Best Practices for Aerial Application

Pesticide Spray Drift Series—3 Parts

- March 15, 2018 webinar: "Strategies for Managing Pesticide Spray Drift"
  - Presented by Dr. Greg Kruger, University of Nebraska-Lincoln
  - Covers fundamentals of pesticide spray particle drift management
  - Materials available: https://www.epa.gov/reducing-pesticide-drift/strategies-managing-pesticide-spray-drift-webinar-materials

- Today's webinar: "Best Practices for Aerial Application"
  - Presented by Br. Bradley Fritz, United States Department of Agriculture
  - Dr. Greg Kruger will join for the Q+A discussion

- October 25, 2018 webinar: "Best Practices for Ground Application"
  - Presented by Dr. Greg Kruger, University of Nebraska-Lincoln
  - Register at: https://www.epa.gov/pesticides/register-oct-25-webinar-best-practices-pesticide-ground-application
  - Dr. Bradley Fritz will join for the Q+A discussion

Aerial Application Technology

Co-moderator

Greg Kruger, Ph.D.

- Weed science and pesticide application technology specialist
- University of Nebraska-Lincoln, Department of Agronomy and Horticulture
- Director of the Pesticide Application Technology Laboratory
- Areas of research: droplet size and efficacy, spray drift deposition and canopy penetration, influence of nozzle type, orifice size, spray pressure, and carrier volume rate on spray droplet size

Aerial Application Technology

Presenter

- Bradley Fritz, Ph.D
- Agricultural engineer and Research Leader, Agricultural Research Service, US Department of Agriculture
- Research areas: examining the role of spray nozzles, spray solutions, and operational settings in resulting droplet size of spray; exploring the transport and fate of applied spray under field conditions
- Numerous publications: https://www.ars.usda.gov/people-locations/person?person-id=33323

Best Practices for Aerial Application

Presenter:

Bradley Fritz

Research Leader and Agricultural Engineer
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Disclaimer

The use of trade, firm, or corporation names in this presentation is for the information and convenience of the viewer. Such use does not constitute an official endorsement or approval by the United States Department of Agriculture or the Agricultural Research Service of any product or service to the exclusion of others that may be suitable.

Aerial Application in the U.S.

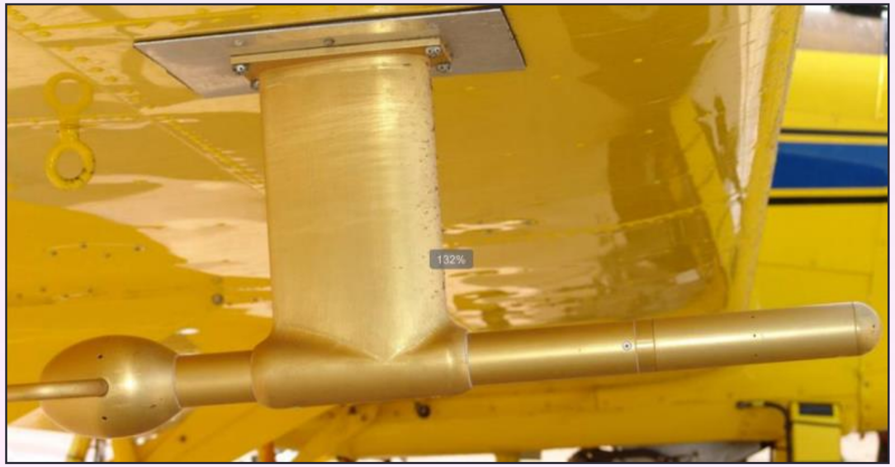
- More than 1300 aerial application services and 4000+ aircraft in the U.S.;
- Accounts for ~25% of all applied crop protection products on commercial farms
- ~100% of forest protection products
- 71 million acres treated aerially.
- Public health application for control of insects vectoring diseases.
- Wildfire/forest fire suppression.

Aerial Applications - Crops

- While aerial applications are made on nearly all US agricultural crops, based on an industry survey, the 5 most predominate crops are:
  - Corn
  - Wheat/barley
  - Soybeans
  - Pastures/Rangelands
  - Alfalfa

Aerial Equipment in the US

- 88% Fixed-Wing
- 12% helicopter
- 67% turbine, 33% piston
- Industry standards: GPS, flow control, aerial specific nozzles, AIMMS



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Aerial Applicators in the US

- Average applicator has over 21 years experience.
- Commercial pilot and applicator license.
- Participation in annual system testing and other training programs.

Spray Droplet Sizing – Understanding the Basics

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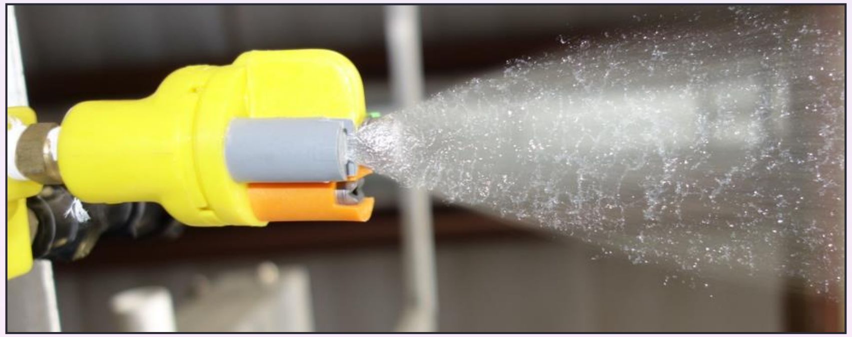
Scale of Measurement - Micrometer

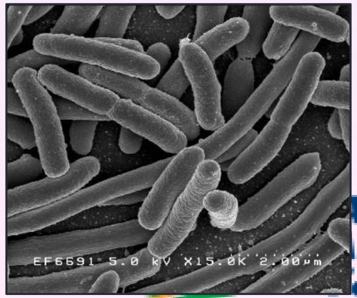
Raindrops
500 to 4000 um

Agricultural Sprays
50 to 2500 um

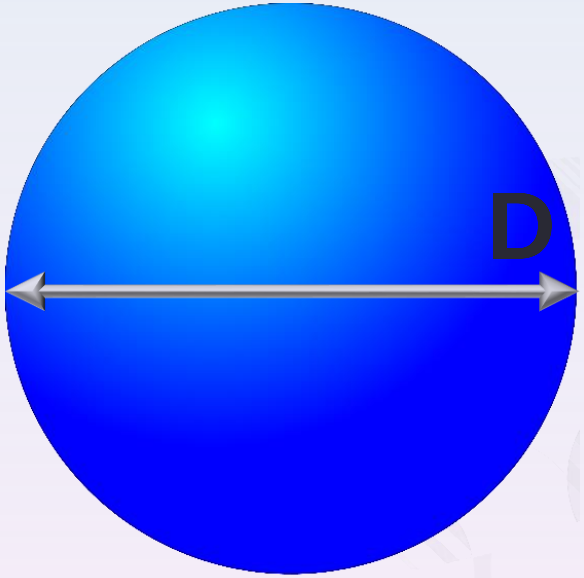


Human Hair
20 to 180 um

Bacterium
1 to 10 um



Droplet Diameter



$$V = \frac{1}{6}\pi D^3$$

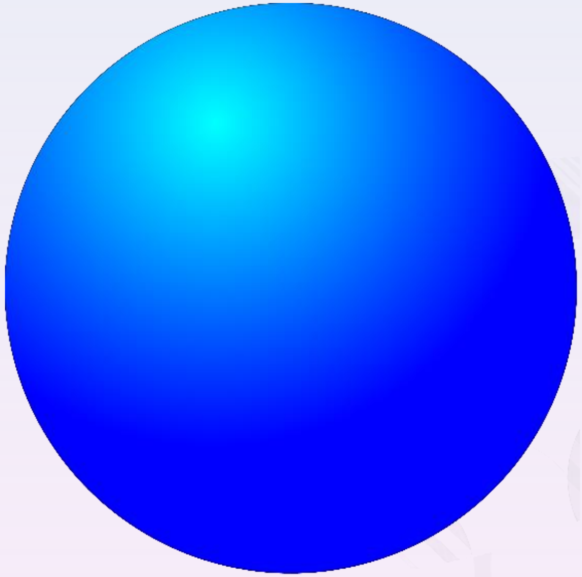
D = droplet diameter
V = droplet volume

A droplet of ½ D, = 1/8 the Volume of D.

$$\frac{V_1}{V_2} = \frac{D_1^3}{0.5D_1^3} = \frac{1^3}{0.5^3} = \frac{1}{0.125} = 8$$

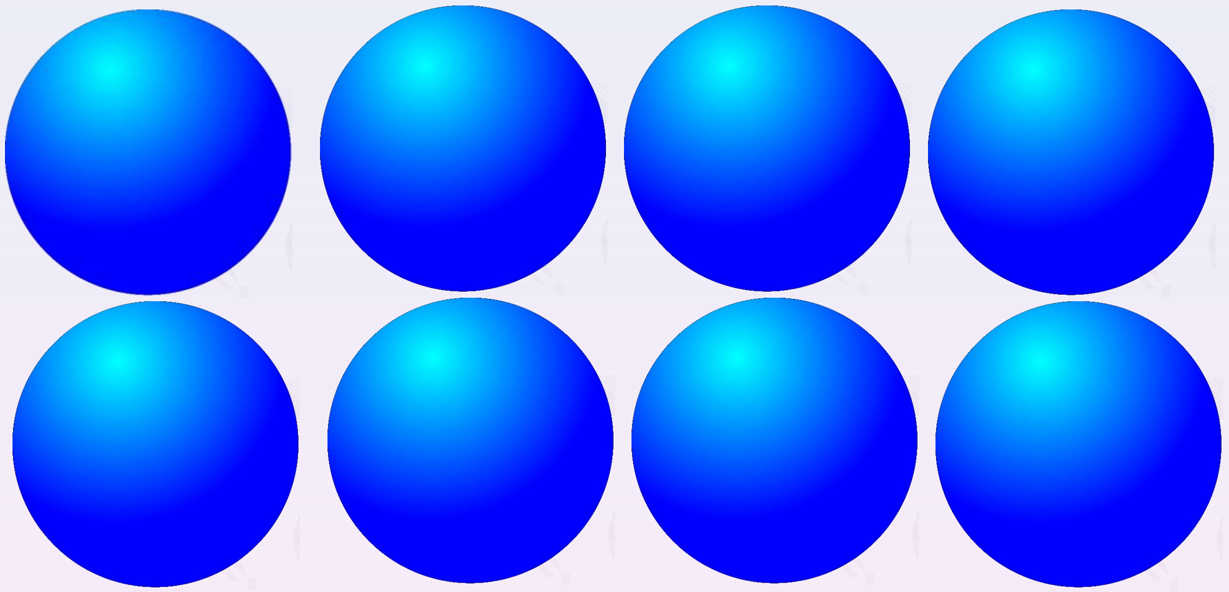
8X the Droplets to get the same Volume

Droplet Volume in the Spray Cloud



One 400 µm drop

Droplet Volume in the Spray Cloud



8 - 200 µm drops

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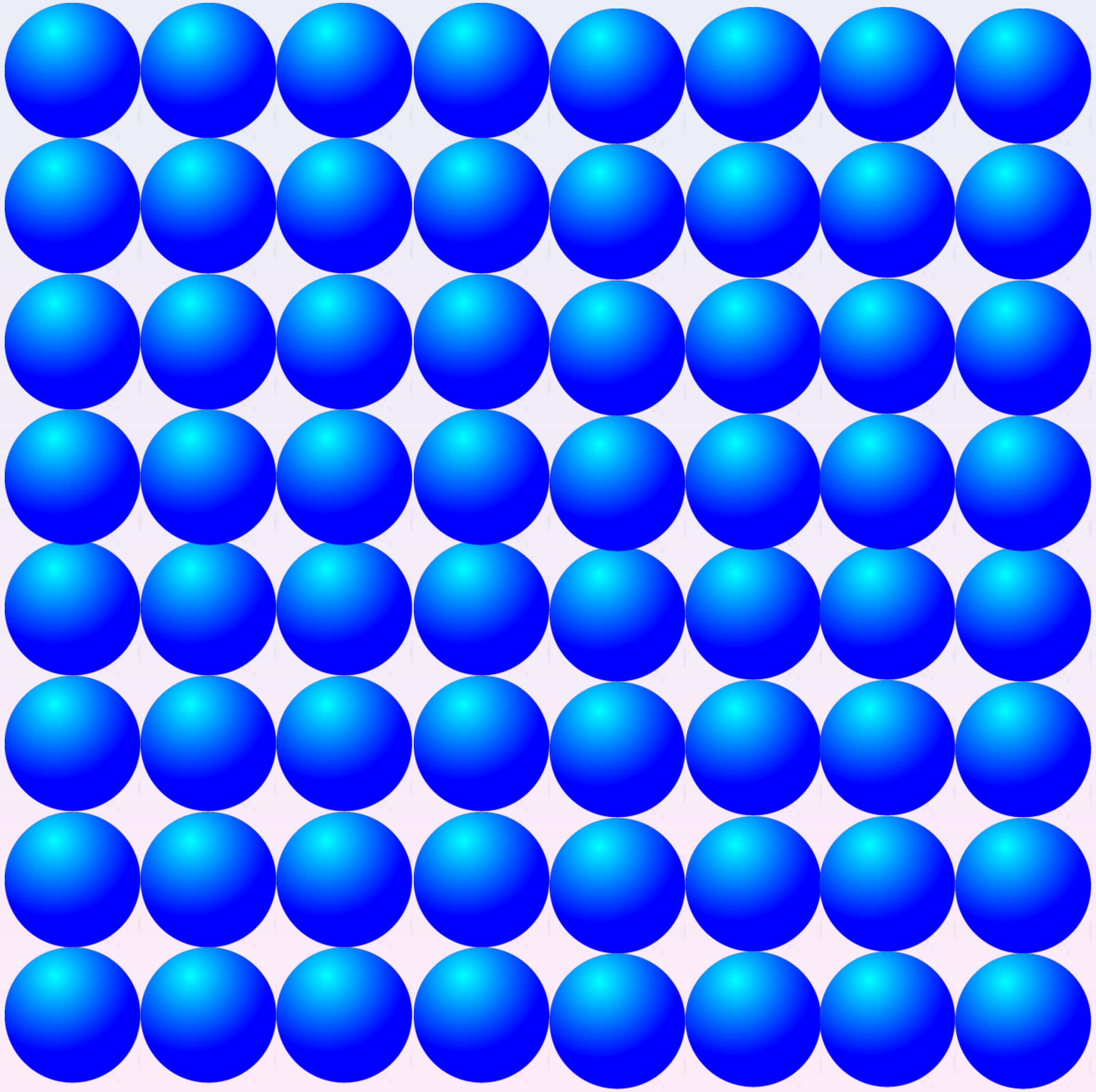
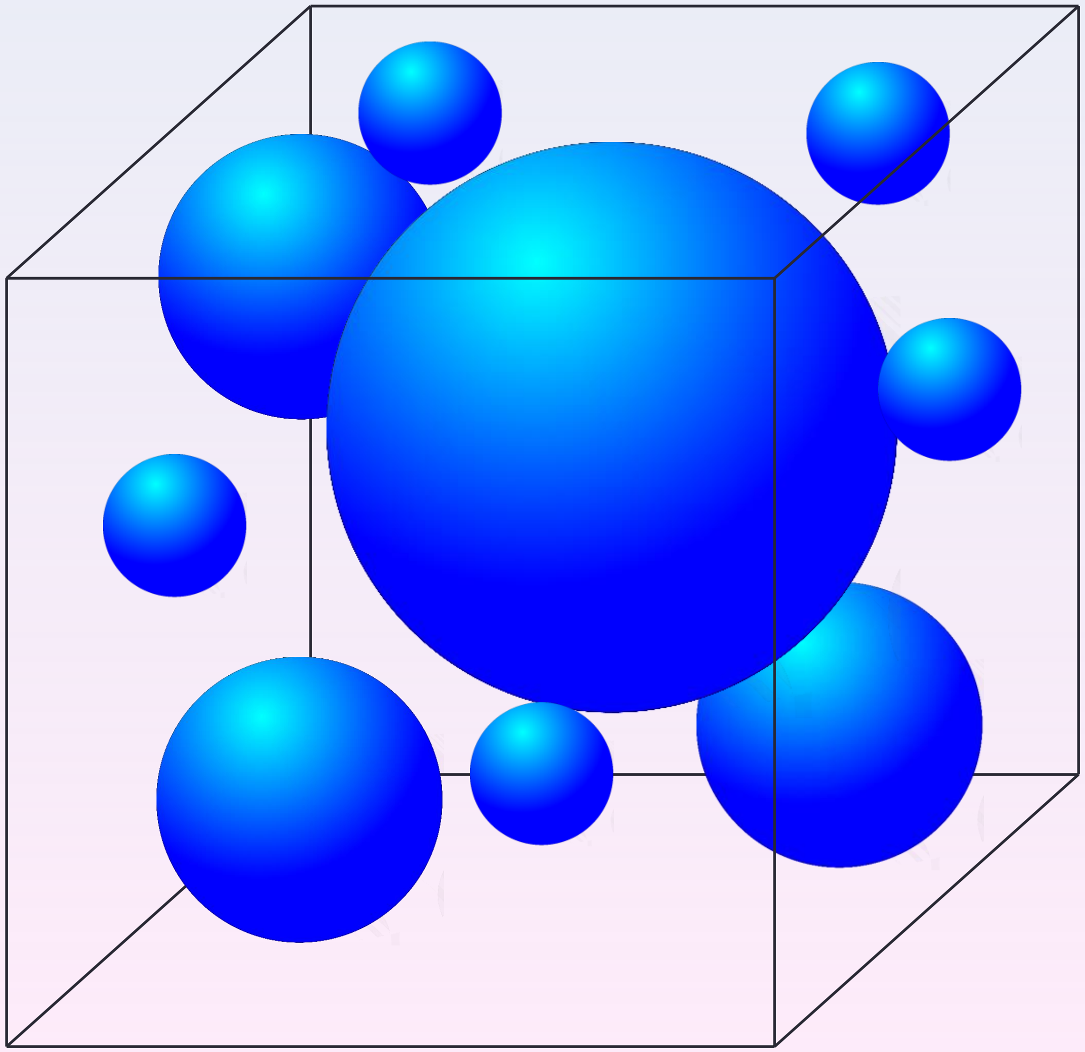
Droplet Volume in the Spray Cloud



64 - 100 µm
drops

Total Spray Volume



Characteristics of total spray volume.

