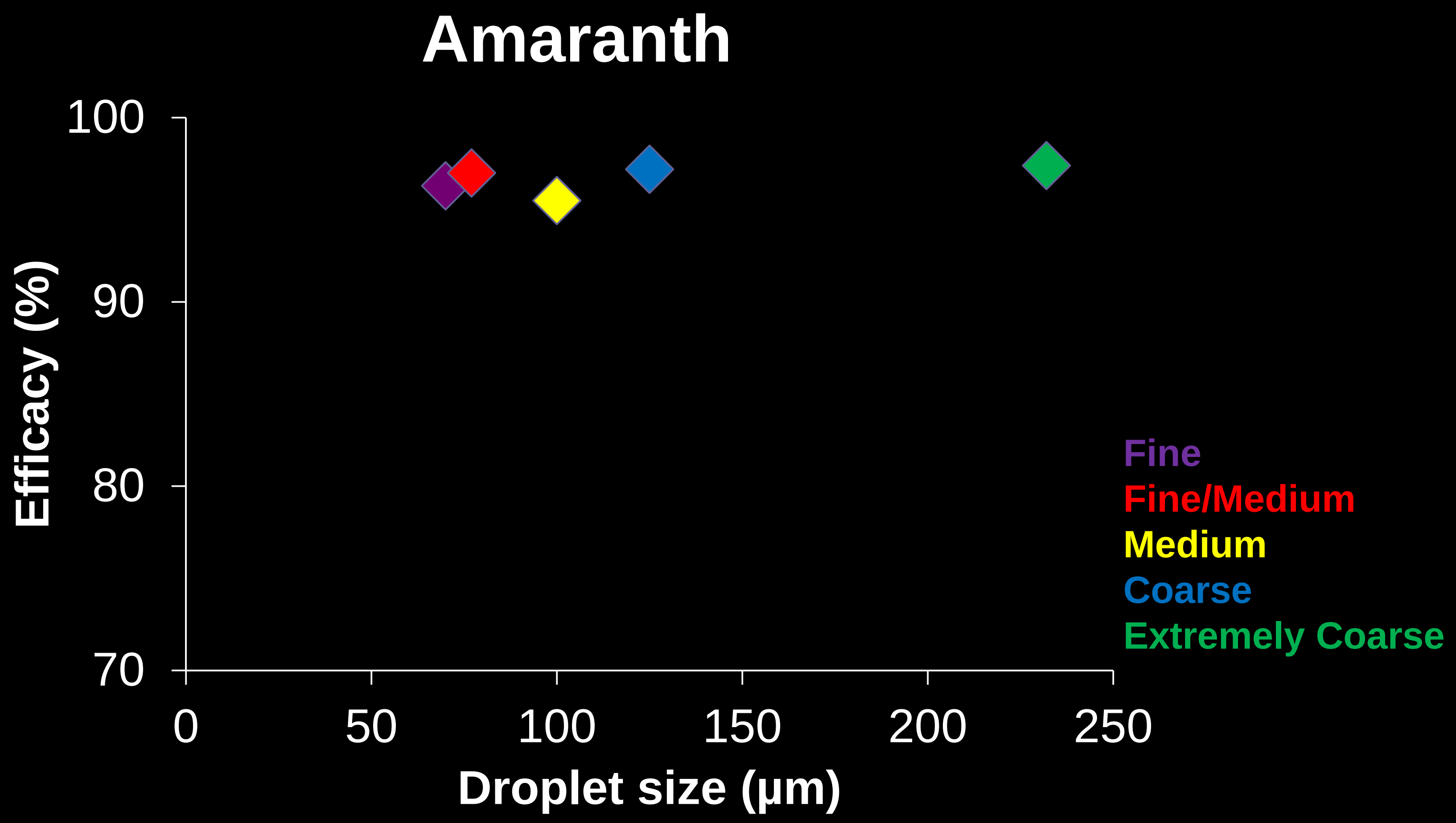


Ebert et al. 1999

2011 Field Studies

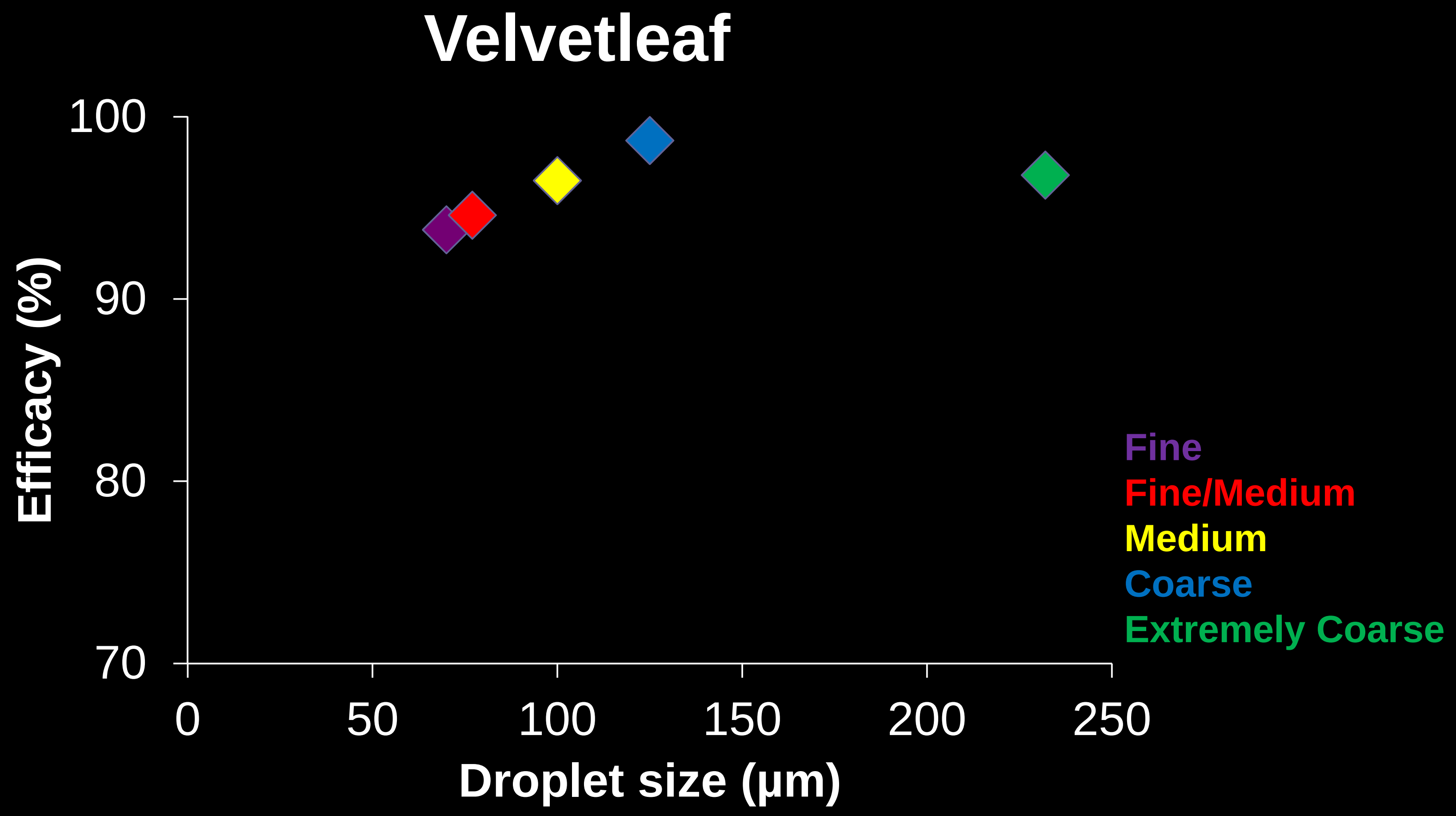
- Four locations in Nebraska
  - Bancroft, Clay Center, Courtland, Elba
- Four replications per location
- Five planted species
  - Amaranth, Flax, Velvetleaf, Soybean, Corn
- Five Nozzles plus an Untreated
  - XR11002 (Fine), XR11003 (Fine/Medium), TT11002 (Medium), AIXR11002 (Coarse), AI11002 (Extremely Coarse)

Glyphosate

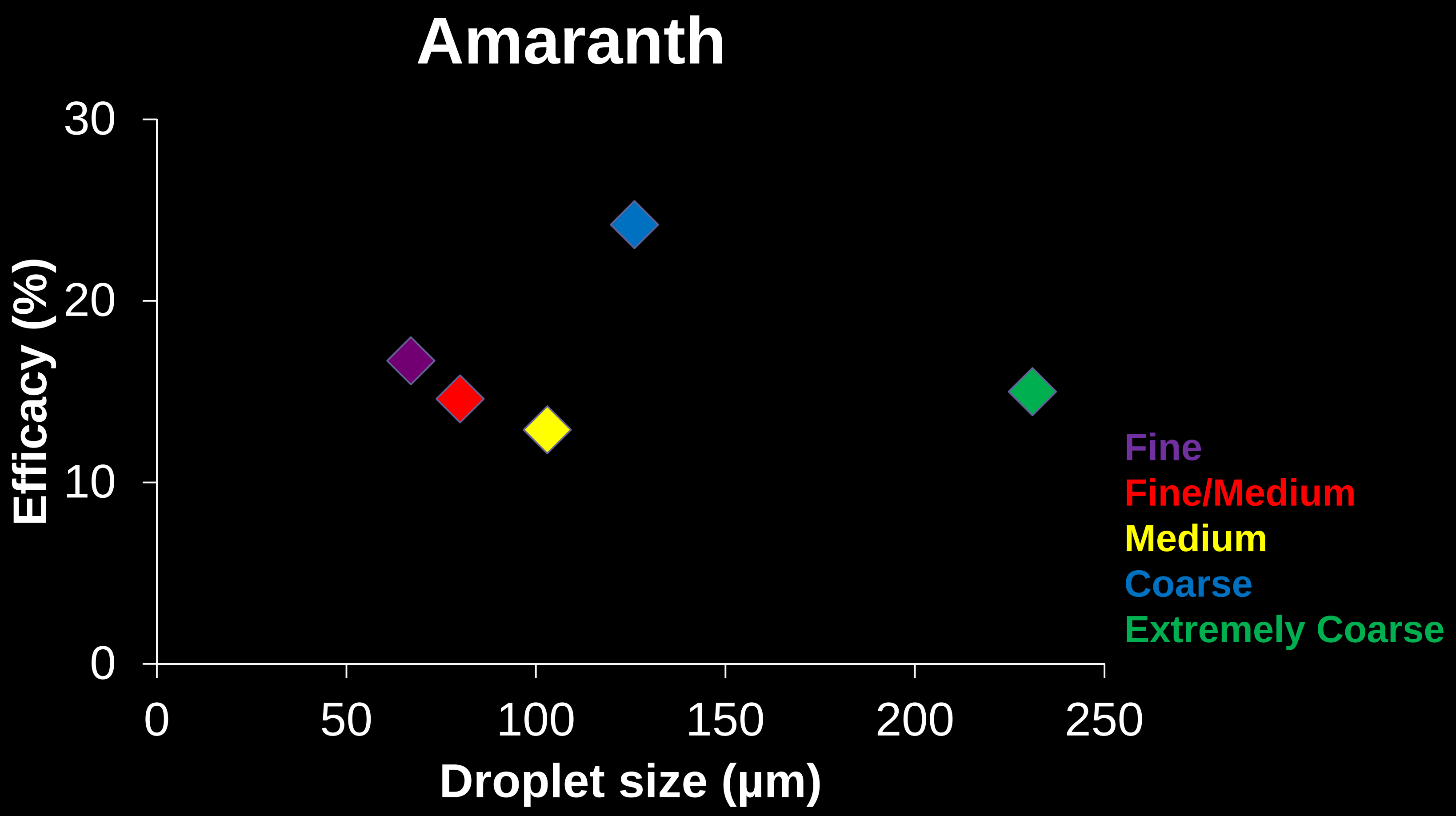


Amaranth
100
90
80
70
Efficacy (%)
0
50
100
150
200
250
Droplet size (µm)
Fine
Fine/Medium
Medium
Coarse
Extremely Coarse

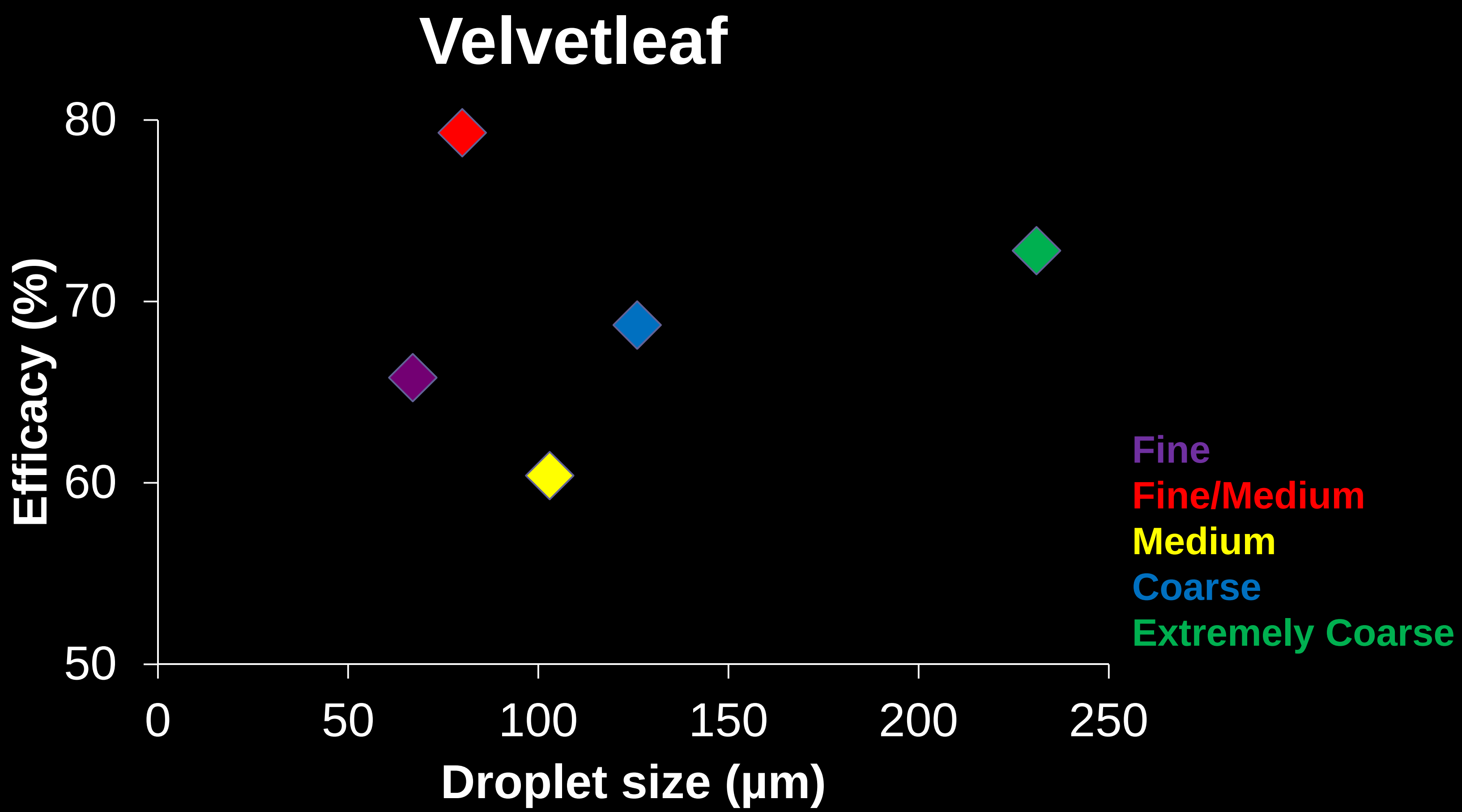
Glyphosate


Velvetleaf
Efficacy (%)
100
90
80
70
0
50
100
150
200
250
Droplet size (µm)
Fine
Fine/Medium
Medium
Coarse
Extremely Coarse

