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Calibrating Boom Sprayers

Application Technology Series

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Using the correct amount of chemical during pesticide application is crucial to achieving the best results from a pest control product. Most performance complaints involving pesticides, however, are directly related to dosage errors or improper application. Therefore, proper calibration, or adjustment, of the sprayer is essential to ensure it is applying the correct amount of chemical evenly over a given area. Failure to calibrate a sprayer can cause plant injury, result in pollution, and waste money.

In addition to adjusting the sprayer at the start of the application season, routine calibration is necessary because abrasive pesticides can damage nozzle tips and cause wear, increasing the orifice size over time. As a result, nozzle flow rate increases and poor spray patterns develop, leading to faulty pesticide performance.

Even with the widespread use of electronics to monitor and control the pesticide application, a thorough sprayer calibration procedure is essential to avoid misapplication. The following information details variables that affect application, specific steps for nozzle selection and sprayer calibration, and helpful equations to achieve the best application results.

Variables Affecting Application Rate

Three variables affect the amount of spray material applied per acre: (1) nozzle flow rate, (2) ground speed of the sprayer, and (3) width sprayed per nozzle. To calibrate and operate a sprayer properly, it is important to understand how each of these variables affects sprayer output.

Nozzle Flow Rate

The nozzle flow rate varies according to the size of the orifice, the nozzle pressure, and the density of the spray liquid. The flow rate increases by installing a nozzle with a larger orifice, increasing the nozzle pressure, and decreasing the density of the spray liquid. Manufacturer flow rate charts are based on the flowability of water. Adjustments are necessary when making applications with materials other than water as the main carrier, for example, 28 percent nitrogen fertilizer. Multiply the calibrated nozzle flow rate by the conversion factor. Conversion factors based on comparisons of the specific gravity of water and the other solutions are used. Water has a specific gravity of 1.00 and weighs 8.34 pounds per gallon. The 28 percent nitrogen fertilizer weighs 10.67 pounds per gallon and has a specific gravity of 1.28 (10.76/8.34). The conversion factor for this example is 1.13 ($\sqrt{1.28}$). Table 1 shows conversion factors for the specific gravity of different solutions.

To increase nozzle output, the pressure must be multiplied by the square of the desired increase in flow rate. In other words, simply doubling the pressure will not double the nozzle flow rate. To double the flow rate, you must increase the pressure four times. For example, with the XR, TT, or AI "04" orifice size, to double the flow rate of a nozzle from 0.24 gallons per minute at 15 pounds per square inch (psi) to 0.48 gallons per minute, the pressure must be increased to 60 psi (4 × 15). See highlighted section of Table 2, XR04 (red).

Table 1. Conversion factors for solutions other than water.

Weight of Solution (lb/gal)	Specific Gravity	Conversion Factor
7.0	.84	.92
8.0	.96	.98
8.4	1.00 (water)	1.00
9.0	1.08	1.04
10.0	1.20	1.10
10.65	1.28 (28% nitrogen)	1.13
11.0	1.32	1.15
12.0	1.44	1.20

Pressure changes are not the answer for major adjustments in the flow rate. The pressure can be changed, however, to correct for minor variations in flow rate resulting from nozzle wear. To obtain a uniform spray pattern and minimize drift, the operating pressure must be maintained within the recommended range for each nozzle.

Ground Speed

The spray application rate varies inversely with the ground speed. Doubling the ground speed of the sprayer *reduces* the gallons of spray applied per acre (gpa) by half. For example, a sprayer that applies 20 gpa at 6 miles per hour (mph) would apply 10 gpa if the speed were increased to 12 mph while the pressure remained constant. If speed were lowered to 3 mph and pressure remained constant, the sprayer would apply 40 gpa.

Many low-pressure field sprayers have a metering system that maintains a constant application rate while operating at different travel speeds. Metering systems such as ground-driven piston pumps, electronic feedback control systems, and various centrifugal pump arrangements vary nozzle pressure to compensate for changes in travel speed, thus keeping the application rate constant. However, metering systems may cause a dramatic change in pressure, resulting in spray drift, improper overlap, and less effective application. Although all the systems work over various travel speeds, the range of speed that allows for a precise application is limited by the spray nozzle orifice size and pressure operating range.