Volume
Distribution to account for A.I.

Droplet Size Definitions

- From ASABE Standard S327.4 - *Terminology and Definitions for Applications of Crop or Forestry Production and Protective Agents*
- $D_{V0.5}$ or Volume Median Diameter (VMD)
  - Droplet diameter at which 50% of the total spray volume is in droplets of smaller diameter
- $D_{V0.1}$ and $D_{V0.9}$
  - Droplet diameters at which 10% and 90%, respectively of the total spray volume is in droplets of smaller diameter
- Using some measurement system, these data are determined.

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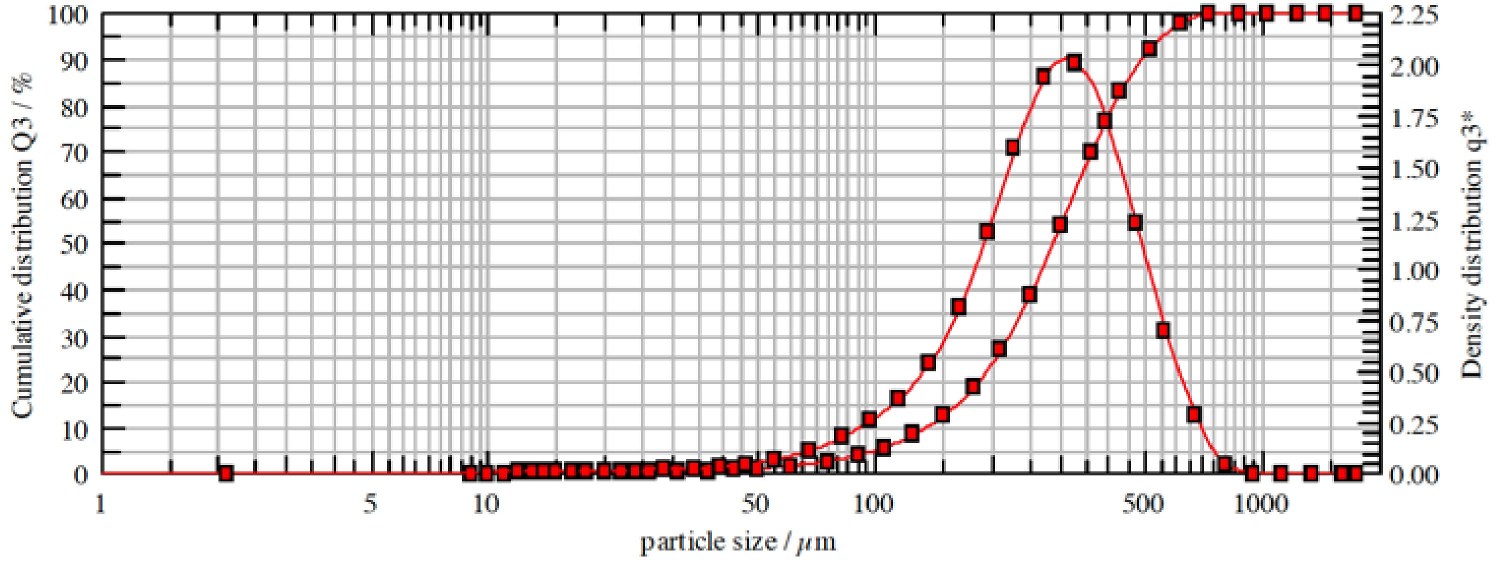
4008 @ 30 psi and 130 mph – Herbicide Mix

cumulative distribution

x0/µm	Q3/%	x0/µm	Q3/%	x0/µm	Q3/%	x0/µm	Q3/%
9.00	0.00	37.00	0.15	150.00	4.19	610.00	5.41
11.00	0.00	43.00	0.18	180.00	6.38	730.00	2.23
13.00	0.00	50.00	0.26	210.00	7.89	870.00	0.28
15.00	0.01	60.00	0.48	250.00	12.06	1030.00	0.00
18.00	0.03	75.00	1.02	300.00	15.30	1230.00	0.00
22.00	0.06	90.00	1.37	360.00	15.82	1470.00	0.00
26.00	0.07	105.00	1.70	430.00	13.24	1750.00	0.00
31.00	0.11	125.00	2.72	510.00	9.03		

Dv10= 135.95 +/- 0.00 µm **Dv50= 286.95+/- 0.00 µm** **Dv90= 491.53+/- 0.00 µm**

Relative Span = 1.24 %Less75um = 2.37



Example output from Sympatec HELOS laser diffraction measurement system.

Distribution data and plot.

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Relative Span

$$\mathrm{RS} = \frac{\mathrm{D_{V0.9}} - \mathrm{D_{V0.1}}}{\mathrm{D_{V0.5}}}$$

An indicator of the **width** of distribution.

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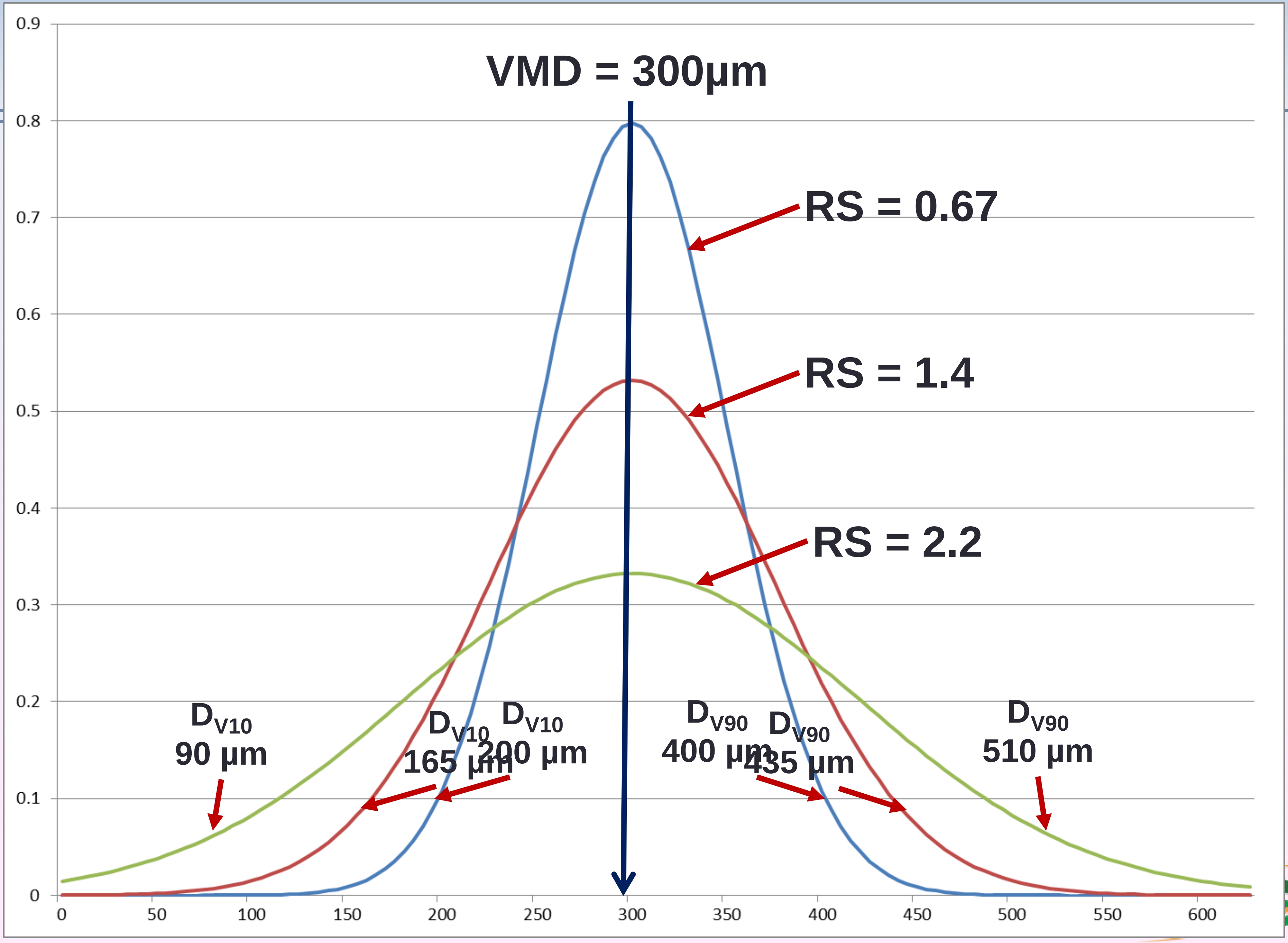

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VF/F

F/M

M/C

C/VC

VC/XC

ANSI/ASAE S572.2 JUL2018
Approved July 2018 as an American National Standard

Spray Nozzle Classification by Droplet Spectra

Developed by the ASAE Pest Control and Fertilizer Application Committee; approved by the Power and Machinery Division Standards Committee; adopted by ASAE August 1999; reaffirmed February 2004; revised March 2009; approved as an American National Standard March 2009, reaffirmed by ASABE December 2013, reaffirmed by ANSI January 2014; Corrigendum issued January 2014; reaffirmed by ASABE and ANSI December 2017; revised and approved by ASABE and ANSI July 2018.

Keywords: Chemicals, Drop size, Droplet, Fertilizer, Nozzle, Spray

1 Purpose and Scope

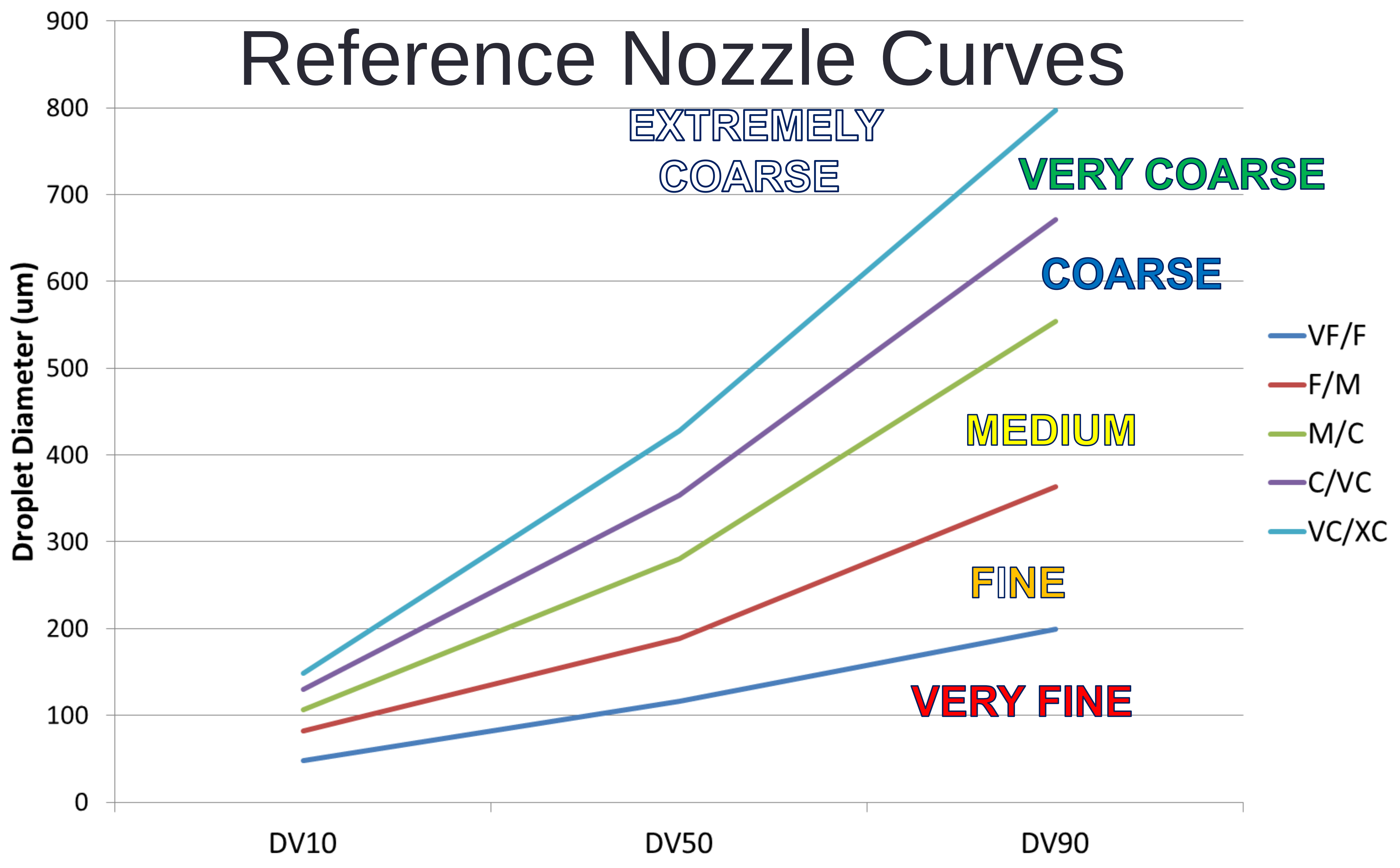
1.1 This Standard defines droplet spectrum categories for the classification of spray nozzles, relative to specified reference fan nozzles discharging spray into static air or so that no stream of air enhances atomization. The purpose of classification is to provide the nozzle user with droplet size information primarily to indicate off-site spray drift potential and secondarily for application efficacy.

1.2 This Standard defines a means for *relative nozzle comparisons only based on droplet size*. Other spray drift and application efficacy factors, such as droplet discharge trajectory, height, and velocity, air bubble inclusion; droplet evaporation; and impaction on target are examples of factors not addressed by the current Standard.