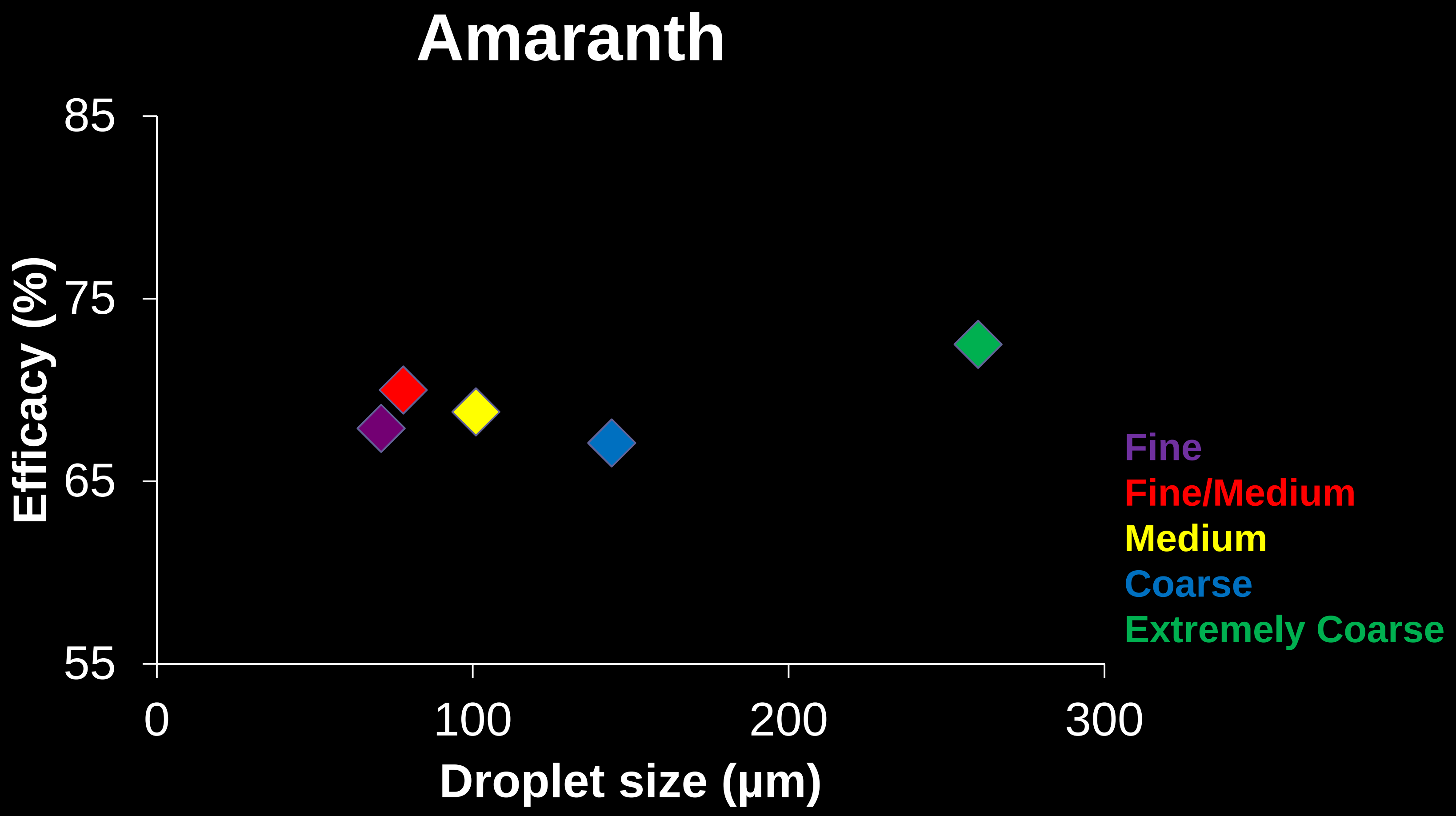
FirstRate


Amaranth
Efficacy (%)
30
20
10
0
0
50
100
150
200
250
Droplet size (µm)
Fine
Fine/Medium
Medium
Coarse
Extremely Coarse

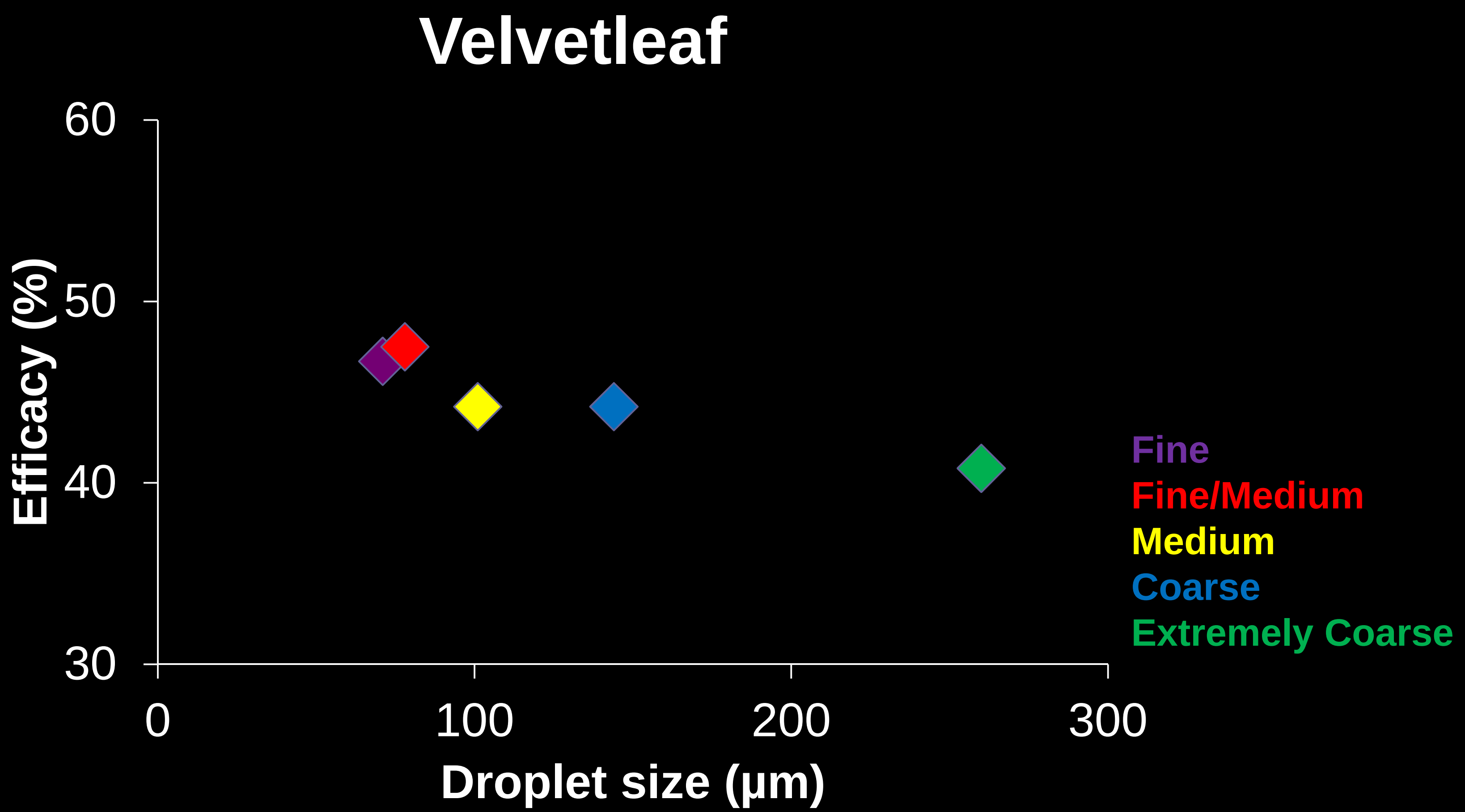
FirstRate


Velvetleaf
80
70
60
50
0
50
100
150
200
250
Efficacy (%)
Droplet size (µm)
Fine
Fine/Medium
Medium
Coarse
Extremely Coarse

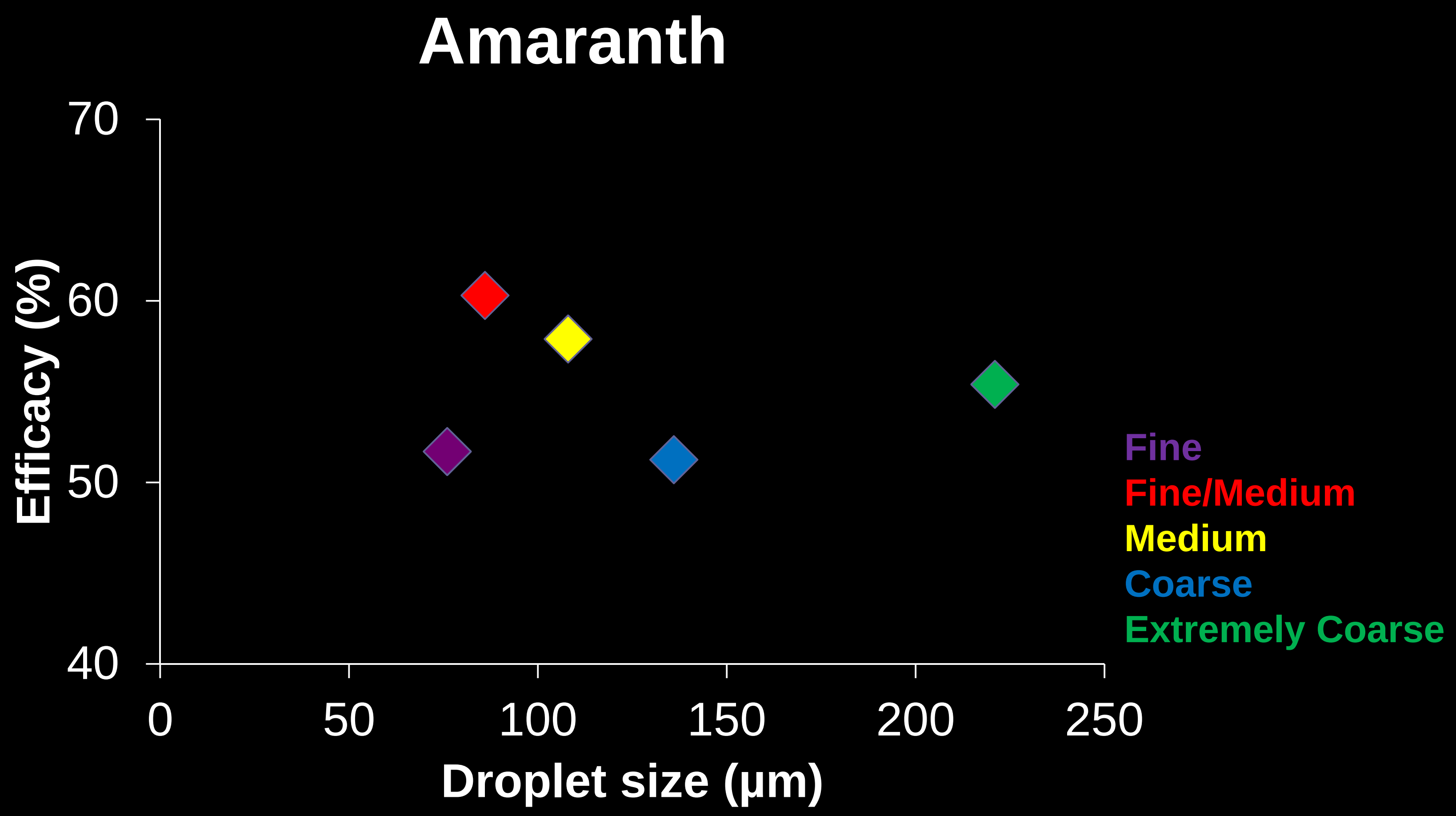
Clarity


Amaranth
85
75
65
55
Efficacy (%)
0
100
200
300
Droplet size (µm)
Fine
Fine/Medium
Medium
Coarse
Extremely Coarse