To regulate nozzle flow in proportion to travel speed using pressure, increase in nozzle pressure must equal the square of the increase in speed. For example, if the sprayer in the earlier example is traveling at 6 mph while delivering 10 gpa at a nozzle pressure of 15 psi, doubling the speed to 12 mph will require increasing the nozzle pressure (by multiplying times 4) to 60 psi to maintain the 10 gpa. Remember, a fourfold change in pressure drastically reduces the droplet size, resulting in increased drift and a changed pattern width and distribution pattern. For uniform application, the travel speed should be held as constant as possible, even when using controlled metering systems.

To apply pesticides accurately, proper ground speed must be maintained and measured accurately. Do not rely on a conventional speedometer as an accurate indicator of speed. Common causes of speedometer errors include slippage of the drive wheels and changes in tire size. Electronic kits, radar, sonar, and global positioning systems (GPS) give more accurate readings because they do not depend on the drive wheels for speed measurements. The accuracy of all speedometers should be checked periodically.

Width Sprayed Per Nozzle

The effective width sprayed per nozzle is another variable that affects the spray application rate. Doubling the effective width sprayed per nozzle *decreases* the applied amount by half. For example, when applying 20 gpa with flat-fan nozzles on 20-inch spacings, changing to flooding nozzles with the same flow rate on 40-inch spacings will decrease the application rate to 10 gpa. It is important to remember that a larger spray width means a smaller application rate if flow rate is held constant.

Selecting Nozzle Orifice Size

The size of the nozzle orifice required for an application will depend on the application rate (gpa), ground speed (mph), and effective width sprayed (W). Some manufacturers advertise "gallon-per-acre" nozzles, but this rating is useful only for standard conditions (for example, 30 psi, 6 mph, and 20-inch spacing). The gallons-per-acre rating is useless if any of the conditions varies from the standard.

The five steps below give specific instructions for selecting the correct nozzle orifice size required for each application:

1. Select the spray application rate in gallons per acre. The spray application rate is the gallons of spray — consisting of both the carrier (water, fertilizer, etc.) and pesticide — applied per treated acre. Pesticide labels recommend ranges for various types of equipment and pest control scenarios.
2. Select or measure an appropriate ground speed in miles per hour, according to existing application site conditions. If the actual ground speed is unknown, instructions for measuring it are given in the "Measuring Ground Speed" section on page 5.
3. Determine the effective width sprayed per nozzle in inches.
   - For broadcast spraying, W = the nozzle spacing
   - For band spraying, W = the band width
   - For row-crop applications or band spraying with multiple nozzles per band, such as spraying from drop pipes or directed spraying,

Table 2. 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	UC	0.26
	20	M	M	0.21		20	VC	0.21		40	XC	0.30
	30	F	F	0.26		30	C	0.26		50	XC	0.34
	40	F	F	0.30		40	C	0.30		60	XC	0.37
	50	F	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	VC	0.45
	20	M	M	0.28		90	F	0.45		100	C	0.47
	30	M	M	0.35	TT 04	15	XC	0.24	AI 04	30	UC	0.35
	40	M	M	0.40		20	VC	0.28		40	XC	0.40
	50	F	F	0.45		30	C	0.35		50	XC	0.45
	60	F	F	0.49		40	C	0.40		60	XC	0.49
XR 05	15	C	M	0.31		50	M	0.45		70	VC	0.53
	20	C	M	0.35		60	M	0.49		80	VC	0.57
	30	C	M	0.43		75	M	0.55		90	VC	0.60
	40	M	M	0.50		90	M	0.60		100	C	0.63
	50	M	F	0.56	TT 05	15	XC	0.31	AI 05	30	UC	0.43
	60	F	F	0.61		20	VC	0.35		40	XC	0.50
XR 06	15	C	C	0.37		30	VC	0.43		50	XC	0.56
	20	C	M	0.42		40	C	0.50		60	XC	0.61
	30	M	M	0.52		50	C	0.56		70	VC	0.66
	40	M	M	0.60		60	M	0.61		80	VC	0.71
	50	M	M	0.67		75	M	0.68		90	VC	0.75
	60	M	F	0.73		90	M	0.75		100	VC	0.79
					TT 06	15	XC	0.37	AI 06	30	UC	0.52
						20	VC	0.42		40	UC	0.60
						30	VC	0.52		50	XC	0.67
						40	VC	0.60		60	XC	0.73
						50	C	0.67		70	XC	0.79
						60	C	0.73		80	VC	0.85
						75	C	0.82		90	VC	0.90
						90	M	0.90		100	VC	0.95

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

[1]Droplet spectra classification based on ASABE S-572.
[2]Nozzle flow rate in gallons per minute at specified pressure.

$$W = \frac{\text{row spacing (or band width)}}{\text{number of nozzles per row (or band)}}$$

4. Determine the flow rate required from each nozzle in gallons per minute by using a nozzle catalog, tables, or Equation 2 on page 5.
5. Select a nozzle orifice size that will give the determined flow rate when the nozzle is operated within the recommended pressure range. This information is available in a catalog of available nozzles or on manufacturer's website. If operating previously used nozzles, return to Step 2 and select a speed that allows operation within the recommended pressure range using Equation 5 on page 5.