Table 1 – Classification category threshold values for flat spray nozzles

Classification Category Threshold	Nozzle Spray Angle (°)	Nominal Rated Flow Rate[1]		Reference Flow Rate[2]		Reference Operating Pressure[3]	
		(L/min)	(gpm)	(L/min)	(gpm)	(kPa)	(psi)
XF / VF	IP-16[4], 30	0.12	0.032	0.036	0.010	550	79.8
VF / F	110	0.38	0.10	0.48	0.13	450	65.3
F / M	110	1.14	0.30	1.18	0.31	300	43.5
M / C	110	2.27	0.60	1.93	0.51	200	29.0
C / VC	80	3.03	0.80	2.88	0.76	250	36.3
VC / XC	65	3.78	1.00	3.22	0.85	200	29.0
XC / UC	65	5.68	1.50	4.22	1.12	150	21.7

Reference Nozzle Curves



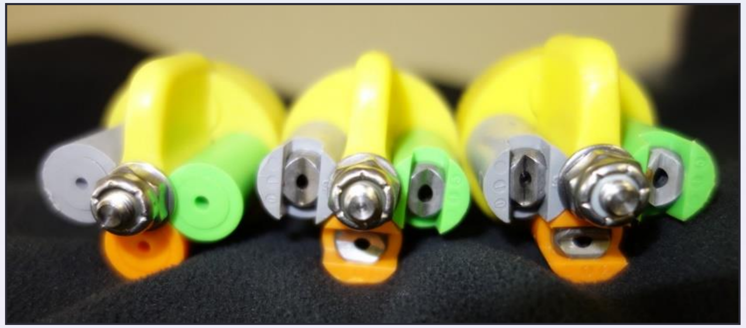
Take Home

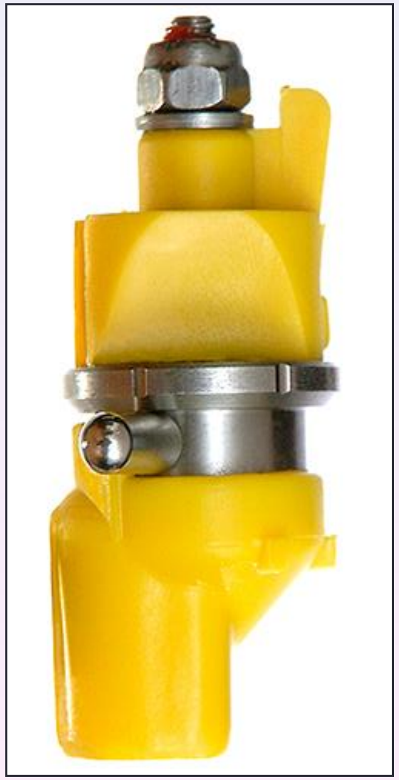
- At equal volume:
  - **Halving the diameter** creates **8X** droplets
  - **Quartering** creates **64X** droplets
    - The smaller the diameter, the greater the number of droplets, and the less control you have over them.
- **Volume** Distribution corresponds to available product and efficacy
  - $D_{V0.1}$, $D_{V0.5}$ (VMD), $D_{V0.9}$, RS
- **Droplet Size Classification** provides a relative size rating of a spray.

Aerial Application Nozzles and Droplet Size Trends

Standard Nozzle Types

- Hydraulic Nozzles
  - Flat Fans
  - Straight Streams
  - Anvil Impaction
- Rotary Atomizers
  - Air driven
  - Electrical driven





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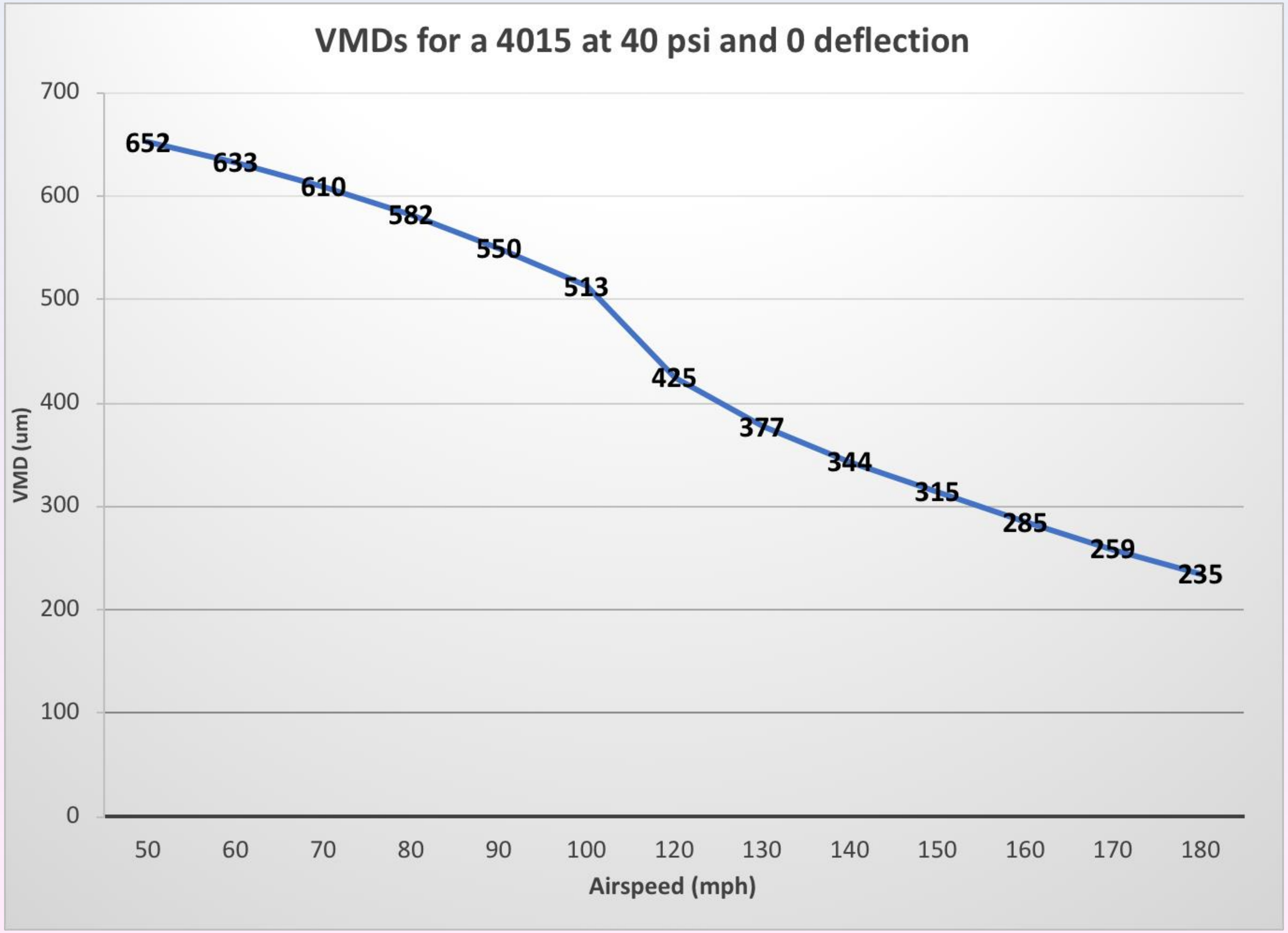
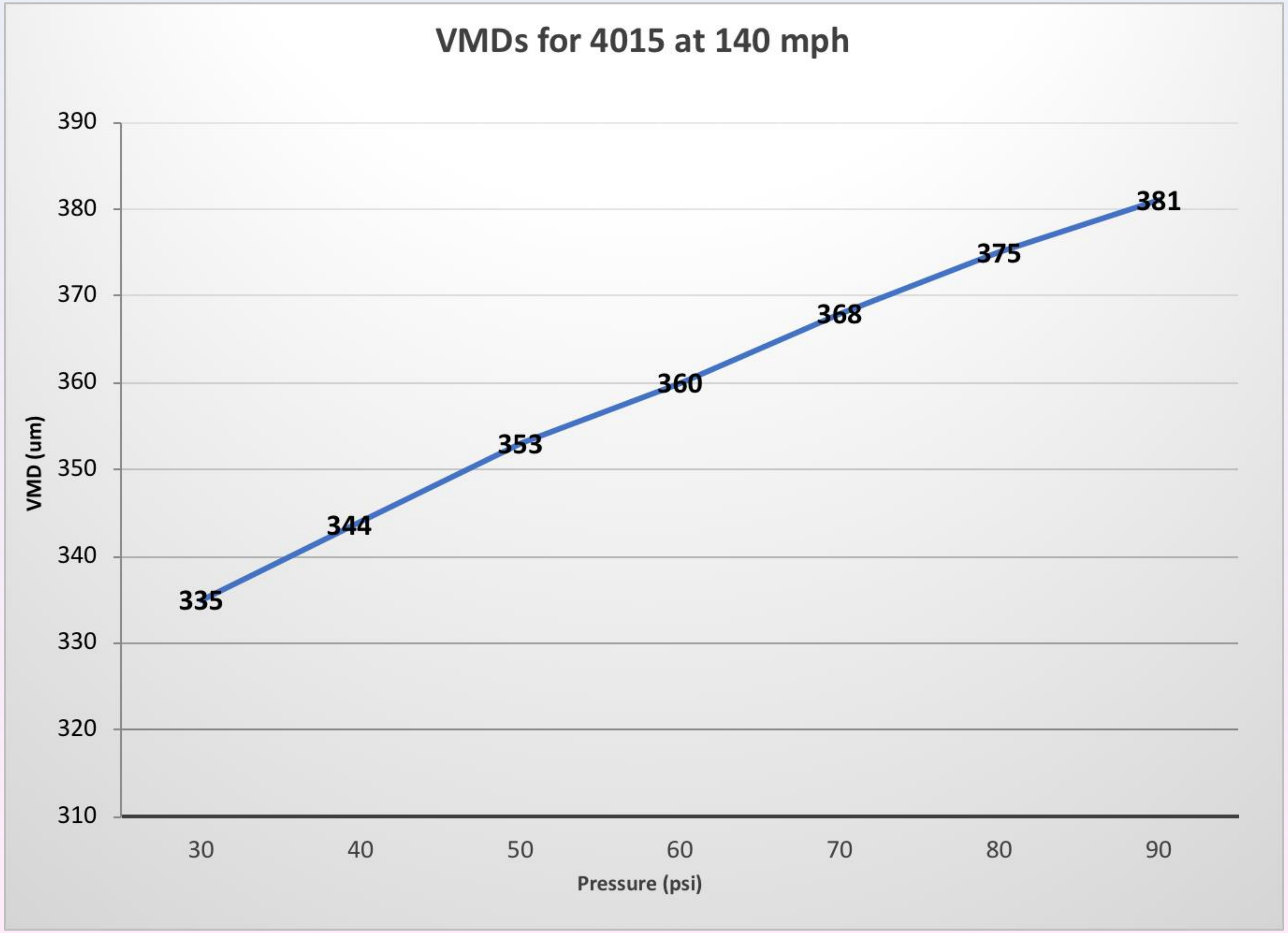
Hydraulic Nozzles - Airspeed



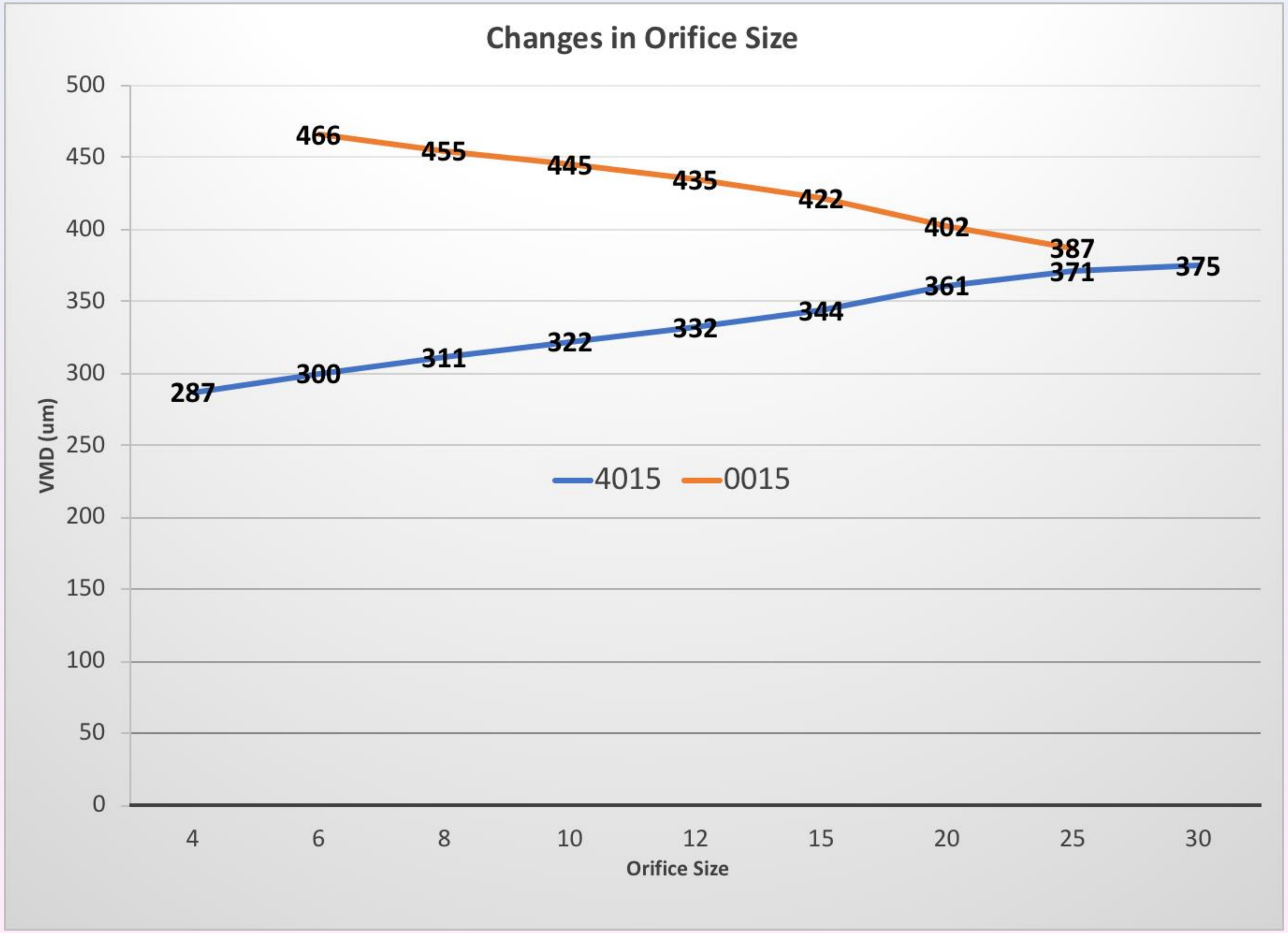
As airspeed increases, droplet size decreases.

Hydraulic Nozzles - Pressure



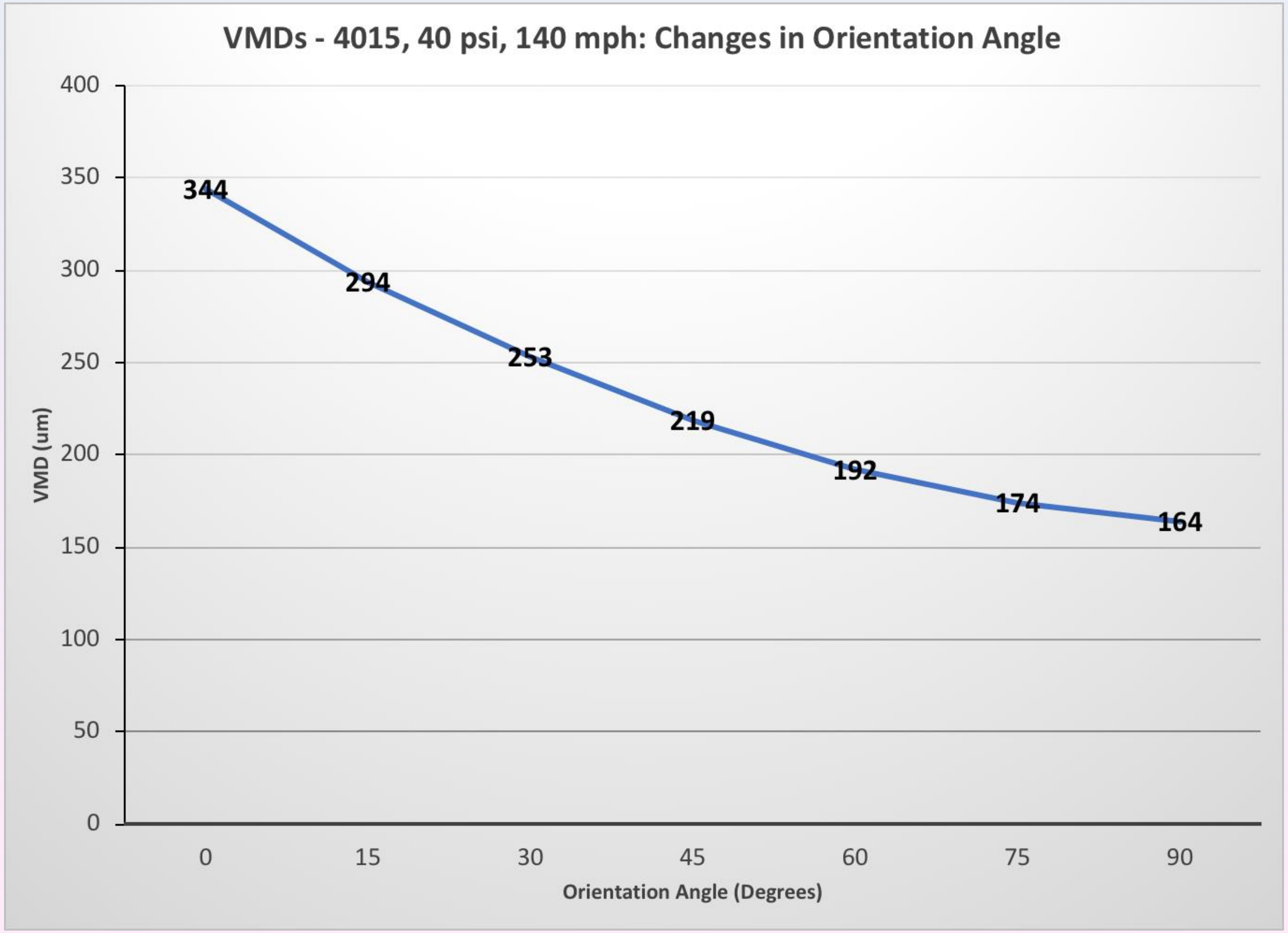
As pressure increases, droplet size increases.