Clarity

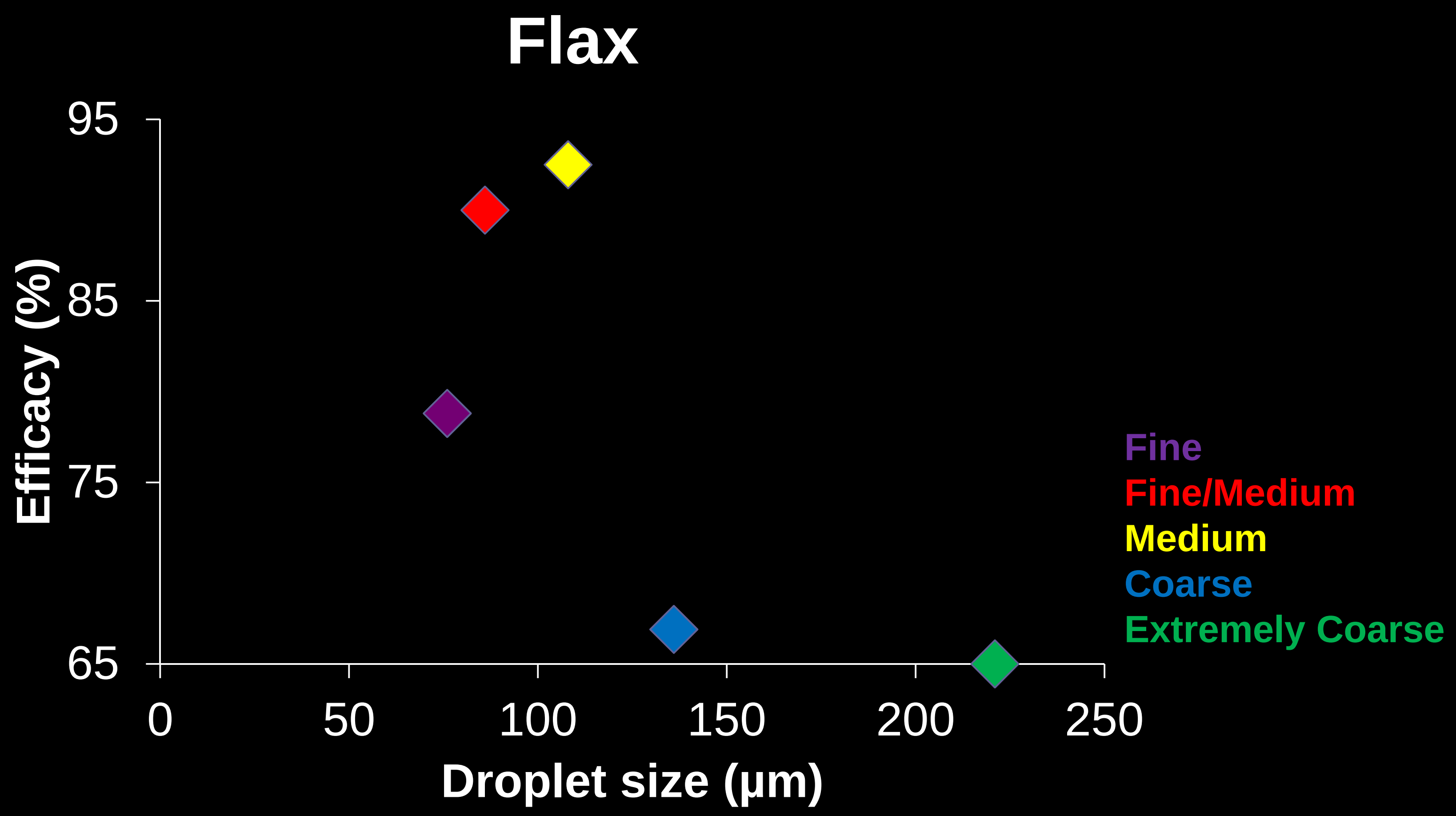

Velvetleaf
60
50
40
30
Efficacy (%)
0
100
200
300
Droplet size (µm)
Fine
Fine/Medium
Medium
Coarse
Extremely Coarse

Reflex

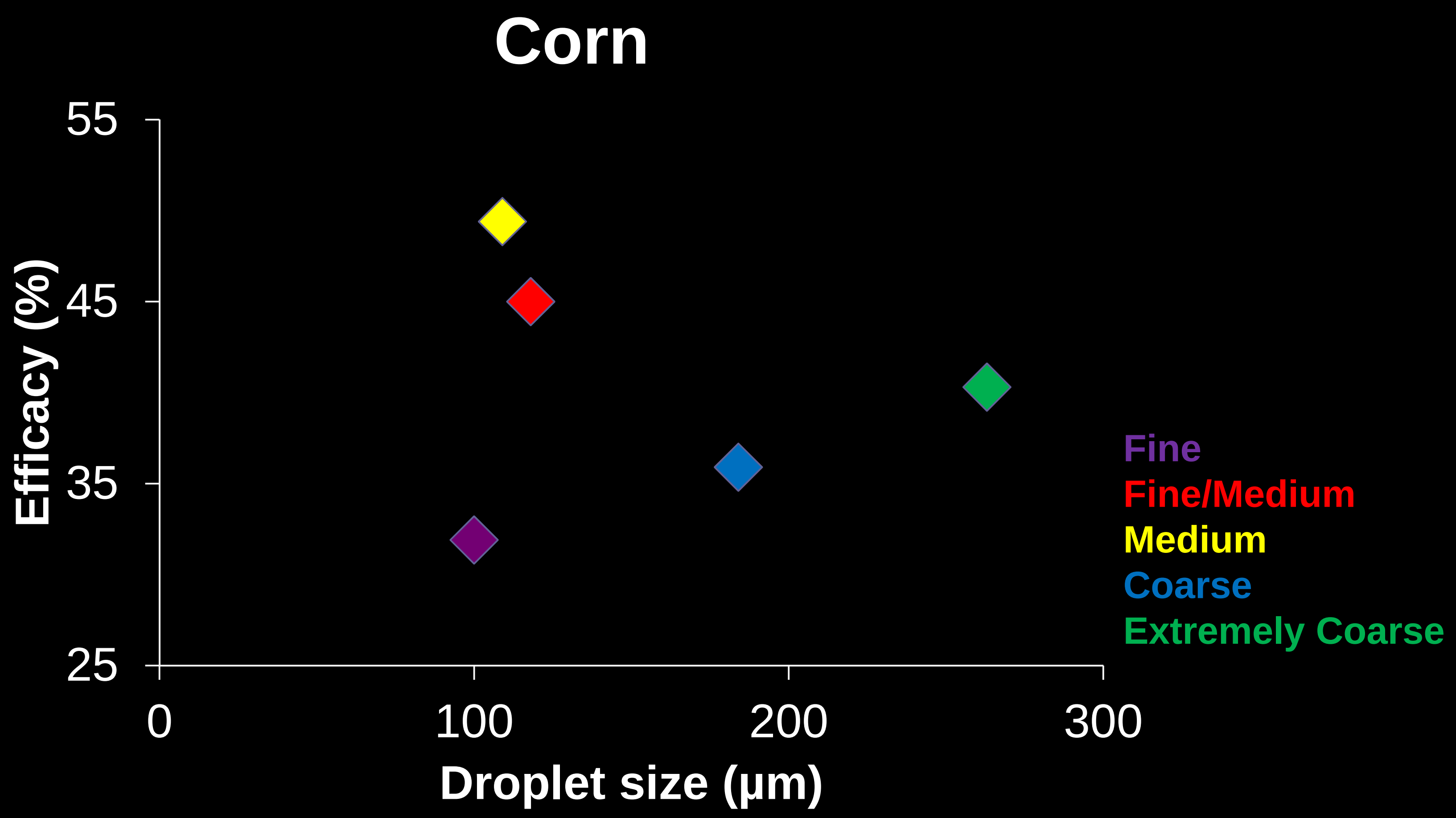


Amaranth
70
60
50
40
Efficacy (%)
0
50
100
150
200
250
Droplet size (µm)
Fine
Fine/Medium
Medium
Coarse
Extremely Coarse

Reflex


Flax
Efficacy (%)
95
85
75
65
0
50
100
150
200
250
Droplet size (µm)
Fine
Fine/Medium
Medium
Coarse
Extremely Coarse

SelectMax



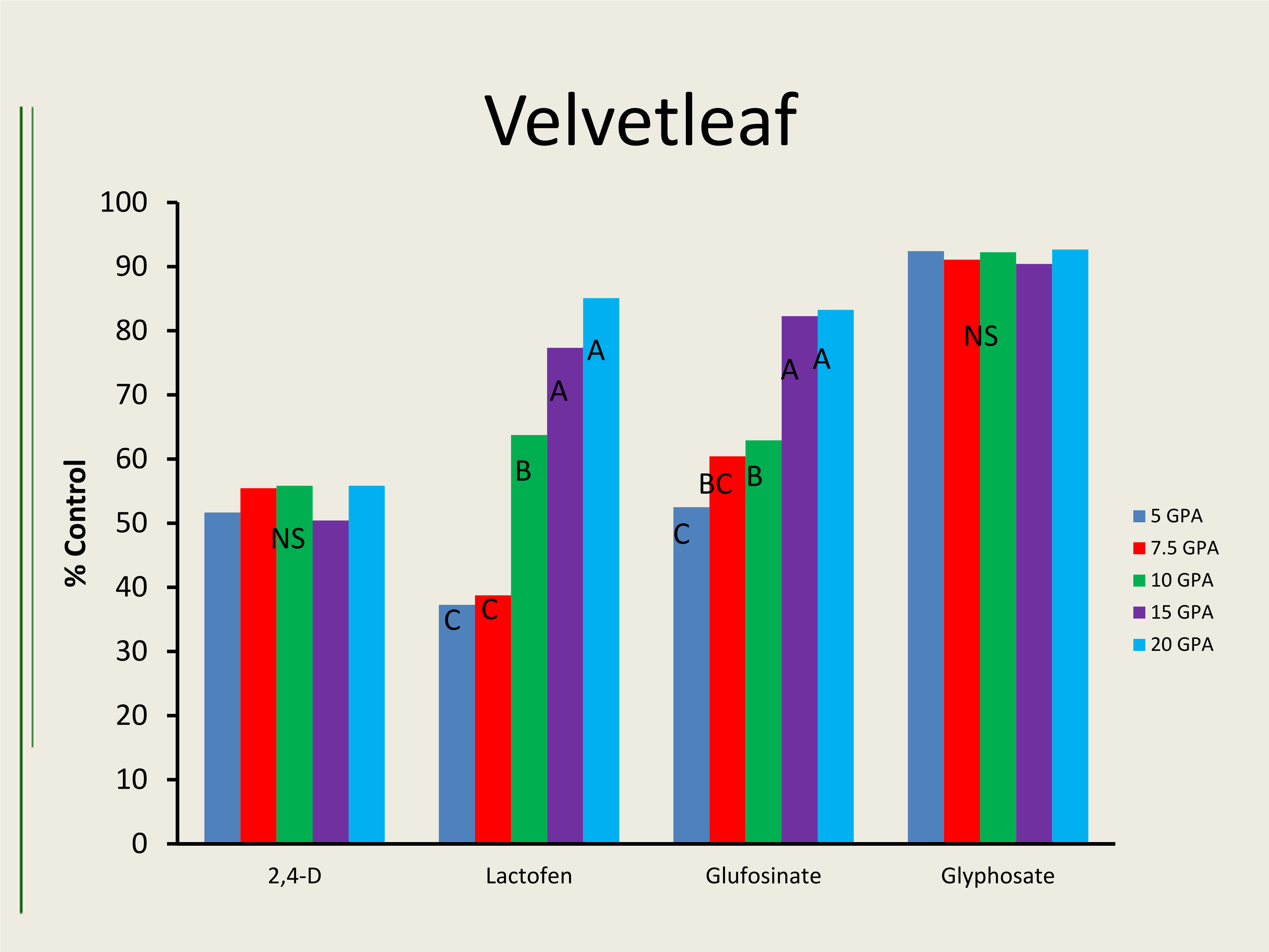
Corn
55
45
35
25
Efficacy (%)
0
100
200
300
Droplet size (µm)
Fine
Fine/Medium
Medium
Coarse
Extremely Coarse

Materials and Methods

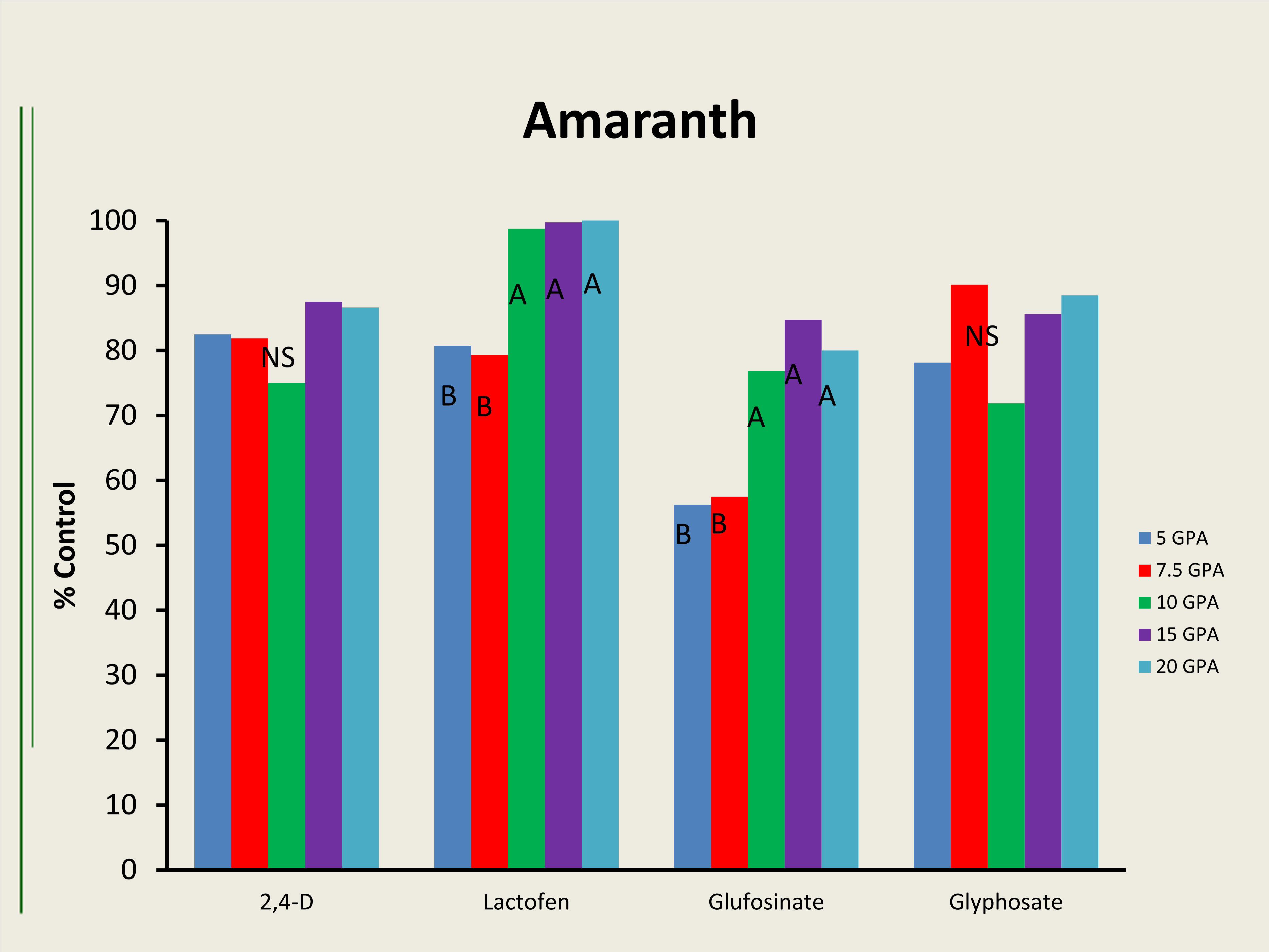
- Four locations in Nebraska
  - Lexington
  - O'Neill
  - Platte Center
- Four replications per location
- Five planted species
  - Amaranth, Flax, Velvetleaf, Soybean, Corn
- Herbicides
  - Glyphosate (RoundUp PowerMax at 32 oz/ac)
  - Glufosinate (Liberty at 22 oz/ac)
  - Lactofen (Cobra at 12.5 oz/ac)
  - 2,4-D (Weedone at 1 qt/ac)

