Droplet Size Calibration: A New Approach to Effective Spraying

Application Technology Series

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Proper calibration of a sprayer to achieve accurate, safe, and efficient application of crop protection products has long been a goal for a prudent spray operator. The calibration steps are taken to ensure that the desired amount of spray material is being dispersed according to label recommendations. The steps taken to properly calibrate the sprayer will involve a calculation to determine the nozzle flow rate required to deliver the recommended carrier application volume in gallons per acre (GPA). The formula used,

$$GPM = \frac{GPA * MPH * W}{5940}$$

will incorporate the desired application volume (GPA), an appropriate ground speed in miles per hour (MPH), and nozzle spacing (W – inches) on the boom resulting in gallons per minute (GPM) flow rate per nozzle. The proper orifice size for the nozzle type and pressure is then selected from the appropriate chart and the nozzles are placed on the sprayer at each nozzle location. Then the spray process must take place maintaining the calibrated speed and pressure to obtain the desired application volume.

Most applicators are familiar with how to use flow rate charts from spray equipment catalogs and Web sites to determine the nozzle orifice size needed as described above. Applicators are also comfortable in making those applications with the benefit of an automatic rate controller to help improve the uniformity of application volume across the field. However, a sprayer calibrated in this manner does not guarantee the application will achieve its highest level of efficacy or minimize drift.

The next step in calibration is designed to achieve this, but is one that most applicators are not yet familiar with. This calibration step requires applicators to review droplet size charts to choose nozzle types, sizes, and pressure levels that will meet a specified droplet classification listed on the label. The droplet size created by a nozzle becomes very important when the efficacy of a particular plant protection product is dependent on coverage (Table 1), or when the minimization of material leaving the target area is a priority. Droplet specifications given on the label are provided to guide applicators

Table 1. Droplet spectra category and recommendation for various pesticide types or uses. An X represents a recommendation.

ASABE Standard S-572 Droplet spectrum Categories1	Contact insecticide and fungicide	Systemic insecticide and fungicide	Contact foliar herbicide	Systemic foliar herbicide	Soil-applied herbicide	Incorporated soil-applied herbicide
Very Fine (VF)						
Fine (F)	X					
Medium (M)	X	X	X	X		
Coarse (C)		X		X	X	X
Very Coarse (VC)				X	X	X
Extremely Coarse (XC)						X

[1]Based on $V_{D0.5}$ (Volume Median Diameter – VMD) designation.

Table 2. Spray quality categories.

ASABE Standard S-572 Spray Quality Categories	
Category (symbol)	**Color Code**
Very Fine (VF)	Red
Fine (F)	orange
Medium (M)	yellow
Coarse (C)	Blue
Very Coarse (VC)	Green
Extra Course (EC)	White

in selecting how to best apply that material. Thus, consulting the nozzle manufacturers' droplet sizing charts is **essential**. Applicators should also remember the effect of changing speed when using an automatic rate controller. Major speed fluctuations will cause pressure adjustments that, while maintaining the GPA, may shift the droplet spectrum resulting in possible off-label applications.

To help applicators select nozzles according to droplet size, spray equipment manufacturers are including drop size charts with their respective catalogs and Web sites. These charts classify the droplet size from a given nozzle at various pressure levels according to a standard set up by the American Society of Agricultural and Biological Engineers (ASABE). The standard (S-572) rates droplets as very fine, fine, medium, coarse, very coarse, and extra coarse. Droplet size categories are color-coded as shown in Table 2.

As an example, to achieve 10 GPA at 12 MPH with a 20-inch nozzle spacing, a "04" orifice would be suitable (ie. 8004, 11004) to deliver the 0.40 GPM flow rate (10 GPA * 12 MPH * 20-inch nozzle spacing divided by 5940). Regardless of the nozzle type selected, the pressure for this orifice scenario would need to be 40 PSI to deliver the correct GPA, resulting in a medium droplet with the XR nozzle (either 8004 or 11004), a coarse droplet with the TT nozzle, and an extra coarse with the AI nozzle (see charts below). Similar information can be found on nozzle manufacturers Web sites. Table 3 provides selected examples of companies and Web sites with this information.

Obviously the nozzle type selected for this application scenario will influence coverage as well as drift. For some fungicide and/or insecticide application scenarios the medium/fine option would be very close to the desired specifications for adequate coverage and efficacy. However, when applying certain herbicides, a larger droplet spectrum may be essential to minimize the drift potential.

Table 3. Selected nozzle manufacturer Web sites.