Hydraulic Nozzles - Orifice



Droplet size versus orifice size – Nozzle type dependent.

Hydraulic Nozzles - Deflection



As deflection angle increases, droplet size decreases.

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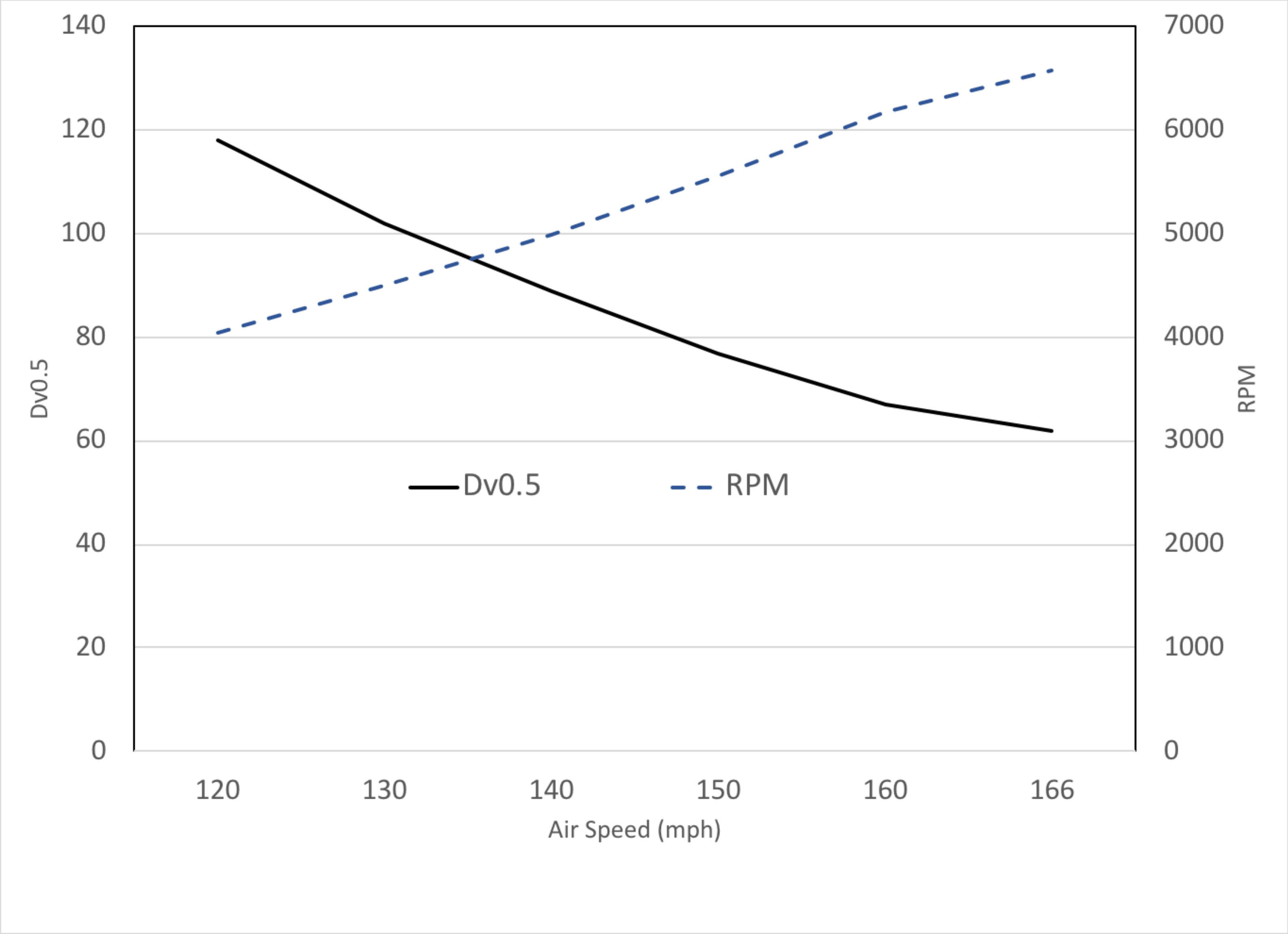
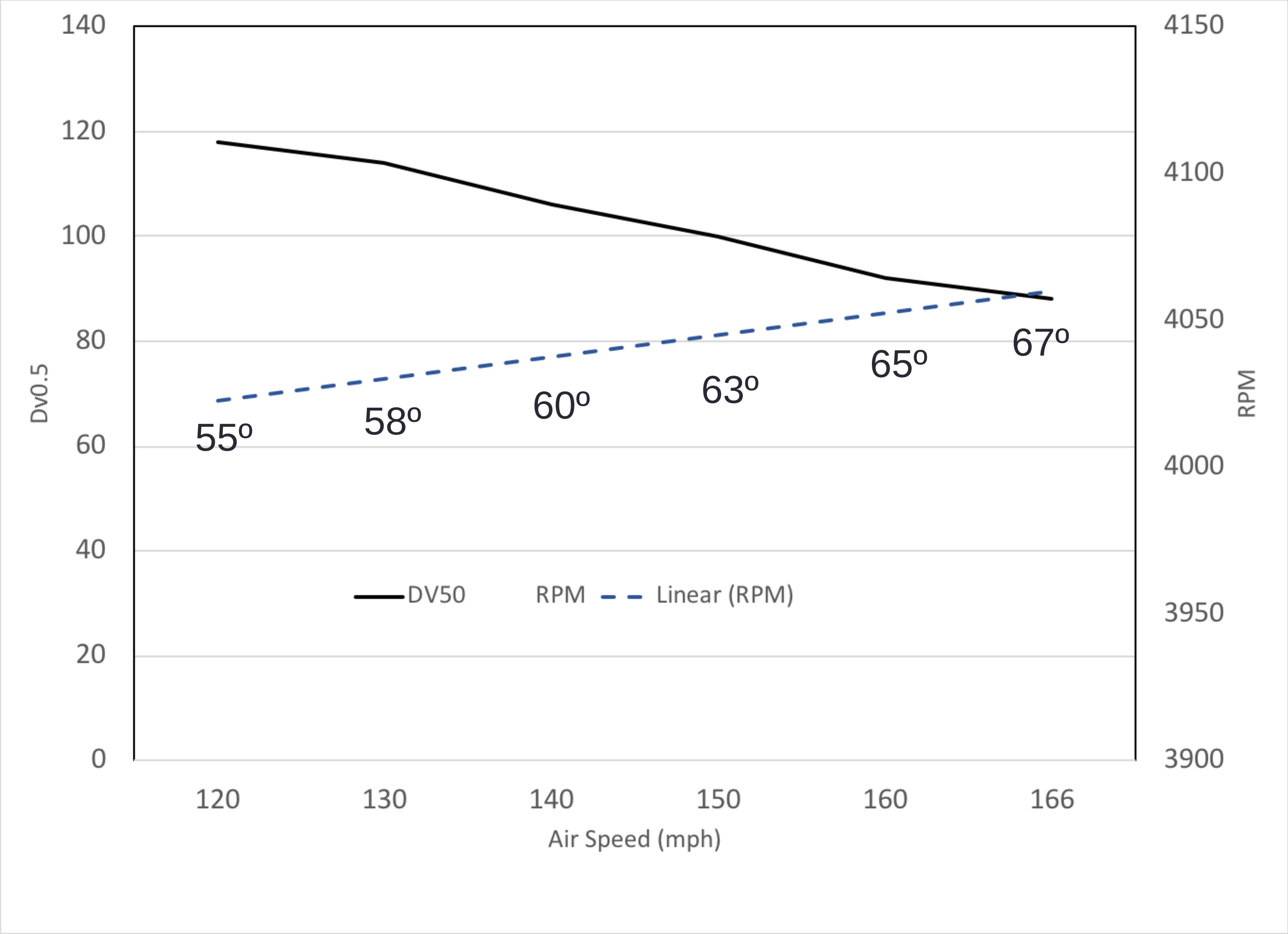
Rotary – AU5000 – Blade Angle 55º



As airspeed increases, rotational velocity increases and droplet size decreases

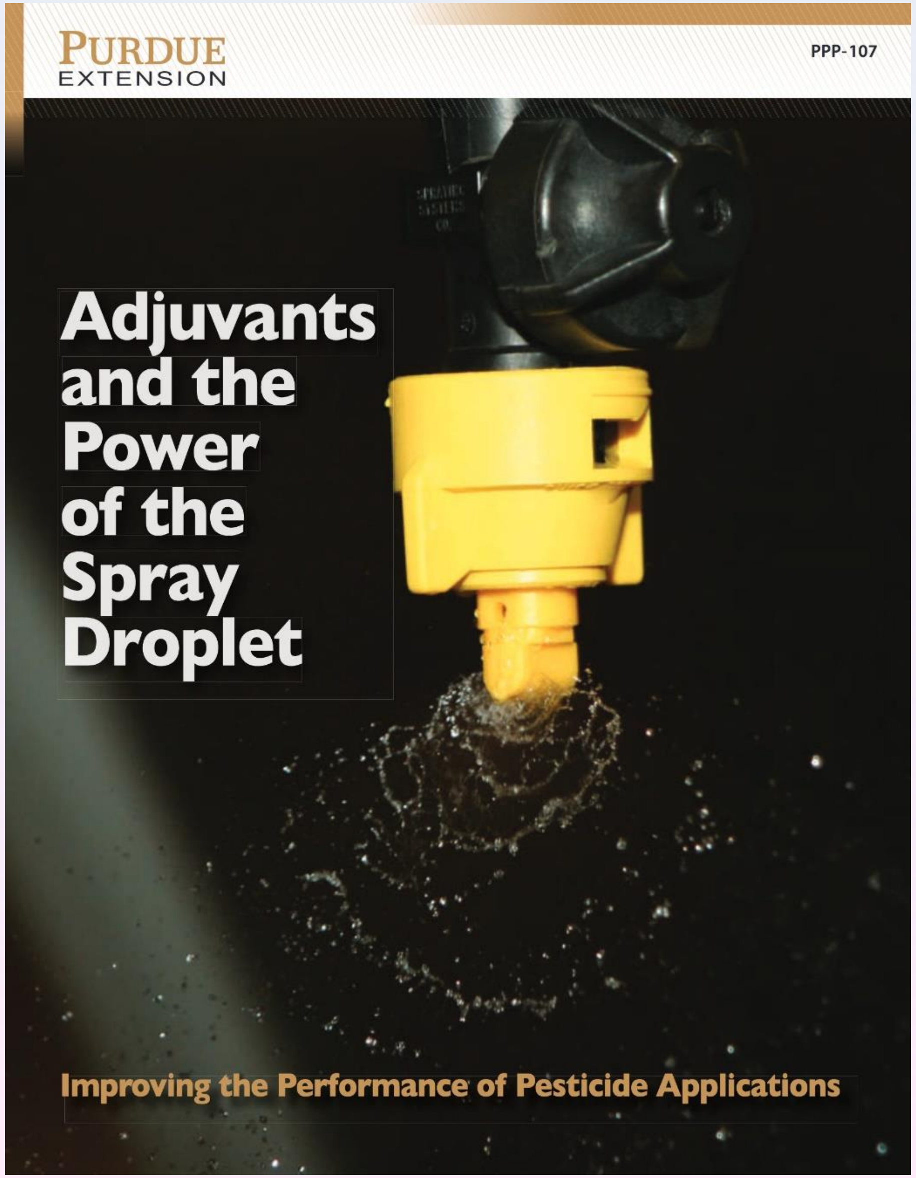
Rotary – AU5000 – Constant RPM



Blade angle can be adjusted to maintain rotational velocity with changing airspeed, reducing changes in droplet size.

Adjuvants

Resource for Adjuvants



https://ppp.purdue.edu/wp-content/uploads/2016/08/PPP-107.pdf

A google search for Purdue Extension PPP-107 will return the web link.

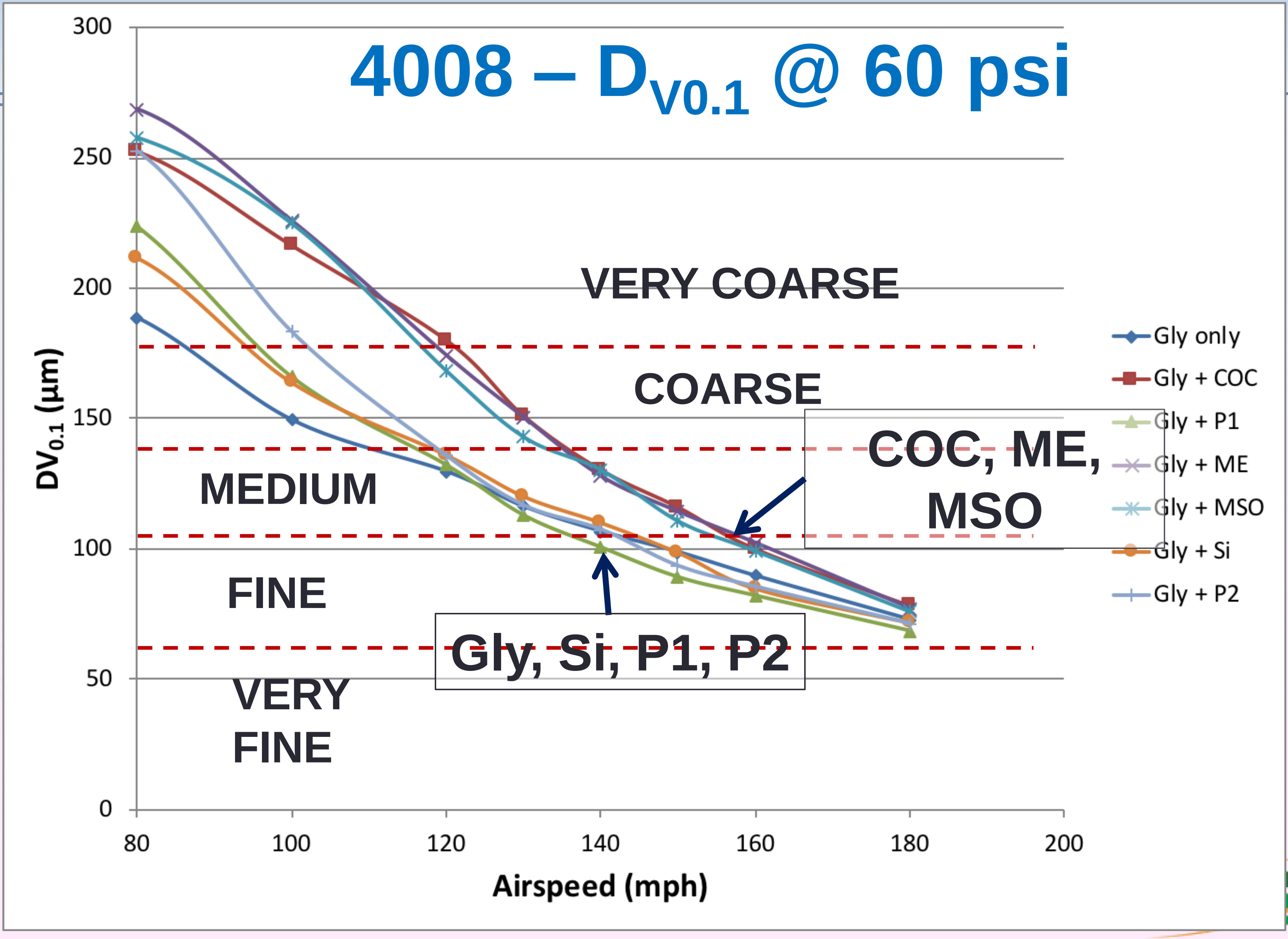
What is an Adjuvant?