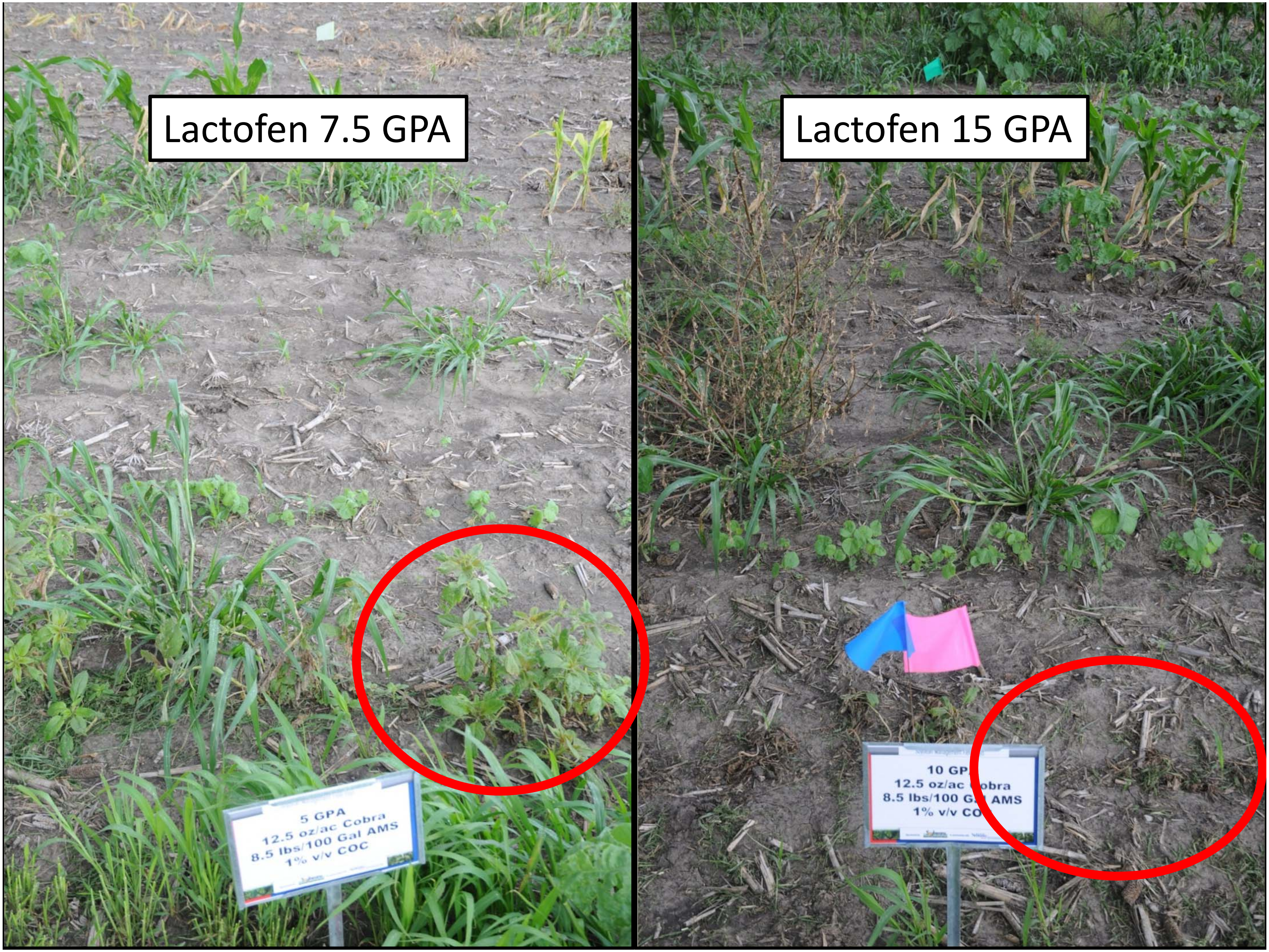
Materials and Methods

Carrier Volume	Nozzle	Pressure	Speed
5 GPA	XR11001	20	3 MPH
7.5 GPA	XR11001	25	3 MPH
10 GPA	XR11001	30	3 MPH
15 GPA	XR110015	40	3 MPH
20 GPA	XR11002	50	3.5 MPH

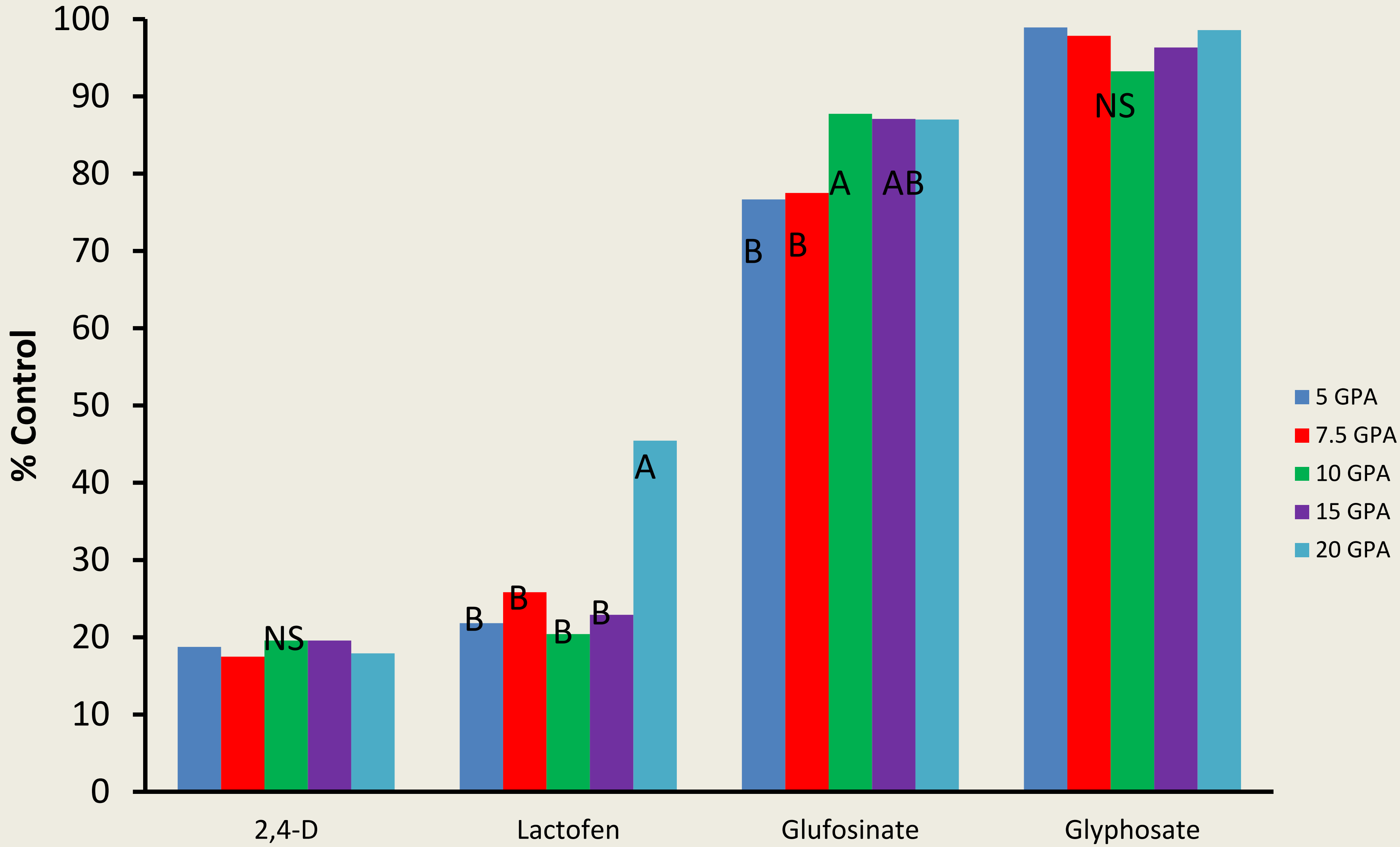


Velvetleaf
% Control
100
90
80
70
60
50
40
30
20
10
0
NS
C
C
B
A
A
C
BC
B
A
A
NS
2,4-D
Lactofen
Glufosinate
Glyphosate
5 GPA
7.5 GPA
10 GPA
15 GPA
20 GPA


Amaranth
% Control
100
90
80
70
60
50
40
30
20
10
0
NS
B
B
A
A
A
B
B
A
A
A
NS
2,4-D
Lactofen
Glufosinate
Glyphosate
5 GPA
7.5 GPA
10 GPA
15 GPA
20 GPA

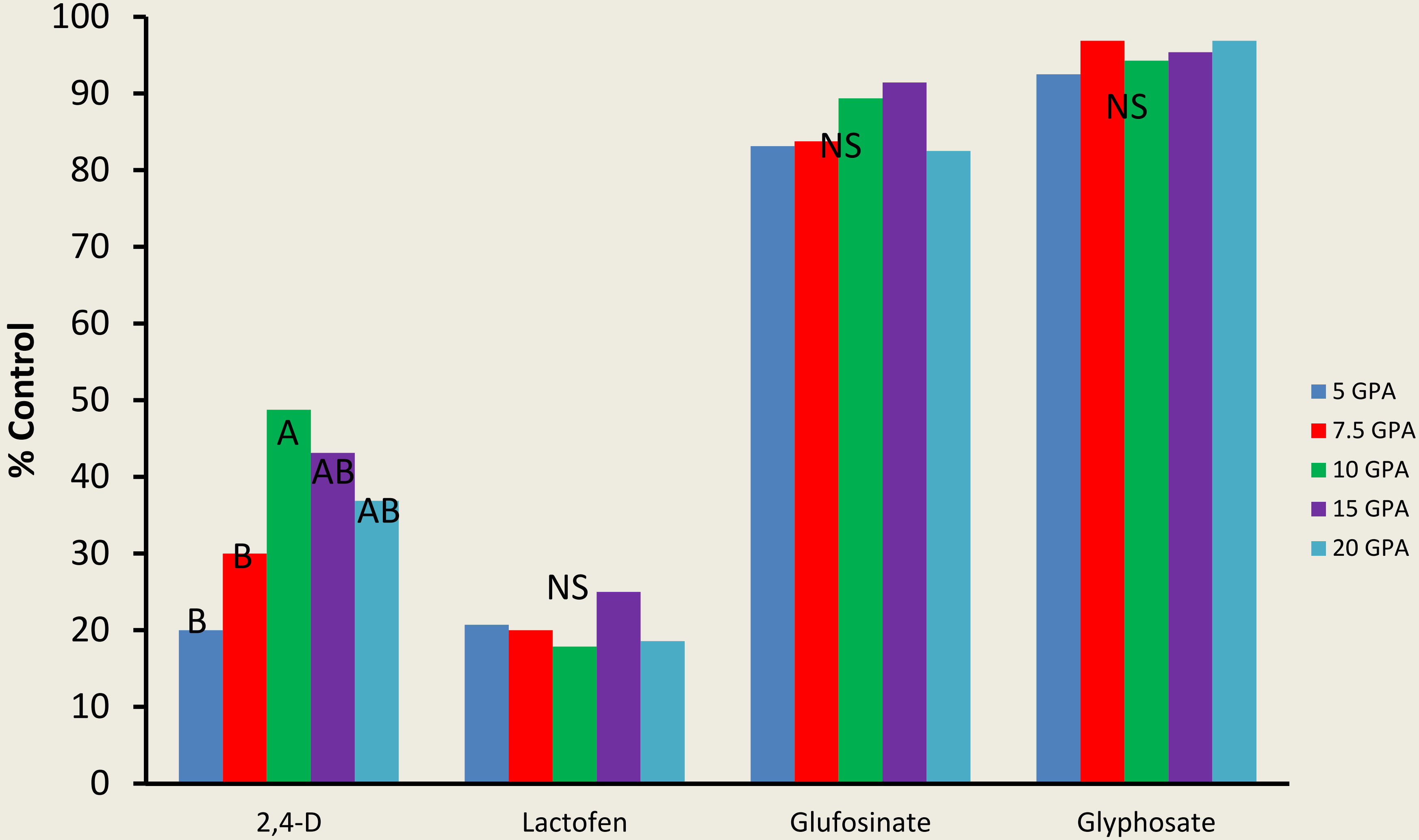

Lactofen 7.5 GPA
Lactofen 15 GPA
5 GPA
12.5 oz/ac Cobra
8.5 lbs/100 Gal AMS
1% v/v COC

Corn



% Control
100
90
80
70
60
50
40
30
20
10
0
NS
B
B
B
B
A
B
B
A
AB
NS
2,4-D
Lactofen
Glufosinate
Glyphosate
5 GPA
7.5 GPA
10 GPA
15 GPA
20 GPA

Soybean



% Control
100
90
80
70
60
50
40
30
20
10
0
B
B
A
AB
AB
NS
NS
NS
2,4-D
Lactofen
Glufosinate
Glyphosate
5 GPA
7.5 GPA
10 GPA
15 GPA
20 GPA

Conclusions

- Easy is OVER!
- Take your time, slow down, think through the process
- Know your products and your target
- READ THE LABEL!