Spraying Systems - TeeJet	*http://www.teejet.com/*
Greenleaf Technologies	*http://www.turbodrop.com/*
Hypro Pumps	*http://www.hypropumps.com/*
Wilger	*http://www.wilger.net/*
Hardi – North America	*http://www.hardi-us.com/*
Delavan Ag Spray	*http://www.delavanagspray.com/*
Lechler	*http://www.lechlerusa.com/*
Albuz	*http://www.albuz.saint-gobain.com/index.htm*
CP Products	*http://www.cpproductsinc.com/*
ABJ Agri Products	*http://www.abjagri.com/*

An influencing factor then becomes the necessity for applicators to have a good knowledge of the 'mode of action' for the crop protection product being used. It is commonly thought that a systemic material such as glyphosate can work well with a medium, coarse, or maybe even a very coarse droplet spectrum while a contact material such as paraquat will need a droplet spectrum promoting more leaf coverage, ie. medium droplets.

A close review of the flow rate and droplet category charts would reveal that several nozzle options could be acceptable for the application scenario mentioned above, each creating the required flow rate but different droplet sizes. In the above example, selecting a larger orifice, the 05 at approximately 26 PSI, would deliver the correct flow rate (0.40 GPM), but would alter the droplet spectrum significantly; the XR would remain medium for the 11005, but would change to coarse with the 8005. With the 05 orifice, the TT becomes very coarse and the AI is now extra coarse. In fact the AI would not be recommended since it falls below its suggested operating pressure for improving coverage potential. Shifting to a smaller orifice, the 03 operated at approximately 70 PSI, results in the required flow rate (0.40 GPM), but the XR being fine for both fan angles and would not be recommended because the 70 PSI exceeds its maximum operating pressure of 60 PSI. The TT11003 would have a medium droplet spectrum, but at 70 PSI is approaching its higher use limit. The AI11003 would become very coarse and can be recommended at 70 PSI. In the above scenarios, the low pressure concerns are related to lack of coverage and the high pressure concerns are related to increasing drift potential.

Droplet size charts for other nozzle types may differ from the examples above. Learning to use these droplet sizing charts is absolutely essential for proper pest control product application. It is also highly possible that certain nozzle types may not meet the label specified droplet spectrum. All nozzle manufacturers' provide this information for the nozzle types they market.

Figure 1. Nozzle types referenced in Table 4.

Table 4. Droplet spectra classification, nozzle type, psi, flow rates.

Nozzle Type	PSI	DSC[1] 80°	DSC[1] 110°	GPM[2]	Nozzle Type	PSI	DSC[1]	GPM[2]	Nozzle Type	PSI	DSC[1]	GPM[2]
XR 03	15	M	M	0.18	TT 03	15	VC	0.18	AI 03	30	XC	0.26
	20	M	M	0.21		20	VC	0.21		40	VC	0.30
	30	M	F	0.26		30	C	0.26		50	VC	0.34
	40	M	F	0.30		40	C	0.30		60	VC	0.37
	50	M	F	0.34		50	M	0.34		70	VC	0.40
	60	F	F	0.37		60	M	0.37		80	VC	0.42
XR 04	15	C	M	0.24		75	M	0.41		90	C	0.45
	20	C	M	0.28		90	M	0.45		100	C	0.47
	30	M	M	0.35	TT 04	15	XC	0.24	AI 04	30	XC	0.35
	40	M	M	0.40		20	VC	0.28		40	XC	0.40
	50	M	F	0.45		30	C	0.35		50	VC	0.45
	60	M	F	0.49		40	C	0.40		60	VC	0.49
XR 05	15	C	M	0.31		50	C	0.45		70	VC	0.53
	20	C	M	0.35		60	C	0.49		80	VC	0.57
	30	C	M	0.43		75	M	0.55		90	C	0.60
	40	M	M	0.50		90	M	0.60		100	C	0.63
	50	M	M	0.56	TT 05	15	XC	0.31	AI 05	30	XC	0.43
	60	M	F	0.61		20	VC	0.35		40	XC	0.50
XR 06	15	C	C	0.37		30	VC	0.43		50	VC	0.56
	20	C	C	0.42		40	C	0.50		60	VC	0.61
	30	C	M	0.52		50	C	0.56		70	VC	0.66
	40	C	M	0.60		60	C	0.61		80	VC	0.71
	50	C	M	0.67		75	C	0.68		90	VC	0.75
	60	C	M	0.73		90	M	0.75		100	C	0.79
					TT 06	15	XC	0.37	AI 06	30	XC	0.52
						20	XC	0.42		40	XC	0.60
						30	VC	0.52		50	VC	0.67
						40	C	0.60		60	VC	0.73
						50	C	0.67		70	VC	0.79
						60	C	0.73		80	VC	0.85
						75	C	0.82		90	VC	0.90
						90	M	0.90		100	C	0.95

Color Code Designation	Very Fine	Fine	Medium	Coarse	Very Coarse	Extra Coarse

[1] Droplet spectra classification based on ASABE S-572.

[2] Nozzle flow rate in gallons per minute at specified pressure.

Brand names appearing in this publication are for product identification purposes only. No endorsement is intended,
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