ASTM Standard E1519: “Standard Terminology Relating to Agricultural Tank Mix Adjuvants”

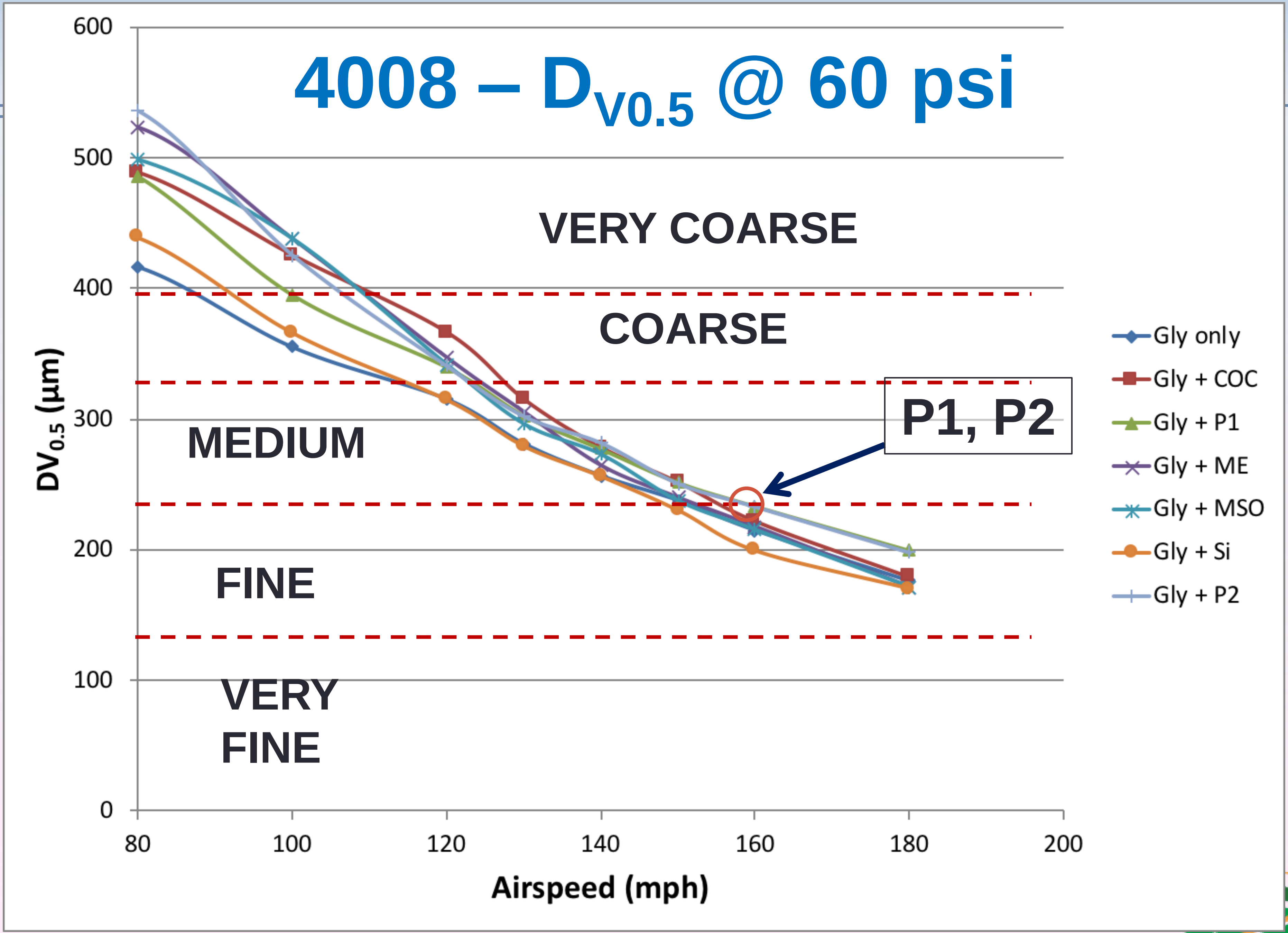
“A material added to a tank mix to aid or modify the action of an agrichemical, or the physical characteristics of the mixture.”

Adjuvant Usage and Benefits

- Improve performance by overcoming issues with:
  - Water quality and other properties;
  - Plant structure and makeup;
  - Spray system limitations;
  - Environmental conditions in field.
- Adjust pH to maintain pesticide efficacy;
- Reduce fine droplet formation;
- Reduce evaporative losses;
- Improve rainfastness;
- Increase plant absorption and uptake;
- Increase retention and spread;
- Etc…


4008 – DV0.1 @ 60 psi
300
250
200
150
100
50
0
DV0.1 (µm)
80
100
120
140
160
180
200
Airspeed (mph)
VERY COARSE
COARSE
MEDIUM
FINE
VERY FINE
COC, ME, MSO
Gly, Si, P1, P2
Gly only
Gly + COC
Gly + P1
Gly + ME
Gly + MSO
Gly + Si
Gly + P2

4008 – $D_{V0.5}$ @ 60 psi



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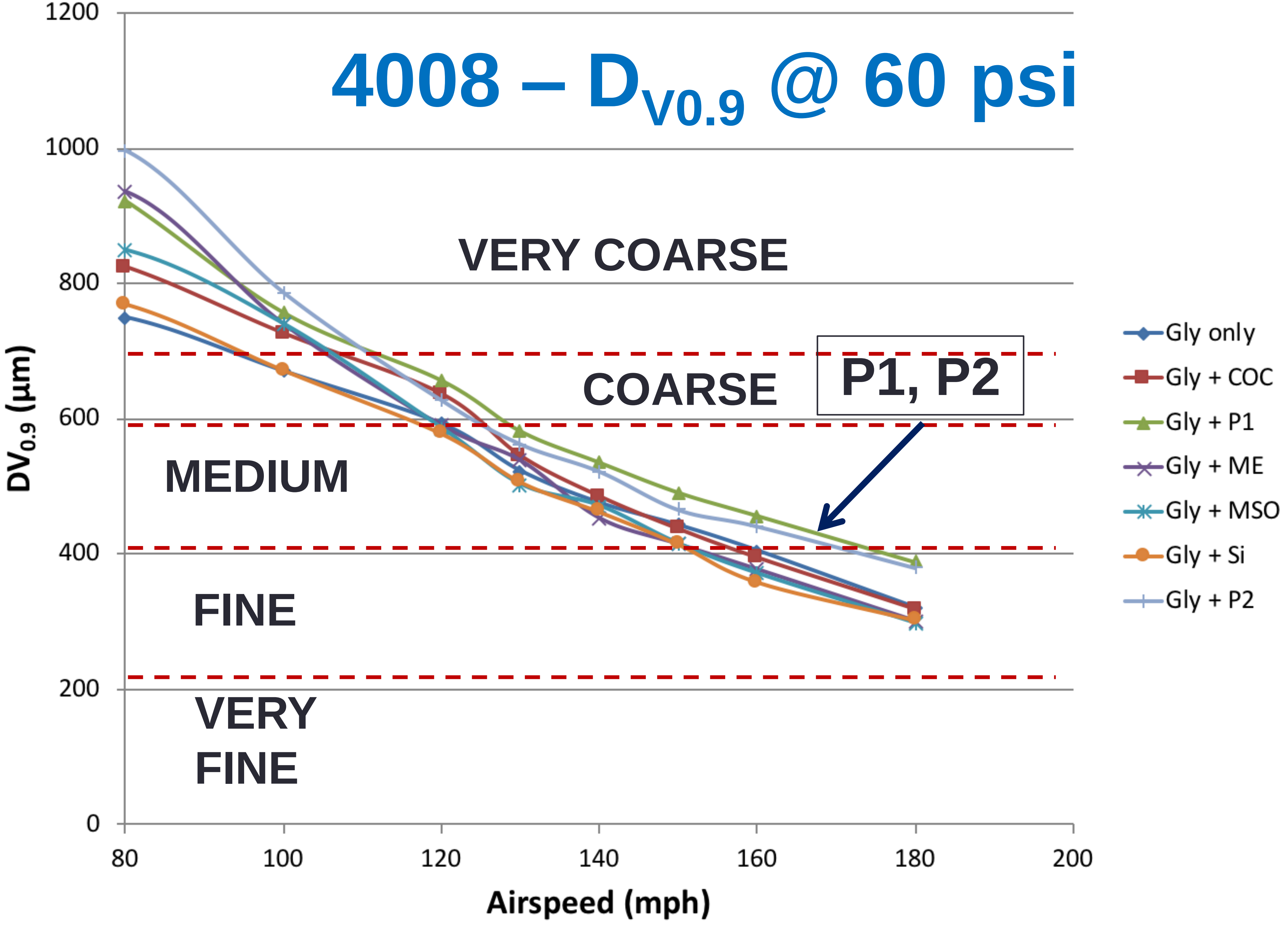
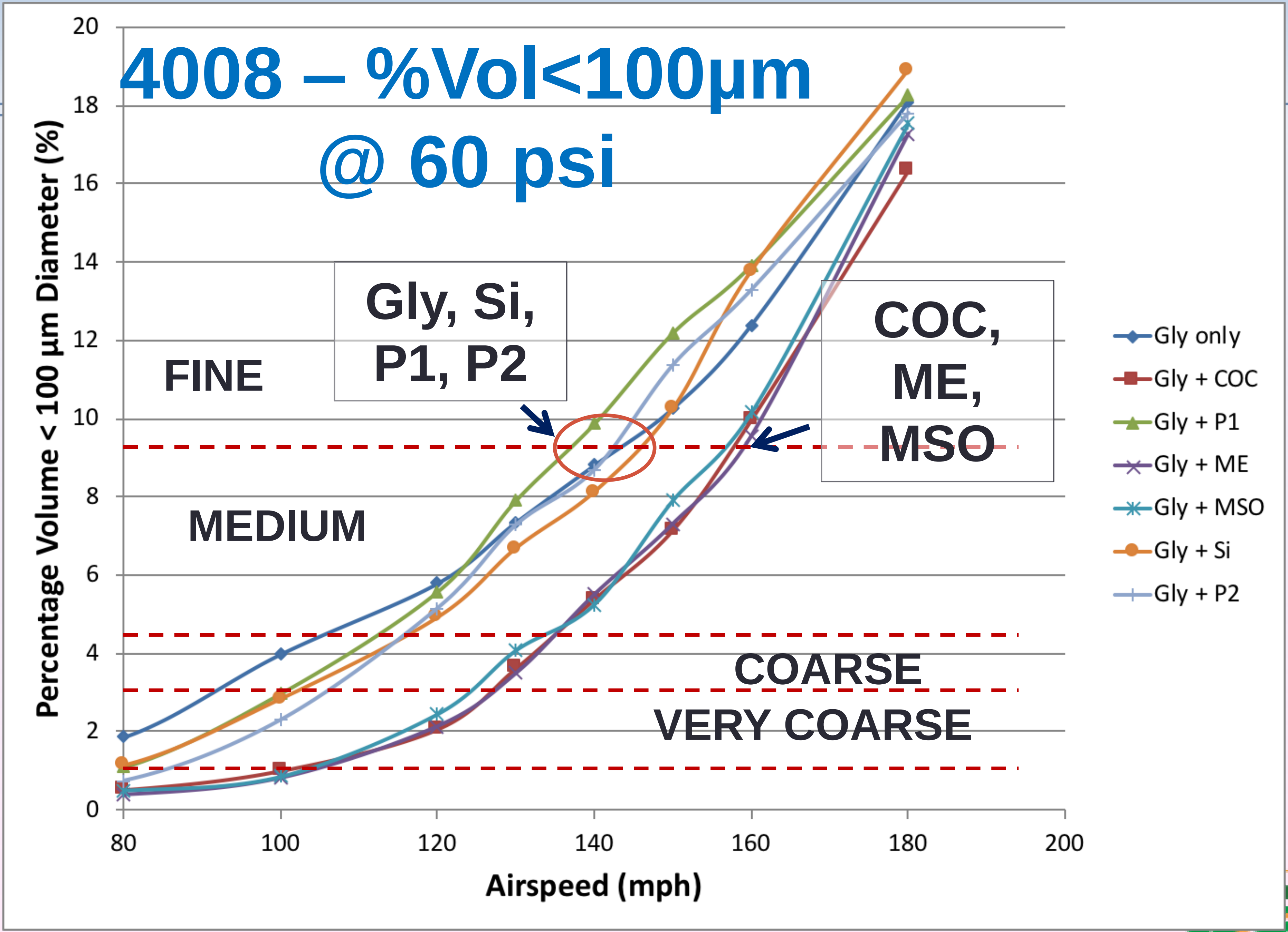
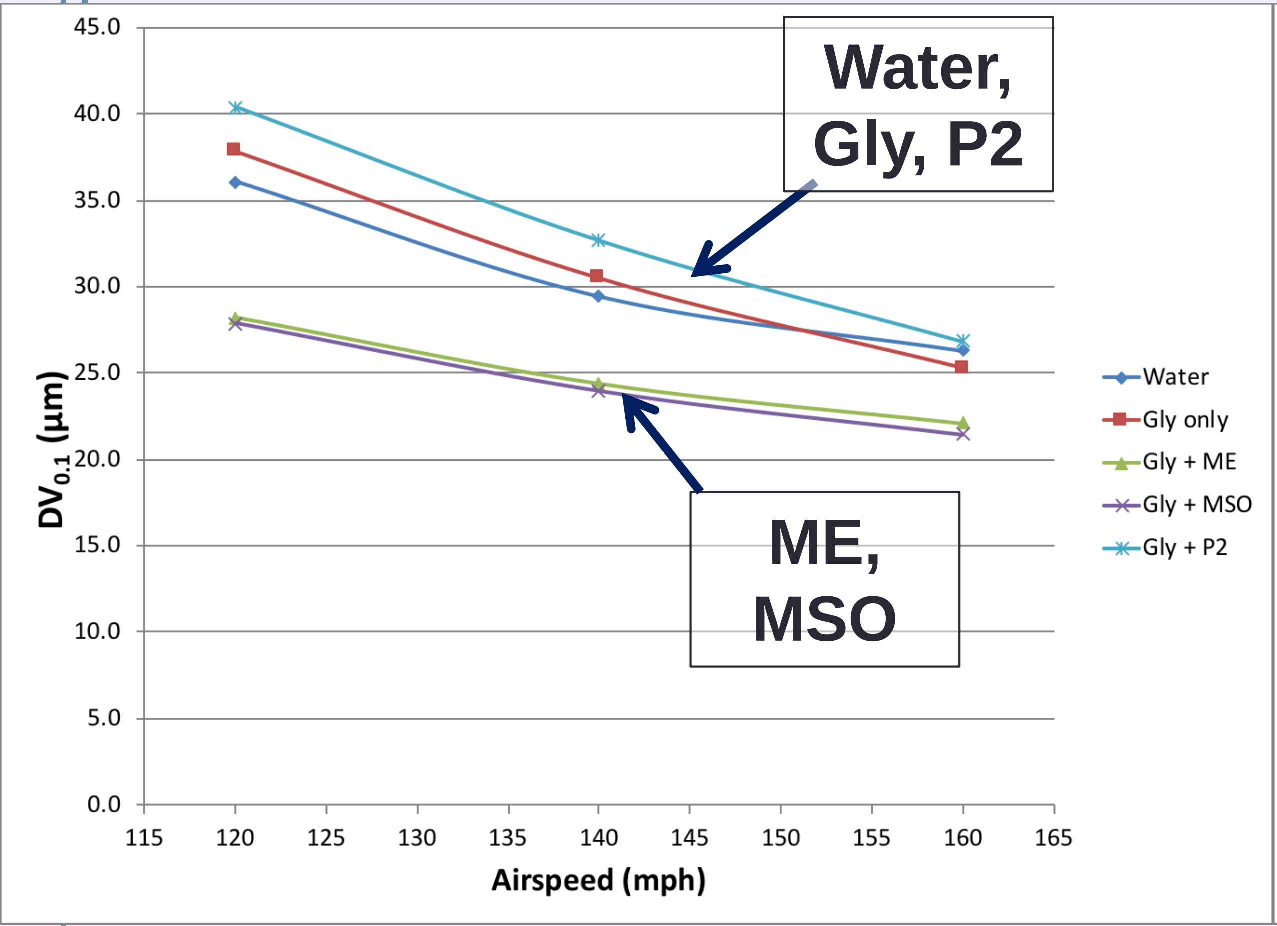
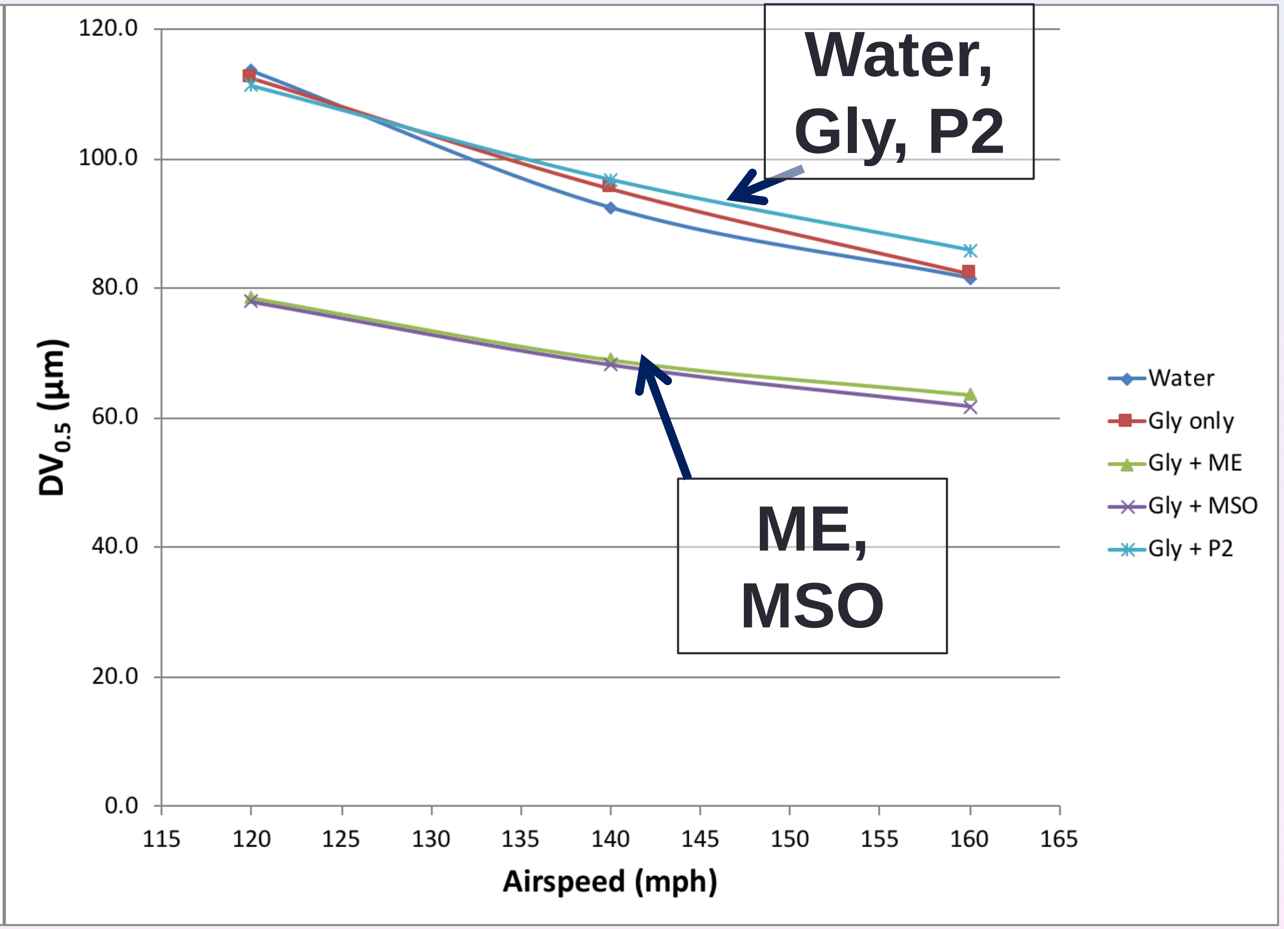
4008 – $D_{V0.9}$ @ 60 psi