Low Volume Aerial Applications

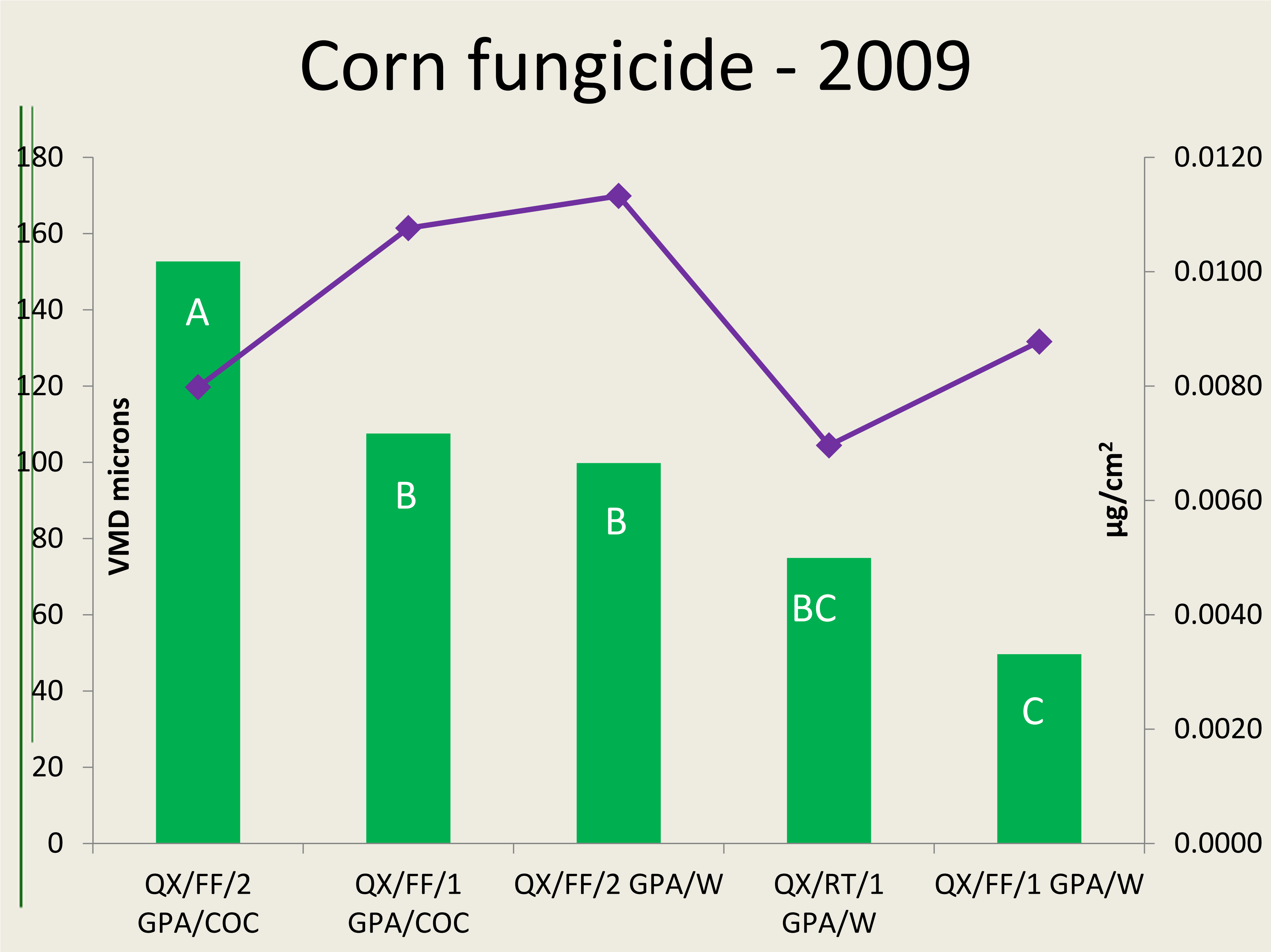
Scott Bretthauer
University of Illinois at Urbana-Champaign

Acknowledgments

- Bob Wolf
- Dennis Gardisser
- Alan McCracken
- Clint Hoffmann
- Brad Fritz
- Dan Martin
- Scott Schertz
- Dave Thomas
- David Eby
- David Kurtz
- Steve Benoit
- Ken Ostlie

Low volume considerations

- Considerations
  - Coverage
  - Drift mitigation
- Ideal droplet size
  - VMD
  - $D_{V0.9}$
  - $D_{V0.1}$
- Application
  - Height
  - Swath width
- Nozzle types
  - Flat fan
  - Rotary atomizer
  - Hollow cone
  - Electrostatic
- Adjuvants
  - Protectant
  - Surfactant
  - Drift reduction

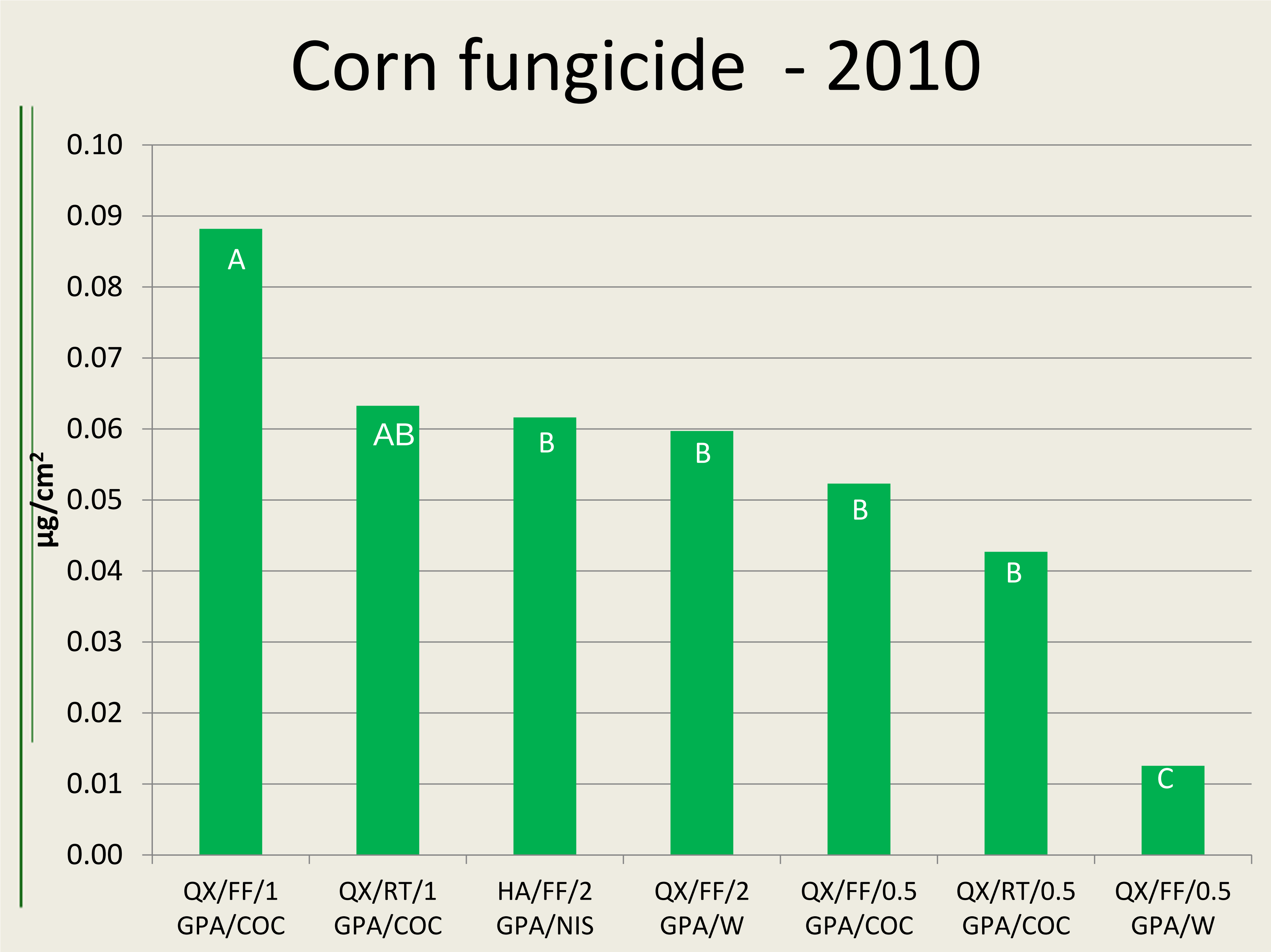


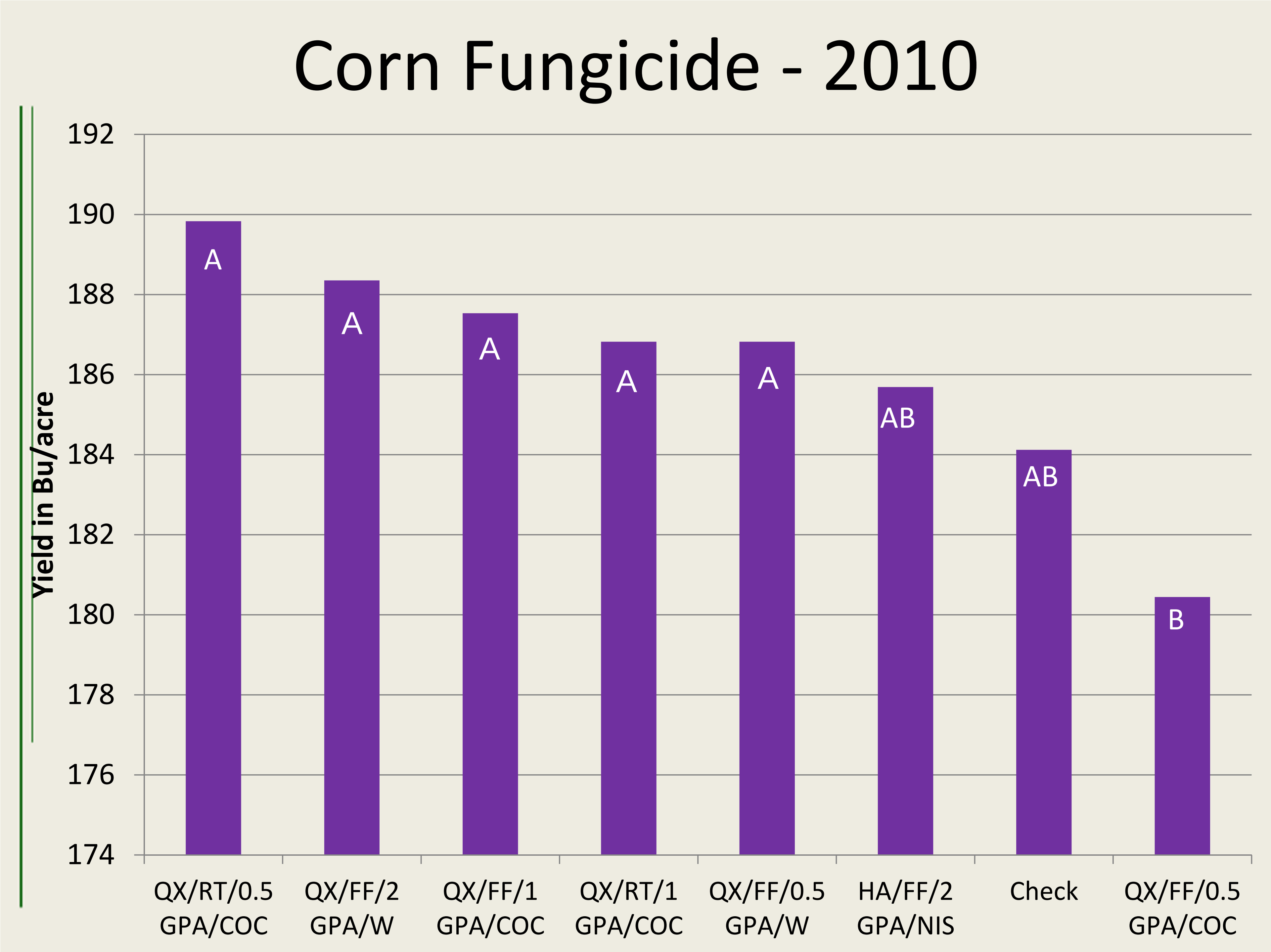
Corn fungicide - 2009
VMD microns
µg/cm²
180
160
140
120
100
80
60
40
20
0
0.0120
0.0100
0.0080
0.0060
0.0040
0.0020
0.0000
A
B
B
BC
C
QX/FF/2 GPA/COC
QX/FF/1 GPA/COC
QX/FF/2 GPA/W
QX/RT/1 GPA/W
QX/FF/1 GPA/W