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

AU4000– @ 40 psi





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General Trends

- Different nozzle/adjuvant combinations may have different effects.
  - Formulation of the active product will change droplet size.
- Air shear is the dominant factor with solution effect lessening past 140 mph.
- Adjuvant type:
  - Oils tend to slightly increase size or have no effect.
  - Thickening type adjuvants tend to increase Relative Span, creating more droplets in the larger and smaller size range.
- Nozzle selection has greatest impact on droplet size.
  - Proper nozzle selection should always be your starting point when setting up an application.

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Aircraft Setup

Setting up a System for an Application

- Pesticide product selected based on pest/application needed, grower, producer or crop consultant requirements
  - Label Requirements
    - Droplet Size
    - Weather conditions
    - Tank Mix modifiers
    - Mixing requirements
    - Spray Rate
  - Nozzle and Boom setup
  - Swath Uniformity and Effective Swath Width

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Spray System Setup

Droplet Size
Spray Rate

Both a Factor of →

Application Airspeed
Nozzle type, orifice size, orientation
Spray Pressure
Number of Nozzles (Spray Rate only)

- Changes to factors alter both droplet size and spray rate.
- Iterative Process

Effective Swath Width
Uniform Spray Pattern

Both a Factor of →

Number of nozzles
Boom setup
Application height
Aircraft type

- At this stage and applicator would do an initial boom setup and have their pattern assessed and adjusted.

Pesticide Labels = Law

ATTENTION:

This specimen label is provided for general information only.

- This pesticide product may not yet be available or approved for sale or use in your area.
- It is your responsibility to follow all Federal, state and local laws and regulations regarding the use of pesticides.
- Before using any pesticide, be sure the intended use is approved in your state or locality.
- Your state or locality may require additional precautions and instructions for use of this product that are not included here.
- Monsanto does not guarantee the completeness or accuracy of this specimen label. The information found in this label may differ from the information found on the product label. You must have the EPA approved labeling with you at the time of use and must read and follow all label directions.
- You should not base any use of a similar product on the precautions, instructions for use or other information you find here.
- Always follow the precautions and instructions for use on the label of the pesticide you are using.

63027K5-10

Roundup POWERMAX® HERBICIDE

CROPSHIELD® FORMULA

Specially formulated for Roundup Ready® crops

GROUP	9	HERBICIDE

Complete Directions for Use

EPA Reg. No. 524-549

AVOID CONTACT OF THIS HERBICIDE WITH FOLIAGE, GREEN STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS (EXCEPT AS SPECIFIED FOR INDIVIDUAL ROUNDUP READY® CROPS), DESIRABLE PLANTS AND TREES, AS SEVERE INJURY OR DESTRUCTION COULD RESULT.

Herbicide for Roundup Ready Crops

Selective broad-spectrum weed control in Roundup Ready crops

Non-selective, broad-spectrum weed control for many agricultural systems and farmsteads

Not all products listed on this label are registered for use in California. Check the registration status of each product in California before using.

Read the entire label before using this product.

Use only according to label instructions.

Read the "LIMIT OF WARRANTY AND LIABILITY" statement at the end of the label before buying or using. If terms are not acceptable, return at once unopened.

THIS IS AN END-USE PRODUCT. MONSANTO COMPANY DOES NOT INTEND AND HAS NOT REGISTERED IT FOR REFORMULATION. SEE INDIVIDUAL CONTAINER LABEL FOR REPACKAGING LIMITATIONS.

1.0 INGREDIENTS

ACTIVE INGREDIENT:
*Glyphosate, N-(phosphonomethyl)glycine, in the form of its potassium salt 48.7%
OTHER INGREDIENTS: 51.3%
100.0%

*Contains 660 grams of the active ingredient glyphosate, in the form of its potassium salt, per liter or 5.5 pounds per U.S. gallon, which is equivalent to 540 grams of the acid, glyphosate, per liter or 4.5 pounds per U.S. gallon (39.8% by weight).

This product is protected by U.S. Patent No's. 5,668,085, RE 37,866 and 6,365,551. Other Patents Pending. No license granted under any non-U.S. patent(s).

2.0 IMPORTANT PHONE NUMBERS

1. FOR PRODUCT INFORMATION OR ASSISTANCE IN USING THIS PRODUCT, CALL TOLL-FREE, 1-800-332-3111
2. IN CASE OF AN EMERGENCY INVOLVING THIS HERBICIDE PRODUCT, OR FOR MEDICAL ASSISTANCE, CALL COLLECT, DAY OR NIGHT, (314)-694-4000

3.0 PRECAUTIONARY STATEMENTS

3.1 Hazards to Humans and Domestic Animals

Keep out of reach of children

CAUTION!

CAUSES MODERATE EYE IRRITATION
Avoid contact with eyes, skin, or clothing

FIRST AID: Call a poison control center or doctor for treatment advice.	
IF IN EYES	• Hold eye open and rinse slowly and gently with water for 15 to 20 minutes. • Remove contact lenses, if present, after the first 5 minutes then continue rinsing eye.
IF ON SKIN	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15 to 20 minutes.
• Have the product container or label with you when calling a poison control center or doctor, or going for treatment. • You can also call **(314) 694-4000**, collect, day or night, for emergency medical treatment information. • This product is identified as **Roundup PowerMAX Herbicide, EPA Registration No. 524-549**.	

DOMESTIC ANIMALS: This product is considered to be relatively nontoxic to dogs and other domestic animals; however, ingestion of this product or large amounts of freshly sprayed vegetation may result in temporary gastrointestinal irritation (vomiting, diarrhea, colic, etc.). If such symptoms are observed, provide the animal with plenty of fluids to prevent dehydration. Call a veterinarian if symptoms persist for more than 24 hours.

Personal Protective Equipment (PPE)

Some of the materials that are chemical-resistant to this product are listed below. If you want more options, follow the instructions for Category A on an EPA chemical resistance category selection chart.

Applicators and other handlers must wear: long-sleeved shirt and long pants, socks, shoes, and chemical-resistant gloves made of any waterproof material such as polyethylene or polyvinyl chloride.

Follow manufacturer's instructions for cleaning/maintaining PPE (Personal Protective Equipment). If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. Do not reuse them.

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d) (4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

IMPORTANT: When reduced PPE is worn because a closed system is being used, handlers must be provided all PPE specified above for "applicators and other handlers" and have such PPE immediately available for use in an emergency, such as a spill or equipment breakdown.

1

Labels indicate requirements and limitations associated with the application of a particular product. Applicators must follow guidance provided on product labels.

Application Method,
Nozzle types,
Spray rate,
Droplet Size,
Meteorological conditions ,
Tank mix partners,
Number of applications,
Etc….

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Labels – Droplet Size

Apply only as a medium or coarser spray (ASAE standard 572) or a volume mean diameter of 300 microns or greater

IMPORTANCE OF DROPLET SIZE

The most effective way to reduce drift potential is to apply large droplets (>150 microns). The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. The presence of sensitive species nearby, the environmental conditions, and pest pressure may affect how an applicator balances drift control and coverage.

Use sufficient carrier volume and appropriate equipment set-up to form droplets large enough to avoid drift potential. Coarse droplets in the 300 to 500 (VMD) micron range are recommended.

Coarse sprays are less likely to drift; therefore, do not use nozzles or nozzle configurations which dispense spray as fine spray droplets. Do not angle nozzles forward into the airstream and do not increase spray volume by increasing nozzle pressure.

Aerial Application: Poor coverage will result in reduced weed control. For optimal weed control, apply Liberty 280 SL Herbicide in a minimum of 10 gallons per acre. Apply Liberty 280 SL Herbicide using nozzles and pressures that generate MEDIUM (about 300 to 400 microns) spray droplets category as reported by the nozzle manufacturer and in accordance to ASABE S 572 based upon the selected air speed. Do not use nozzles and pressures that result in COARSE sprays. FINE sprays should also be avoided to minimize spray drift risk. See the *Spray Drift Management* section of this label for additional information on proper application of Liberty 280 SL Herbicide.

Labeling Issues

INFORMATION ON DROPLET SIZE: The most eff
large droplets. The best drift management strategy
sufficient coverage and control. Applying larger
prevent drift if applications are made improperly, or
(see Wind, Temperature and Humidity, and Temper

CONTROLLING DROP

- Volume – Use high
with higher rated flo
- Pressure – Do not
nozzle types lower
use higher flow rate
- Number of Nozzles
- Nozzle Orientation
produces larger d
Significant deflectio
- Nozzle Type – Use
nozzle types, narr
nozzles. Solid strea
lowest drift.

Volume Median Diameter (VMD) – The VMD value is the median droplet size of the spray pattern. The optimum Rage herbicide VMD is 450 microns with fewer than 10% of the droplets being 200 microns or less. Use sprayer nozzles that meet these VMD guidelines.

s produce larger droplets.
apply the highest practical

nufacturer's recommended
pressure produces larger
d, use higher flow rate noz-

igned for the intended appli-
pray angles produce larger
Solid stream nozzles orient-
ts and the lowest drift. Use
a VMD of 450 microns with
nicrons or less.

AERIAL APPLICATIONS:

Uniformly apply with properly calibrated aerial equipment in 5 or more gallons of water per acre. When applied POSTEMERGENCE, the addition of a non-ionic surfactant AND fertilizer solution are required for optimum weed control. Apply a non-ionic surfactant at the rate of 0.25% v/v of spray solution AND ammonium sulfate at the rate of 2.5 lb/acre. (See MIXING INSTRUCTIONS).

To avoid injury to sensitive crops from drift, aerial applicators must adhere to the following SPECIAL AERIAL USE DIRECTIONS AND PRECAUTIONS:

- Nozzle height above ground must be a maximum of 10 feet.
- Nozzles must be pointed toward the rear of the aircraft. The downward angle of the nozzle should not be greater than 20 degrees.
- To minimize wing-tip vortex roll, nozzles or spray boom must not be located any closer to end of wing or rotor than three-fourths the distance from the center of the aircraft.
- Use a maximum spray pressure of 40 psi.
- A buffer zone must be established between the area to be sprayed and sensitive crops.
- DO NOT spray when wind velocity is greater than 5 mph.

Coarse sprays are less likely to drift; therefore, do not use nozzles or nozzle configurations which dispense spray as fine spray droplets. Do not angle nozzles forward into the airstream and do not increase spray volume by increasing nozzle pressure.

Example – RoundUp PowerMax

AERIAL SPRAY DRIFT MANAGEMENT

The following drift management requirements **must** be followed to minimize off-target drift movement during aerial application.

- 1. The distance of the outermost nozzles on the boom must not exceed 3/4 the length of the wingspan or rotor.
- 2. Nozzles must always point backward, parallel with the air stream and never be pointed downwards more than 45 degrees. Where states have more stringent regulations, they must be followed.

Aerial Application Technology

Example – RoundUp PowerMax

Importance of Droplet Size

- The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if the application is made improperly, or under unfavorable environmental conditions, such as in windy, high temperature with low humidity, and/or inversion conditions
as described below.

Aerial Application Technology

Example – RoundUp PowerMax

Controlling Droplet Size

- **Volume:** Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with the higher rated flows produce larger droplets.
- **Pressure:** Operate at a sprayer pressure towards the lower end of the range listed for the nozzle. Higher pressure reduces droplet size and does not improve canopy penetration. When higher flow rates are needed, use higher flow rate nozzles instead of increasing the pressure.
- **Number of nozzles:** Use the minimum number of nozzles that provide uniform coverage.
- **Nozzle orientation:** Orienting nozzles so that the spray is released backwards, parallel to the air stream, will produce larger droplets than other orientations. Significant deflection from the horizontal will reduce droplet size and increase drift potential.
- **Nozzle type:** Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce larger droplets than other nozzle types.
- **Boom length:** For some use patterns, reducing the effective boom length to less than 3/4 of the wingspan or rotor length could further reduce drift without reducing swath width.
- **Application height:** Application must be made at a height of 10 feet or less above the top of the largest plants unless a greater height is required for aircraft safety. Making the application at the lowest height that is safe reduces the exposure of the droplets to evaporation and wind.

Example – RoundUp PowerMax

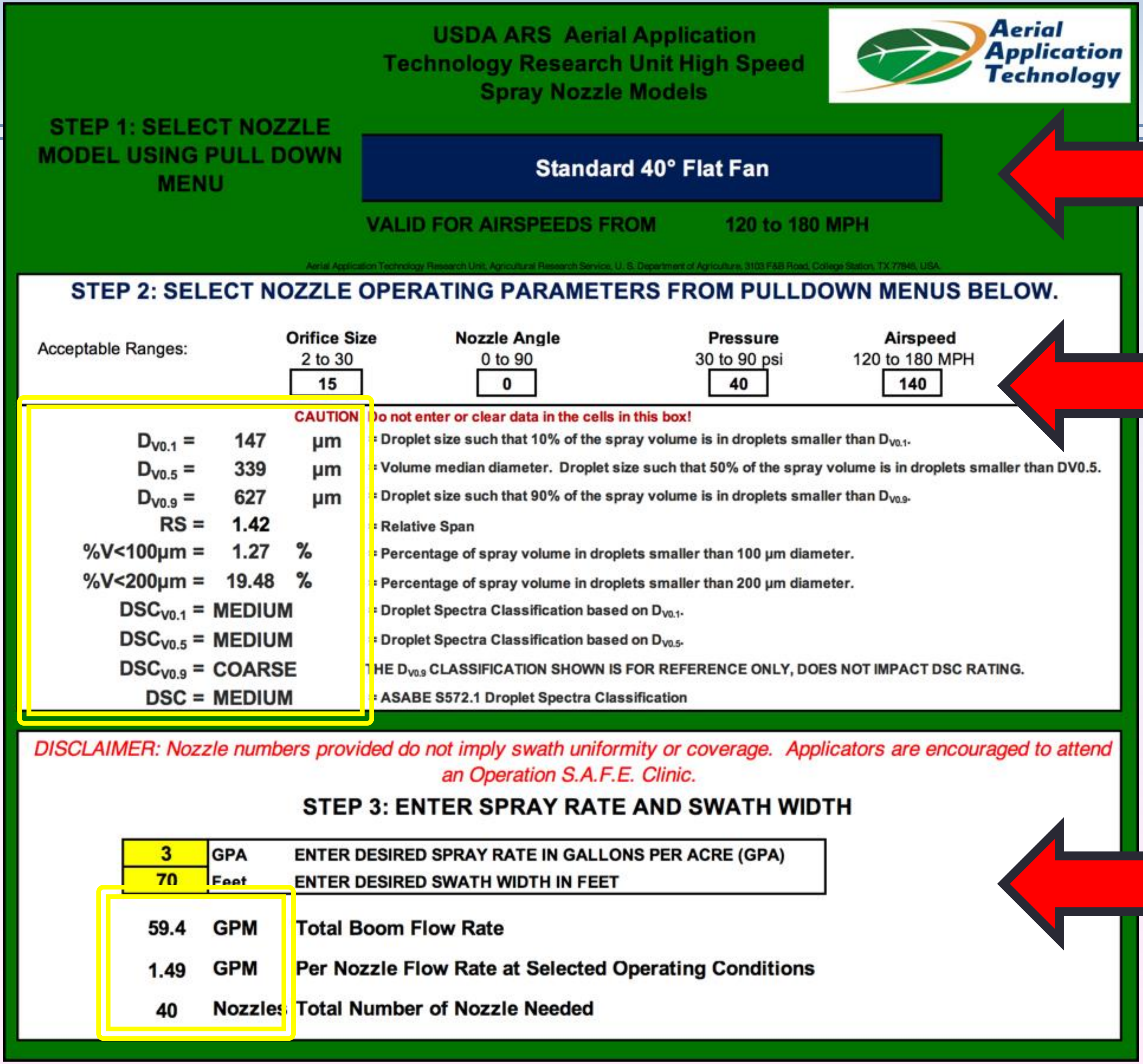
- Annual Weeds:
  - – Aerial: 3 – 5 gallons per acre
- Typical fixed-wing aircraft with the following operational characteristics:
  - – Typical application airspeeds - 130-150 mph
  - – 60-70’ swath
- Based on label we will select nozzles and settings to achieve both a MEDIUM and a COARSE spray application.

Aerial Spray Models

- A set of droplet sizing models were developed by USDA ARS to assist applicators with this process.

http://tiny.cc/DropletSizeModels

- Detailed descriptions and instructions on website.



Select nozzle type

Enter operational settings

Enter spray rate and swath width

USDA ARS Aerial Application Technology Research Unit High Speed Spray Nozzle Models

Aerial Application Technology

STEP 1: SELECT NOZZLE MODEL USING PULL DOWN MENU

Standard 40° Flat Fan

VALID FOR AIRSPEEDS FROM 120 to 180 MPH

Aerial Application Technology Research Unit, Agricultural Research Service, U. S. Department of Agriculture, 3103 F&B Road, College Station, TX 77845, USA

STEP 2: SELECT NOZZLE OPERATING PARAMETERS FROM PULLDOWN MENUS BELOW.

Acceptable Ranges:	Orifice Size	Nozzle Angle	Pressure	Airspeed
	2 to 30	0 to 90	30 to 90 psi	120 to 180 MPH
	15	0	40	125

CAUTION: Do not enter or clear data in the cells in this box!

$D_{V0.1}$ =	165	µm	= Droplet size such that 10% of the spray volume is in droplets smaller than $D_{V0.1}$.
$D_{V0.5}$ =	379	µm	= Volume median diameter. Droplet size such that 50% of the spray volume is in droplets smaller than DV0.5.
$D_{V0.9}$ =	690	µm	= Droplet size such that 90% of the spray volume is in droplets smaller than $D_{V0.9}$.
RS =	1.39		= Relative Span
%V<100µm =	0.45	%	= Percentage of spray volume in droplets smaller than 100 µm diameter.
%V<200µm =	12.38	%	= Percentage of spray volume in droplets smaller than 200 µm diameter.
$DSC_{V0.1}$ =	COARSE		= Droplet Spectra Classification based on $D_{V0.1}$.
$DSC_{V0.5}$ =	COARSE		= Droplet Spectra Classification based on $D_{V0.5}$.
$DSC_{V0.9}$ =	COARSE		SHOWN IS FOR REFERENCE ONLY, DOES NOT IMPACT DSC RATING.
DSC =	COARSE		ectra Classification

DISCLAIMER: Nozzle numbers prov led do not imply swath uniformity or coverage. Applicators are encouraged to attend an Operation S.A.F.E. Clinic.

STEP 3: ENTER SPRAY RATE AND SWATH WIDTH

3	GPA	ENTER DESIRED SPRAY RATE IN GALLONS PER ACRE (GPA)
70	Feet	ENTER DESIRED SWATH WIDTH IN FEET

53.0	GPM	Total Boom Flow Rate
1.49	GPM	Per Nozzle Flow Rate at Selected Operating Conditions
36	Nozzles	Total Number of Nozzle Needed

Aerial Application Technology

USDA ARS Aerial Application Technology Research Unit High Speed Spray Nozzle Models

Aerial Application Technology

STEP 1: SELECT NOZZLE MODEL USING PULL DOWN MENU

Disc Core Straight Stream

VALID FOR AIRSPEEDS FROM 120 to 180 MPH

Aerial Application Technology Research Unit, Agricultural Research Service, U. S. Department of Agriculture, 3103 F&B Road, College Station, TX 77845, USA.

STEP 2: SELECT NOZZLE OPERATING PARAMETERS FROM PULLDOWN MENUS BELOW.

Acceptable Ranges:	Orifice Size	Nozzle Angle	Pressure	Airspeed
	2 to 12	0 to 45	30 to 90 psi	120 to 180 MPH
	7	0	40	150

CAUTION: Do not enter or clear data in the cells in this box!

$D_{V0.1}$ =	180	µm	= Droplet size such that 10% of the spray volume is in droplets smaller than $D_{V0.1}$.
$D_{V0.5}$ =	418	µm	= Volume median diameter. Droplet size such that 50% of the spray volume is in droplets smaller than DV0.5.
$D_{V0.9}$ =	747	µm	= Droplet size such that 90% of the spray volume is in droplets smaller than $D_{V0.9}$.
RS =	1.36		= Relative Span
%V<100µm =	3.21	%	= Percentage of spray volume in droplets smaller than 100 µm diameter.
%V<200µm =	14.18	%	= Percentage of spray volume in droplets smaller than 200 µm diameter.
$DSC_{V0.1}$ =	COARSE		= Droplet Spectra Classification based on $D_{V0.1}$.
$DSC_{V0.5}$ =	COARSE		Droplet Spectra Classification based on $D_{V0.5}$.
$DSC_{V0.9}$ =	VERY COARS		HOWN IS FOR REFERENCE ONLY, DOES NOT IMPACT DSC RATING.
DSC =	COARSE		ctra Classification

DISCLAIMER: Nozzle numbers prov ed do not imply swath uniformity or coverage. Applicators are encouraged to attend an Operation S.A.F.E. Clinic.

STEP 3: ENTER SPRAY RATE AND SWATH WIDTH

3	GPA	ENTER DESIRED SPRAY RATE IN GALLONS PER ACRE (GPA)
70	Feet	ENTER DESIRED SWATH WIDTH IN FEET

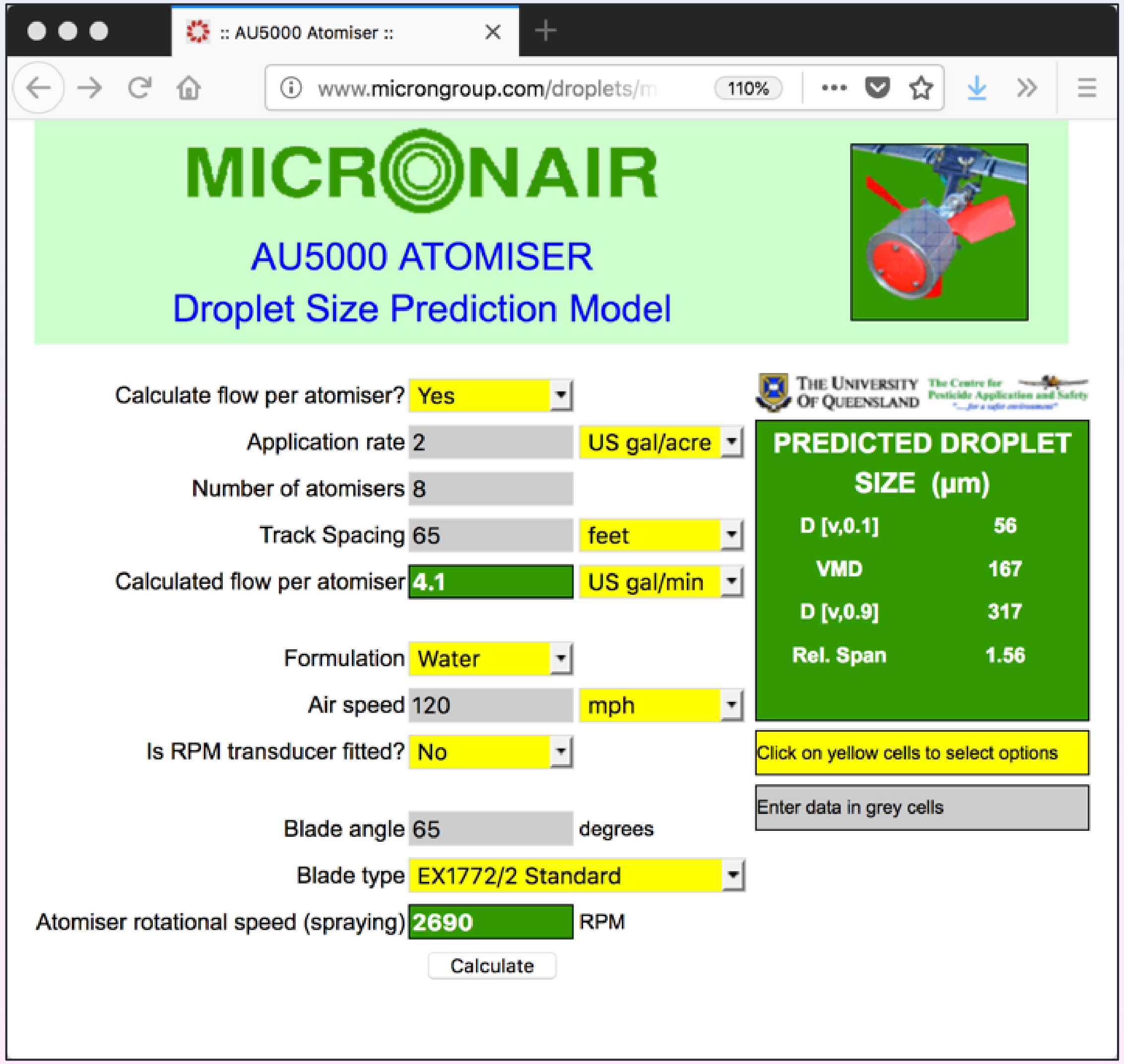
63.6	GPM	Total Boom Flow Rate
1.41	GPM	Per Nozzle Flow Rate at Selected Operating Conditions
45	Nozzles	Total Number of Nozzle Needed

Aerial Application Technology

Mobile App Formats

Aerial Application Technology

Micron Group



http://www.microngroup.com/droplets/models.php

Sign up for a user account to access the models.

Boom Setup and Nozzle Positioning

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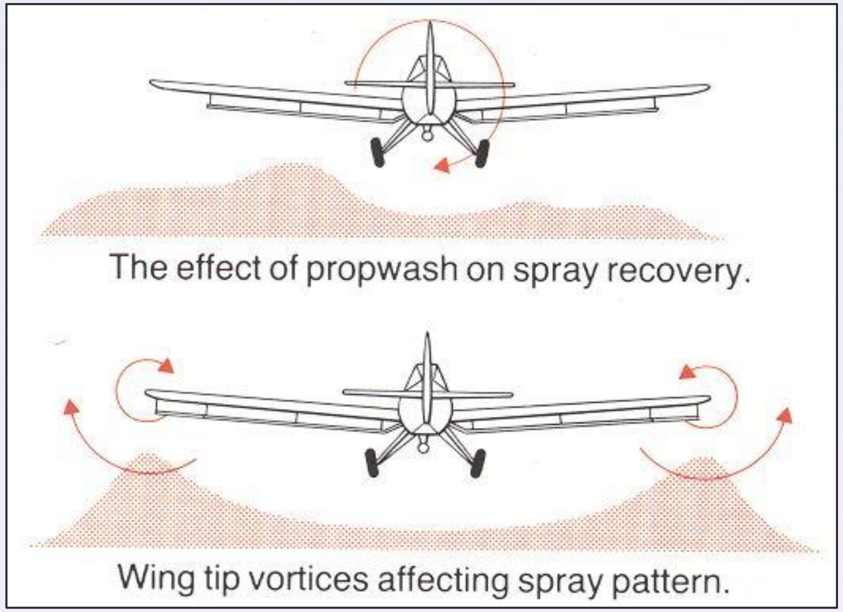
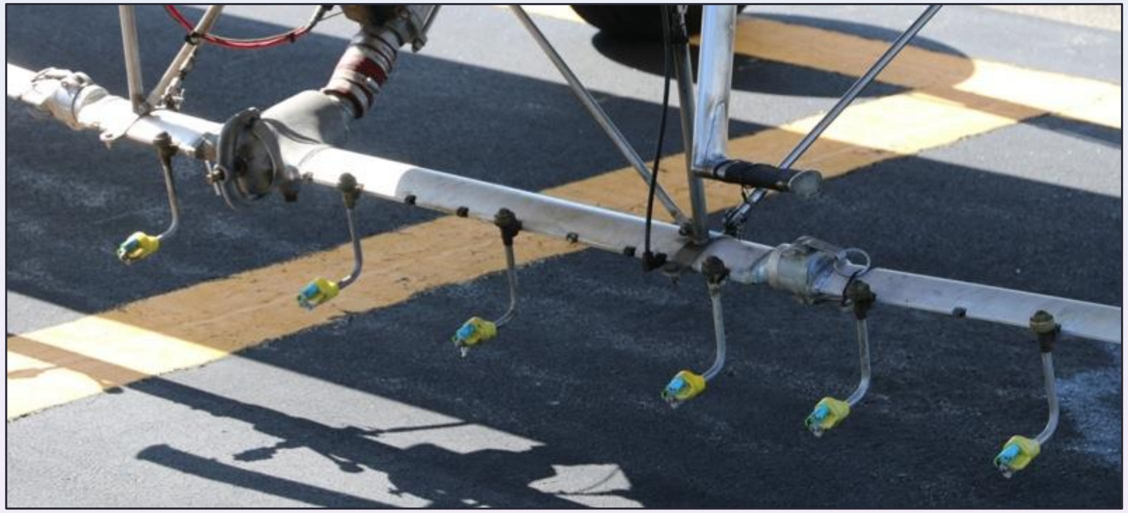
Field Streaking

Nozzle and Boom Positioning





Pattern Measurement

Aerial Application Technology

Best Practices to Consider for Drift Mitigation

What Factors Cause Drift?