Yield – 1 field from 2009

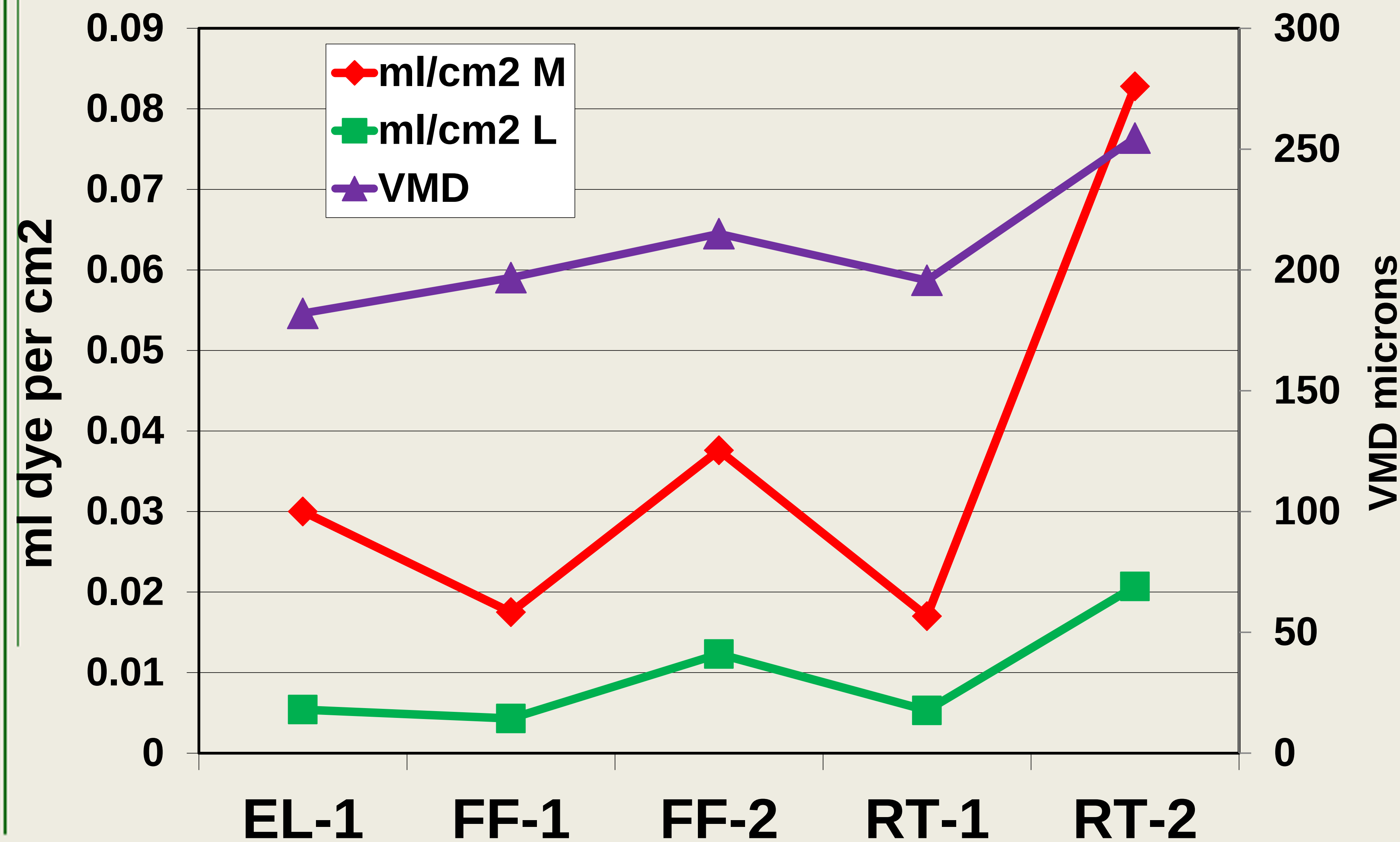
<u>Deposition</u>

- **0.007 B**
- **0.003 C**
- **0.005 BC**
- **0.01 A**
- **0.007 B**

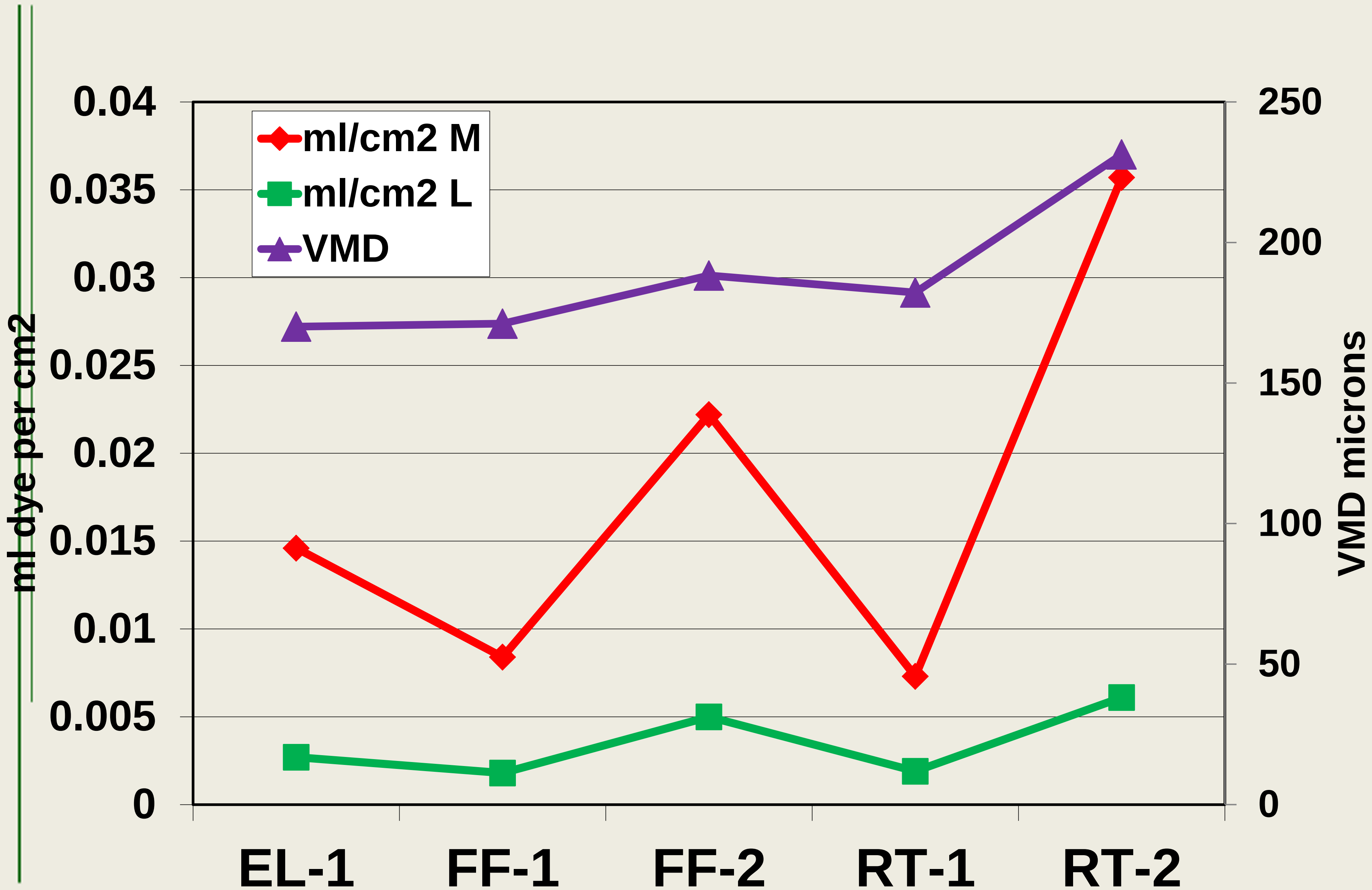

Corn fungicide - 2010
µg/cm2
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
A
AB
B
B
B
B
C
QX/FF/1 GPA/COC
QX/RT/1 GPA/COC
HA/FF/2 GPA/NIS
QX/FF/2 GPA/W
QX/FF/0.5 GPA/COC
QX/RT/0.5 GPA/COC
QX/FF/0.5 GPA/W

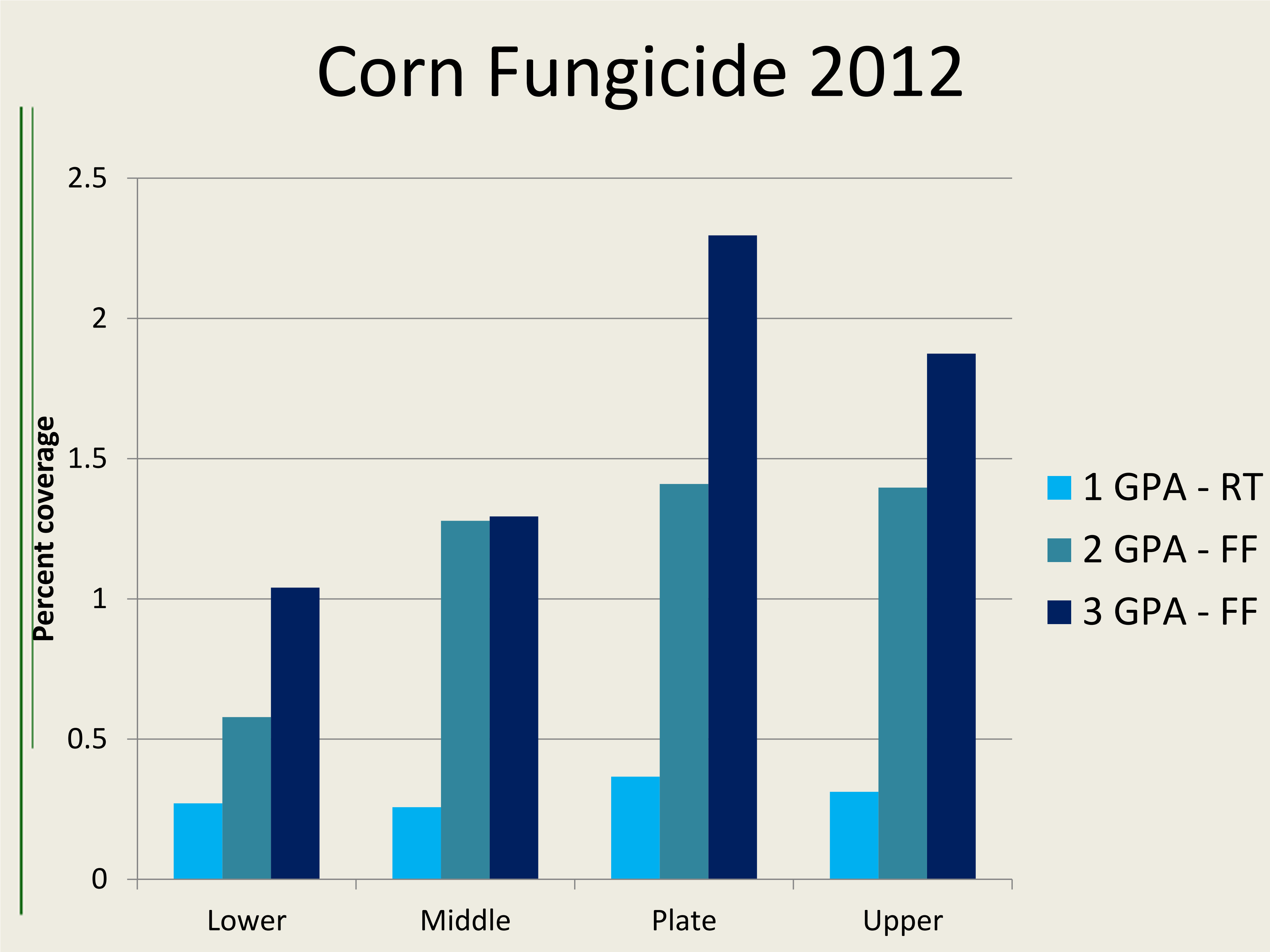

Corn Fungicide - 2010
Yield in Bu/acre
192
190
188
186
184
182
180
178
176
174
A
A
A
A
A
AB
AB
B
QX/RT/0.5 GPA/COC
QX/FF/2 GPA/W
QX/FF/1 GPA/COC
QX/RT/1 GPA/COC
QX/FF/0.5 GPA/W
HA/FF/2 GPA/NIS
Check
QX/FF/0.5 GPA/COC

USDA-ARS – Corn, top canopy

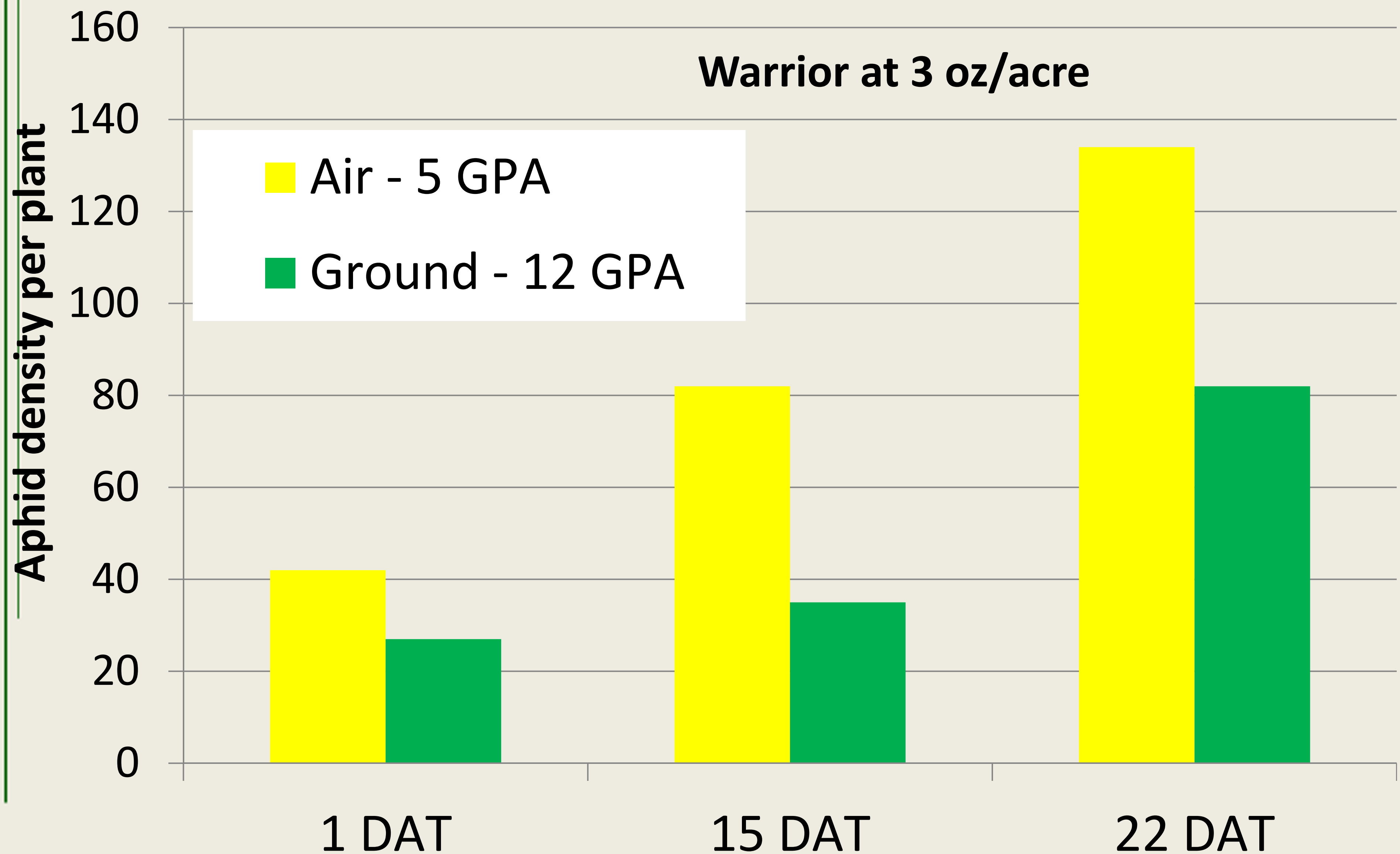


USDA-ARS – Corn, middle canopy

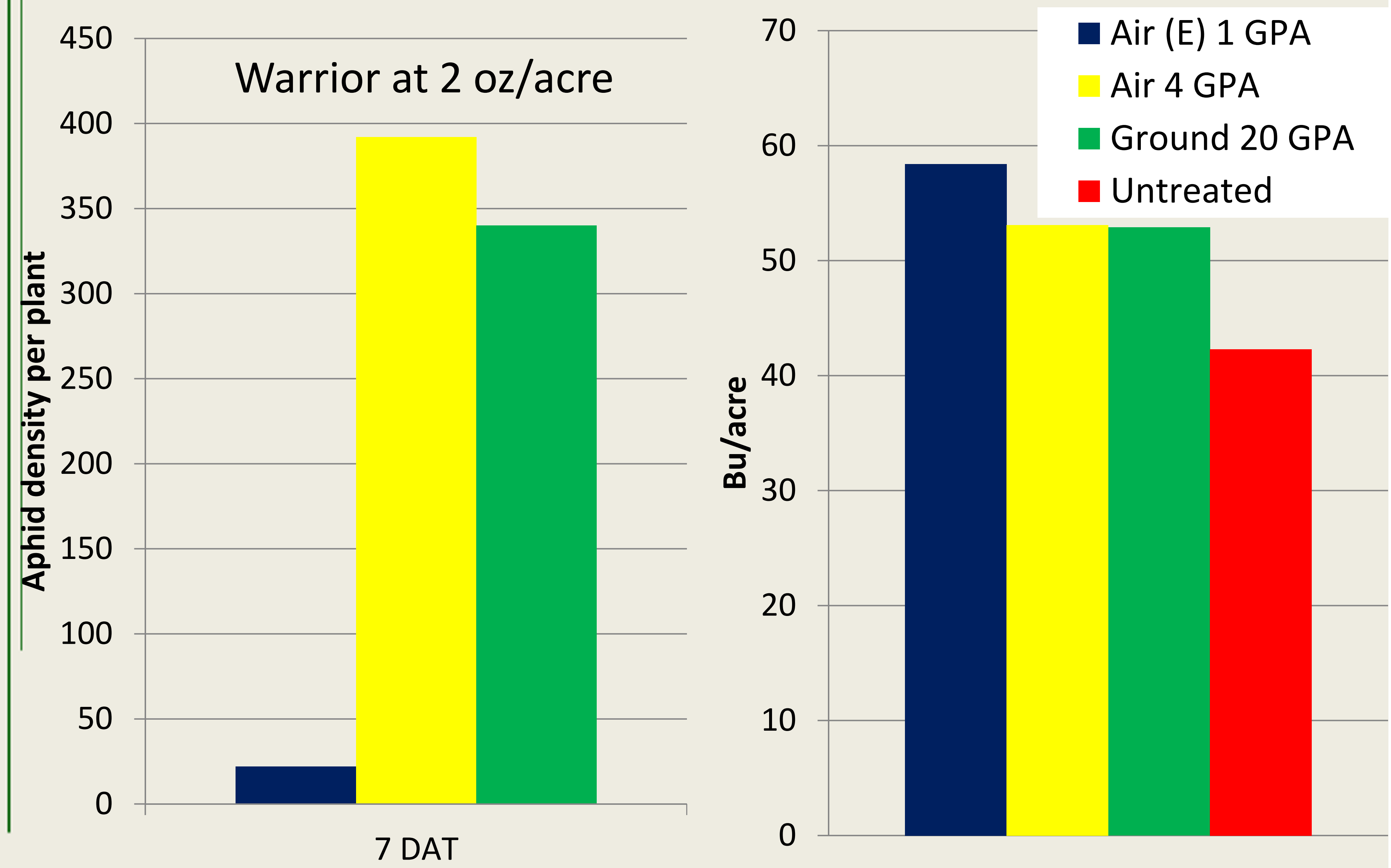



Corn Fungicide 2012
Percent coverage
2.5
2
1.5
1
0.5
0
Lower
Middle
Plate
Upper
1 GPA - RT
2 GPA - FF
3 GPA - FF