- Spray Characteristics
  - Droplet Size (formulation, nozzle, operational settings, airspeed)
  - Evaporation Rate (formulation, weather)
- Aircraft
  - Application Height
  - Wing-tip Vortices (nozzle positioning)
- Weather
  - Wind
  - Temperature and Humidity
  - Inversions

Droplet Size and Wind Speed

- Using AGDISP let's consider:
  - AT-602
  - 75' swath – 65% boom width
  - 80º F at 50% TH
  - 20 spray passes
  - Fine, Medium, Coarse and Very Coarse
  - 5, 10, 15 and 20 mph

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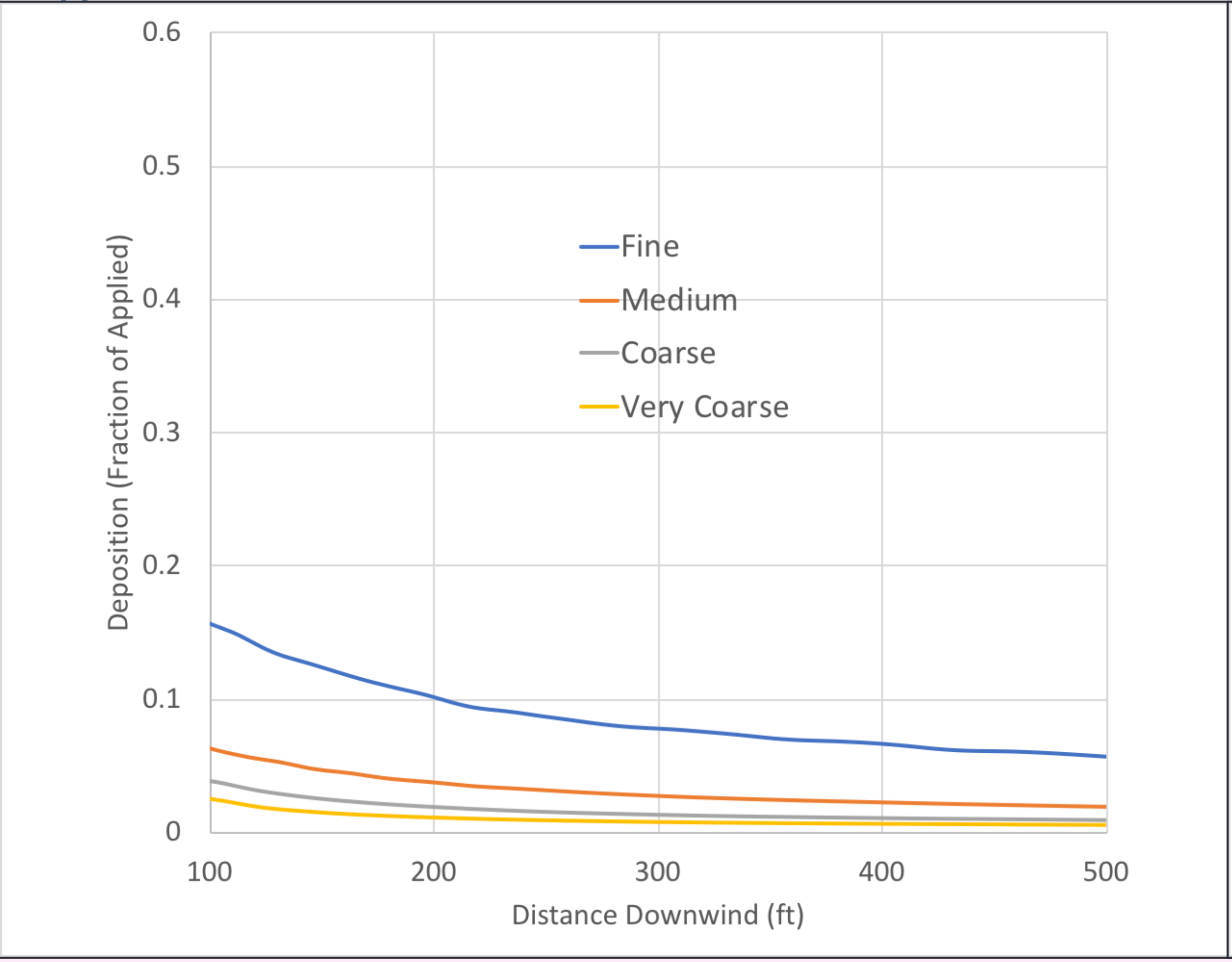
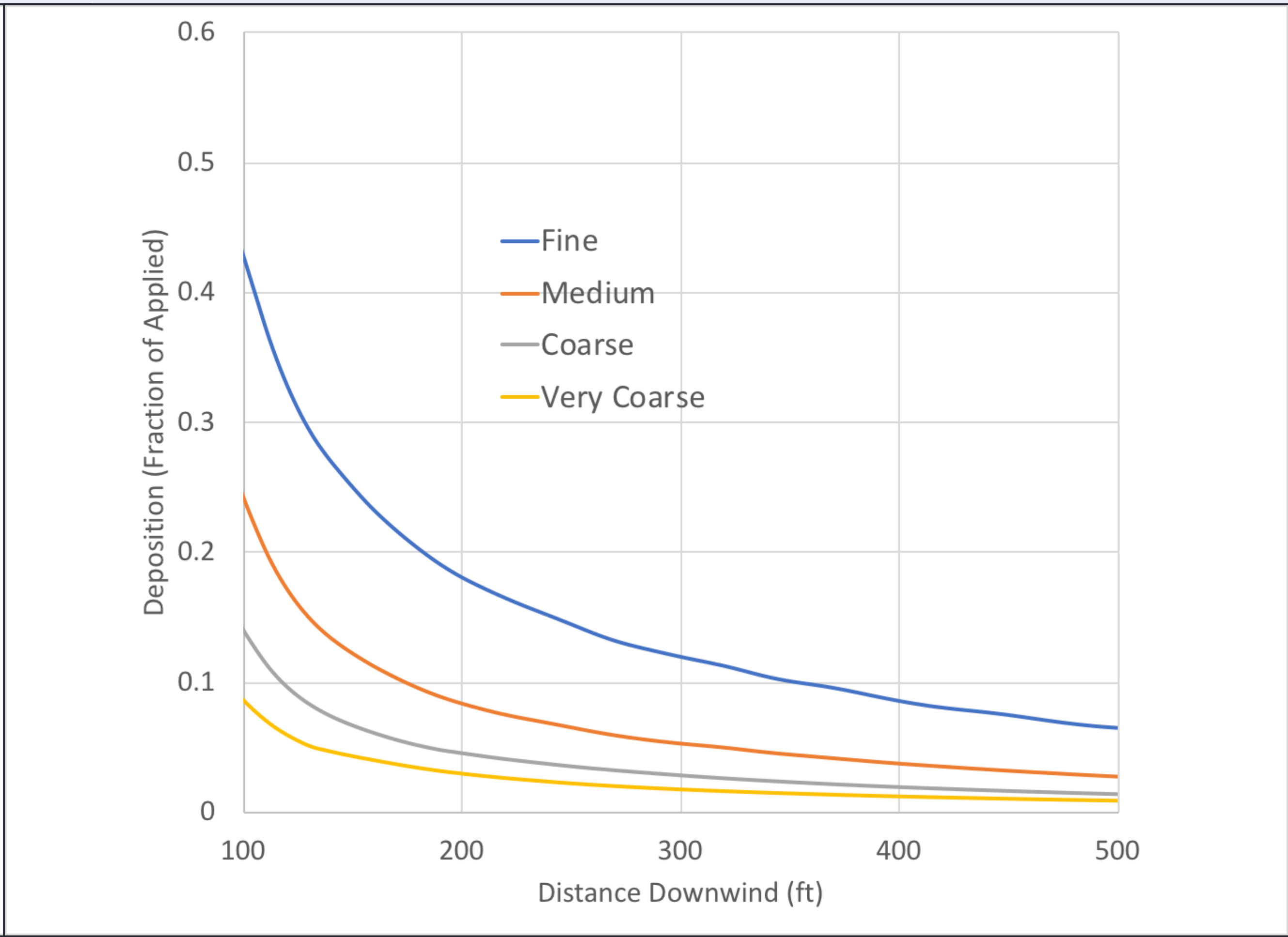
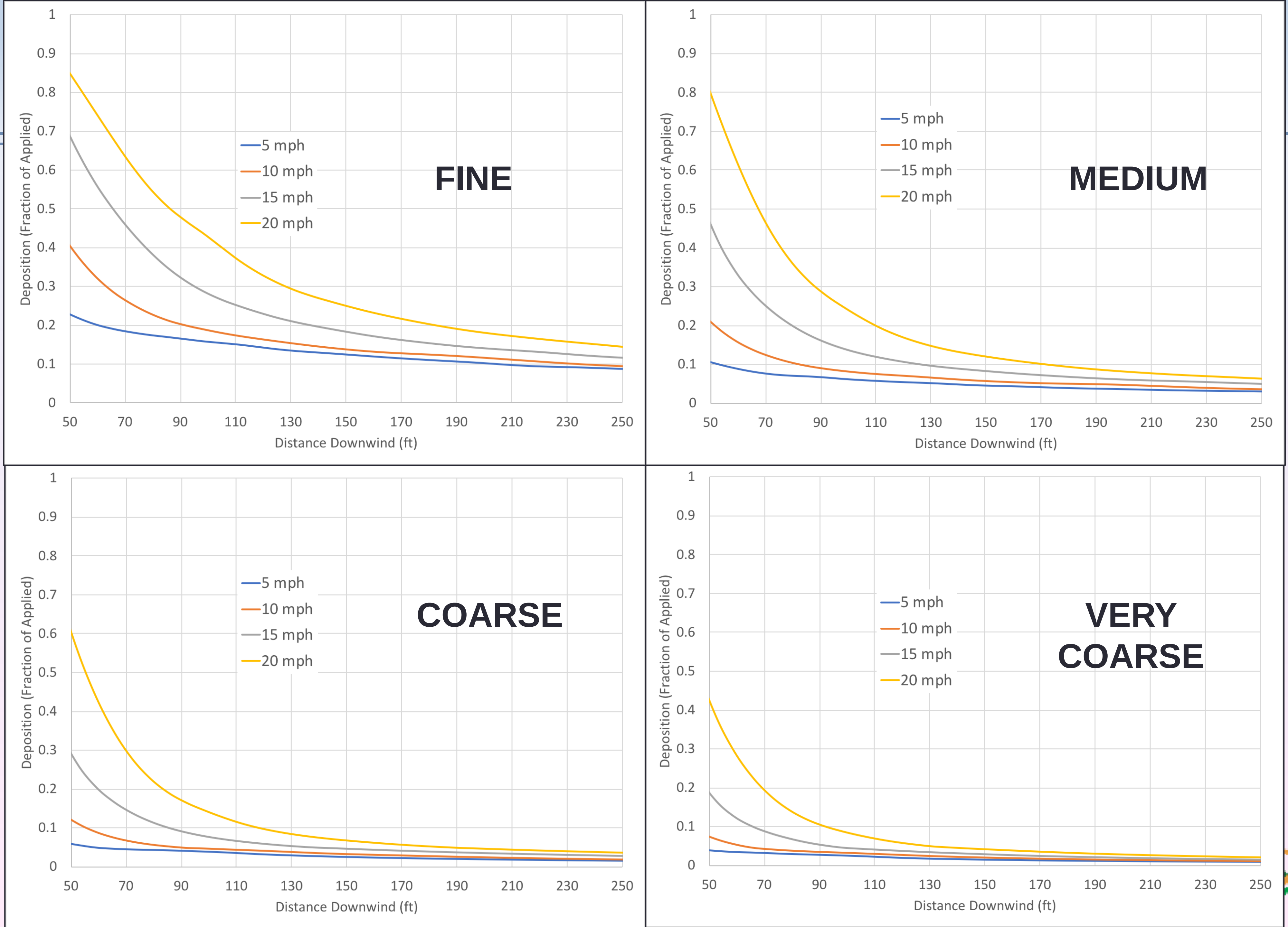
Droplet Size vs Wind Speed

5 mph



20 mph





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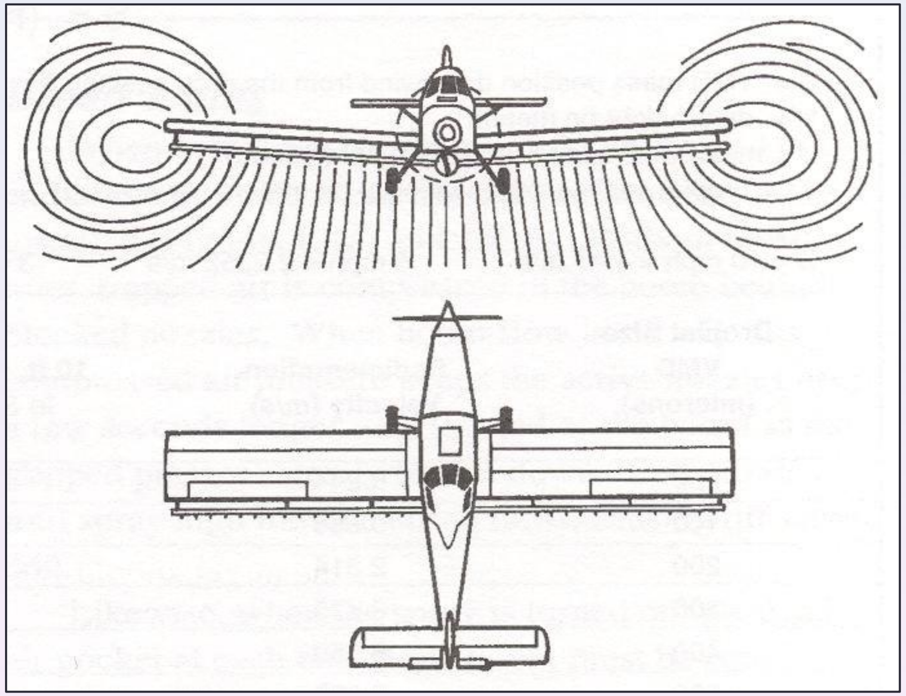
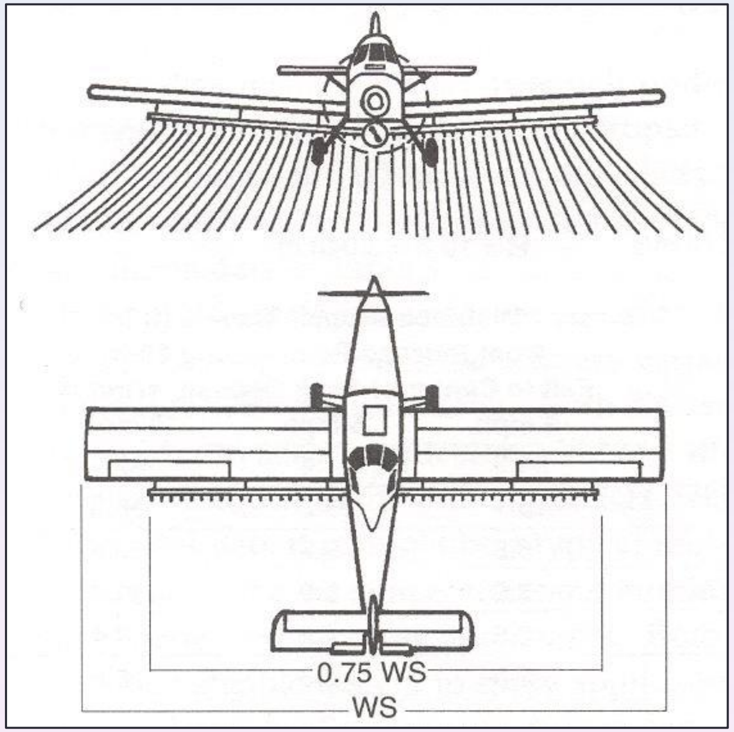
Nozzle Position on Booms



Farthest nozzle <75% of Wing Span



Downwind Edges

- The majority of off-target movement comes from the downwind edges of the field.
  - Spray when wind speed is lower, or when wind direction changes.
  - Modify application to adjust droplet size or nozzle position.
    - Reduced airspeed – 2 or 3 lower airspeed passes can reduce total off target movement by up to 10%
    - ½ boom shutoffs to reduce entrainment from downwind wing


Drift
Evaporation
Speed
Height
Off-Target
Rate
Application
Atomization
Pressure
Labels
Type
Adjuvant
Movement
Weed
Environmental
Position
Tank
Uniformity
Formulation
Class
Nozzles
Species
Health
Spray
Swath
Weather
Streaking
Stewardship
Crop
Safety
Pattern
Droplet
Mix
Boom
Temperature
Airspeed
Pesticide
Geography
Deposition
Public
Effective
Wind
Pest
Size
Solution

http://tiny.cc/AATRU

THANK YOU FOR PARTICIPATING

https://www.ars.usda.gov/

USDA

Aerial Application Technology

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RESOURCES

AATRU Scientists

Publications/Reprints

Popular Press Articles

Droplet Size Models

Imaging Resources


why
when
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QUESTIONS
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