Soybean aphid applications
Ken Ostlie: University of Minnesota



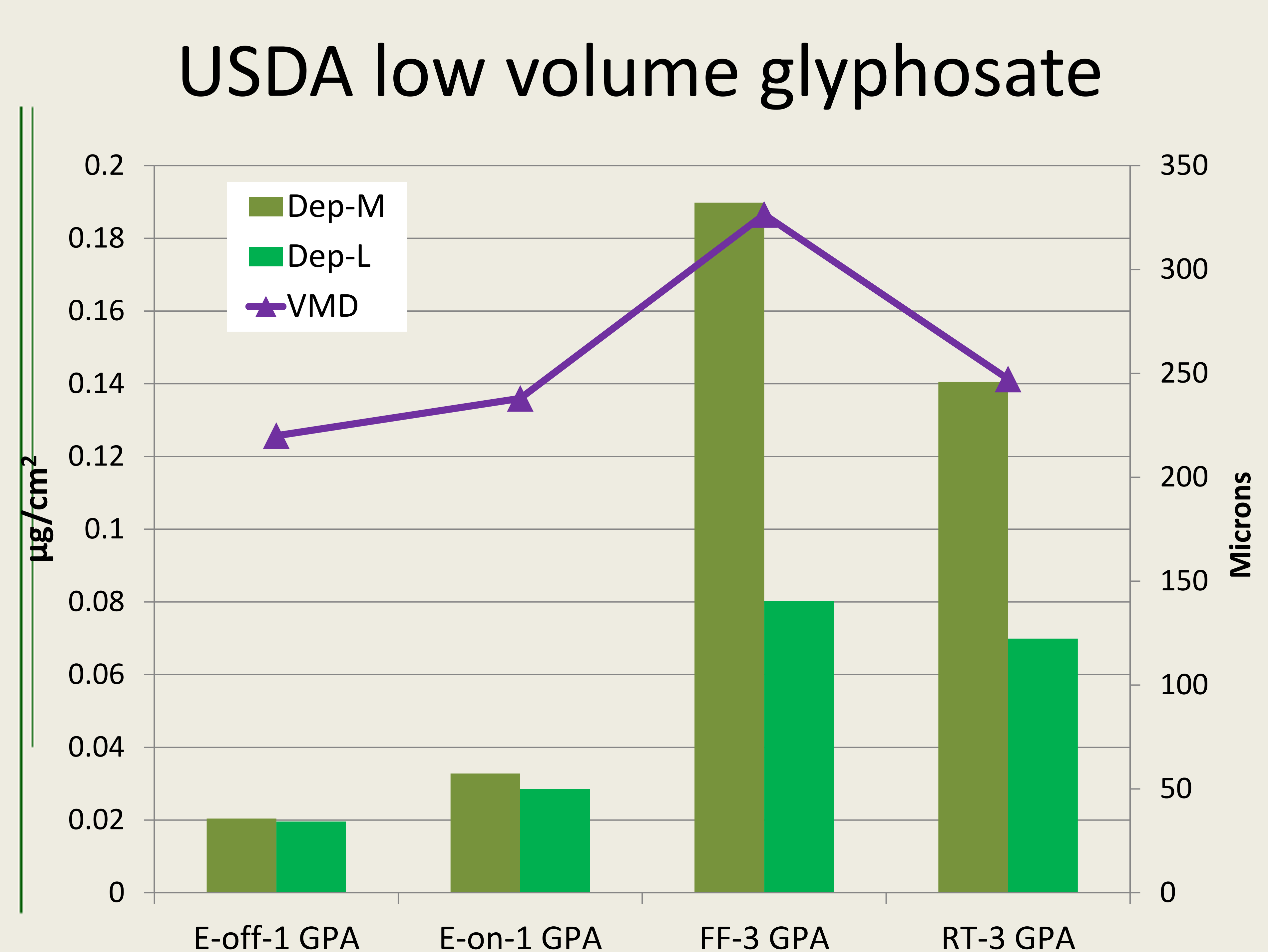
Soybean aphid applications
Ken Ostlie: University of Minnesota



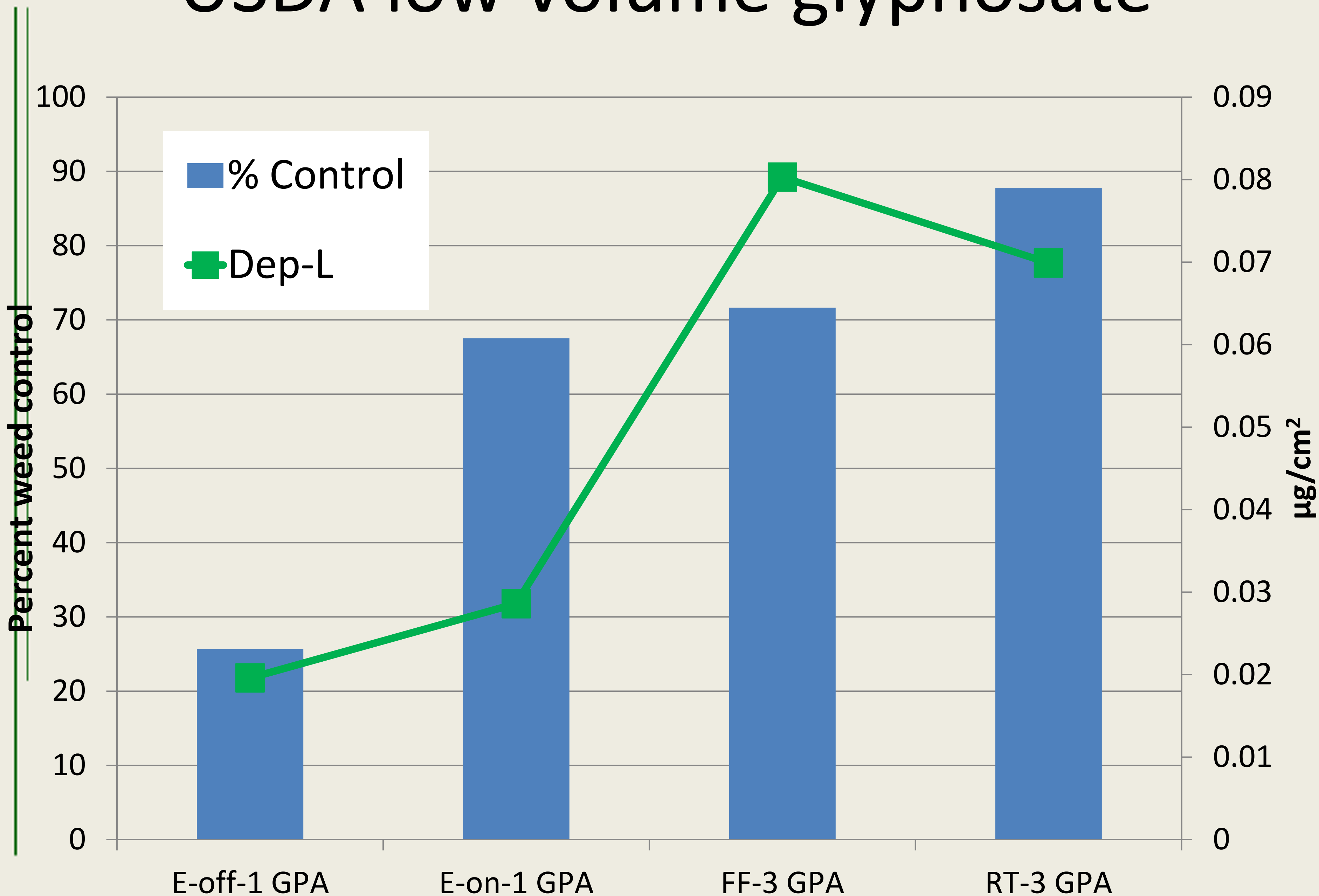
Aerial vs. ground applications

Treatment	Water Hemp	Velvet Leaf	Fall Panicum	Cocklebur
Ground (12 GPA)	56.3	48.8	76.3	99
Aerial (1 GPA)	47.5	46.7	77.5	99

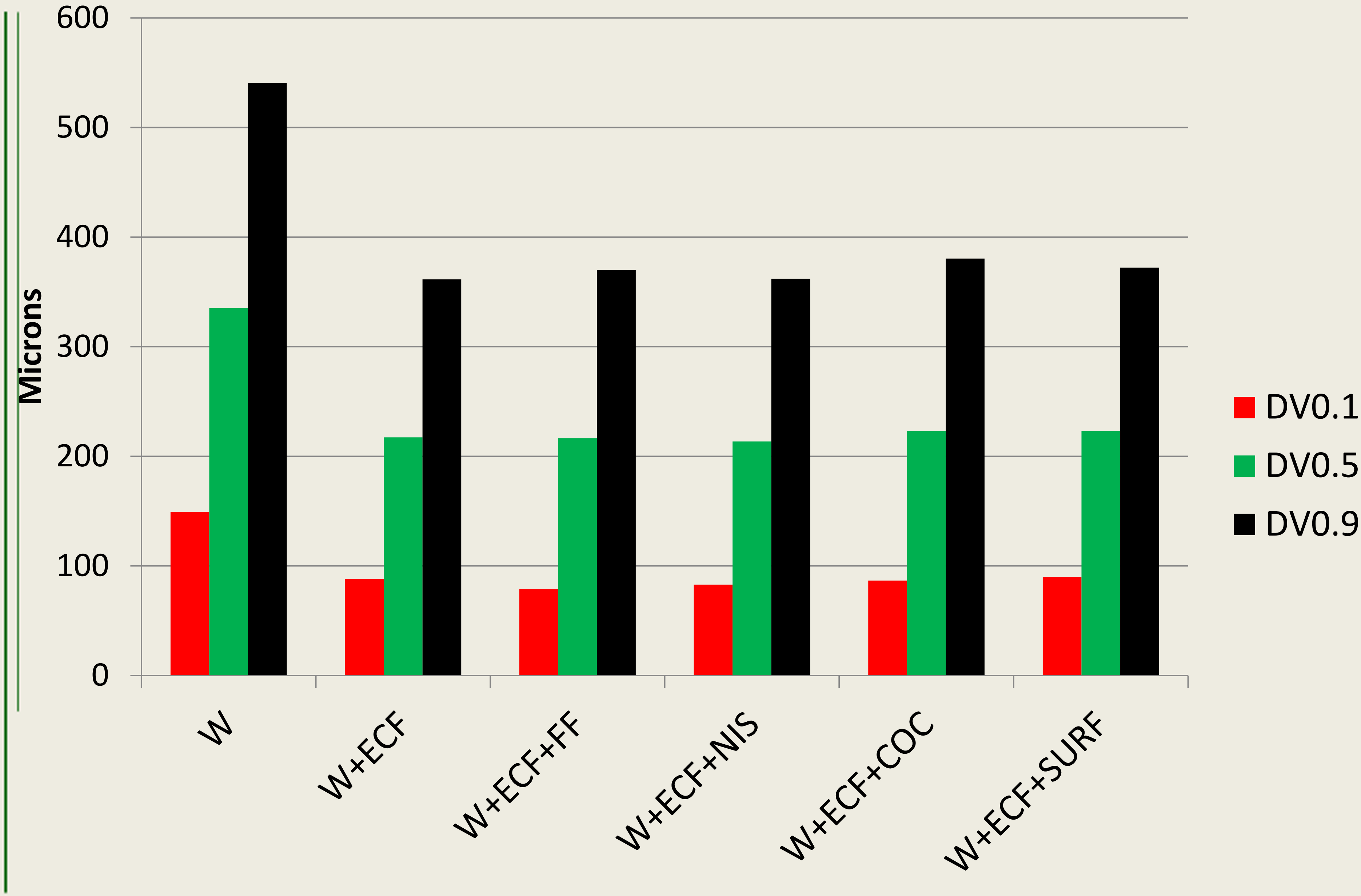
Aerial vs. ground applications

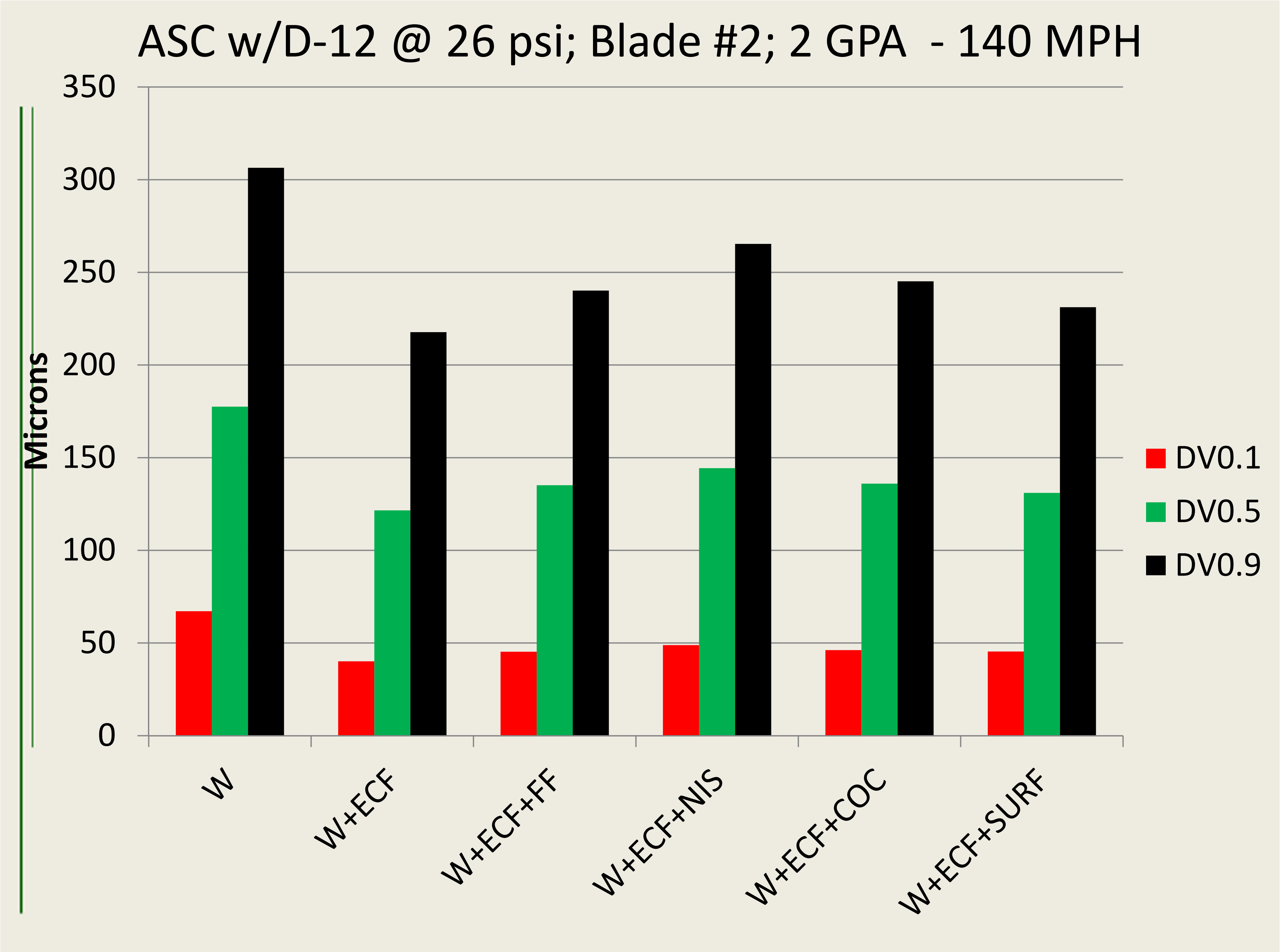

USDA low volume glyphosate
Dep-M
Dep-L
VMD
µg/cm2
Microns
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0
50
100
150
200
250
300
350
E-off-1 GPA
E-on-1 GPA
FF-3 GPA
RT-3 GPA

USDA low volume glyphosate

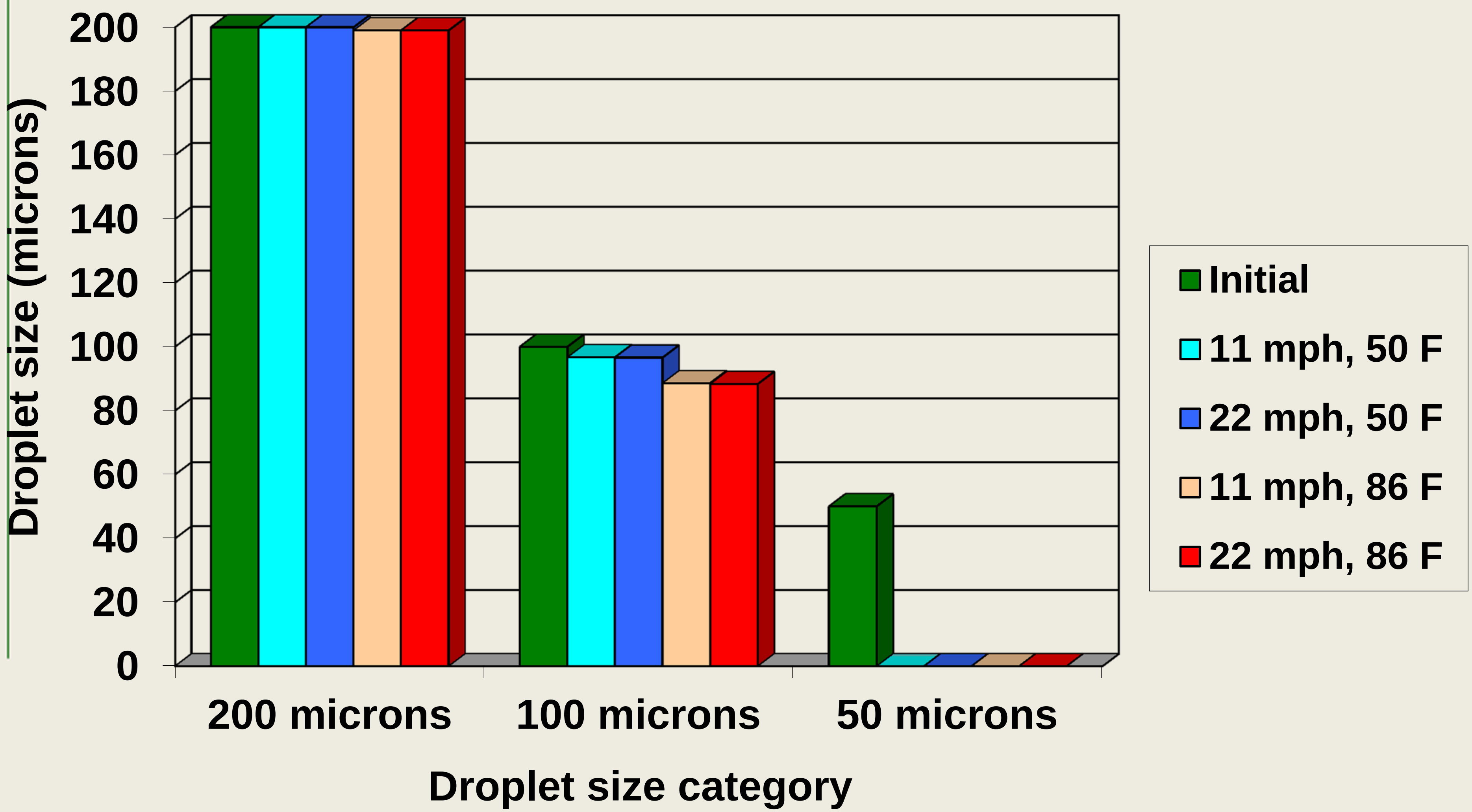


FF4015 @ 40 psi – 23º deflection 2 GPA - 140 MPH



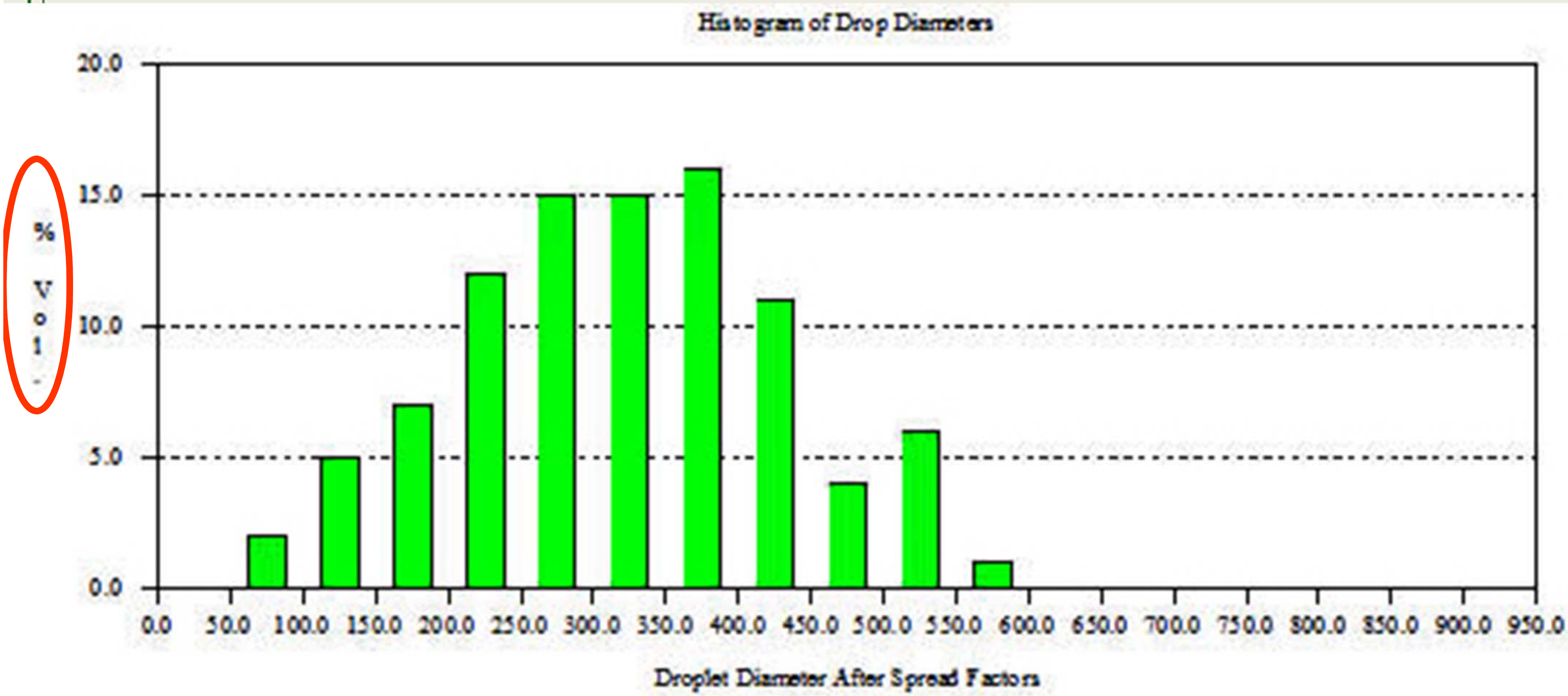

ASC w/D-12 @ 26 psi; Blade #2; 2 GPA - 140 MPH
Microns
350
300
250
200
150
100
50
0
W
W+ECF
W+ECF+FF
W+ECF+NIS
W+ECF+COC
W+ECF+SURF
DV0.1
DV0.5
DV0.9

Evaporation of droplets



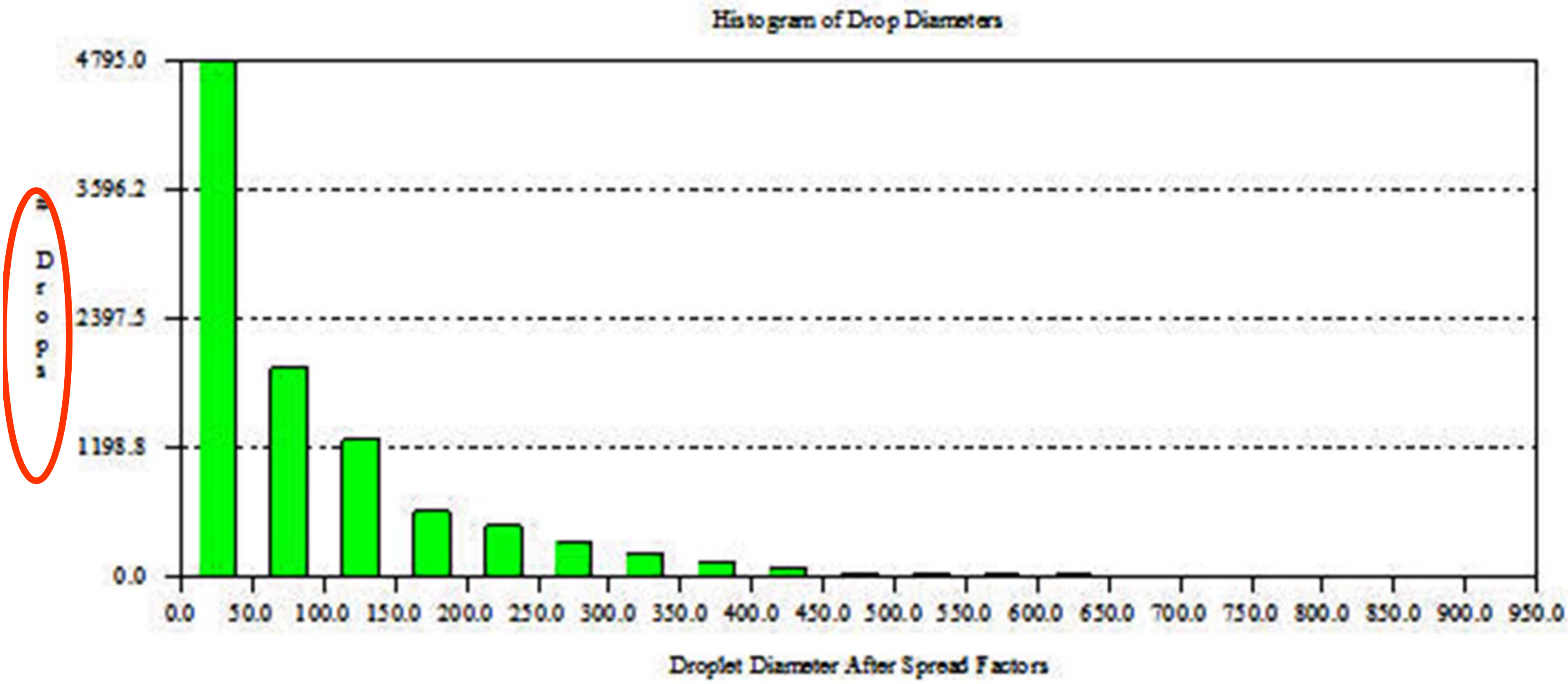
Source: Ohio State University Extension

Volume diameter distribution



Percentage of **volume** in droplet diameter classes

Droplet number diameter distribution



Number of droplets in droplet diameter classes

Low volume considerations

- Considerations
  - Coverage
  - Drift mitigation
- Ideal droplet size
  - VMD: 200-300
  - $D_{V0.9}$: <400
  - $D_{V0.1}$: >100
- Application
  - Height: 10 to 15
  - Swath width: do not widen – tall crop, narrow up 10%??
- Nozzle types: droplets
  - Flat fan
  - Rotary atomizer
  - Hollow cone
  - Electrostatic
- Adjuvants
  - **Protectant**
  - Surfactant
  - Drift reduction
- YIELD DATA

QUESTIONS?

Thank You For Attending

- Please make sure to visit us at the Trade Show
  - Booth 626
- Survey
  - Research topics
  - Topics for next year’s Technical Session