Pre-Calibration

After selecting the correct nozzle orifice size and operating pressure, perform a pre-calibration check. First, make sure the sprayer is clean. Then install the selected nozzles, partially fill the tank with clean water, and operate the sprayer in a stationary position at the calibrated pressure. Place a container (such as a plastic bucket) under each nozzle, and check to see whether all of the containers fill at about the same rate. Replace any nozzle that varies 5 to 7 percent from the manufacturer's specifications (see Table 2). Also, replace any nozzle that has an obviously different fan angle or a nonuniform spray pattern.

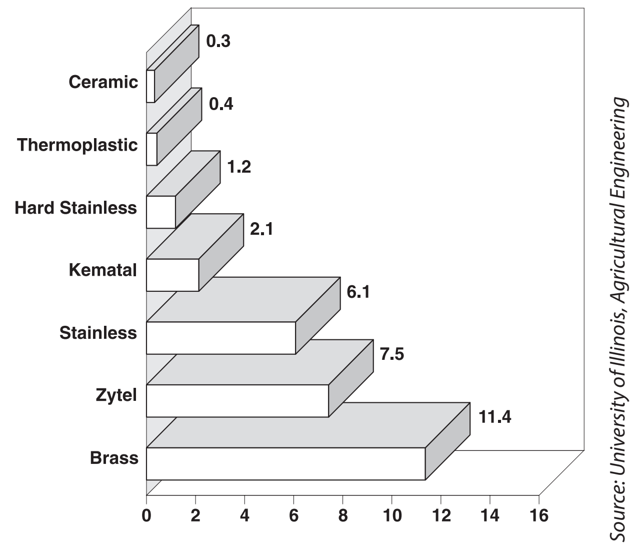
To obtain uniform coverage, spray angle, spacing, and nozzle height must be considered. Different spray angles and nozzle spacings require height readjustments to gain uniform coverage. Check nozzle catalogs for recommended heights for the type and spray angle of the nozzle you are using (See Table 3). Nozzles with different spray angles should not be used on the same boom for broadcast spraying.

Worn or partially plugged nozzles produce nonuniform patterns. Misalignment of nozzle tips is also a common cause of uneven coverage. The boom must be level at all times because uneven coverage will result if one end of the boom is allowed to droop. A good method for determining the exact nozzle height for most uniform coverage is to spray on a warm surface, such as a road, and observe the drying rate. A uniform drying rate indicates uniform coverage, whereas streaking indicates uneven coverage. Adjust the nozzle height to eliminate excess streaking.

Calibration

Once proper nozzles have been selected and installed (Steps 1 to 5 on pages 2-3), calibrate the sprayer (Steps 6 to 11, following). Check the calibration every few days during the spraying season or when changing pesticides. New nozzles still need to be calibrated because some nozzles "wear in," increasing their flow rate more rapidly during the first few hours of use (see Figure 1, taken from KSRE publication MF-2541 page 4). However, most nozzle materials used today are durable and will not wear as quickly as nozzles manufactured in the past. Even so, new nozzles should always be calibrated to ensure they are flowing at the rate given in the manufacturer's charts. Studies show that new nozzles can have an incorrect flow as well as a bad pattern.

Figure 1. Materials and Wear



Percent increase in nozzle flow rate. Flat-fan spray nozzles after 40-hour test.

Use the following calibration method to check application rates:

6. Determine the required flow rate for each nozzle in ounces per minute (opm) by using Equation 3 (on page 5) to convert from gallons per minute.
7. Collect the output from one of the nozzles by spraying into a container marked in ounces for 1 minute. Adjust the pressure until the collected number of ounces matches the previously deter-

Table 3. Suggested minimum spray heights.

	Nozzle spray angle	Nozzle height in inches to achieve proper overlap		
		20-inch spacing	30-inch spacing	40-inch spacing
Narrow angle flat-fan*	65 degrees	22-24 inches	33-35 inches	Not recommended
Common angle flat fan*	80 degrees	17-19 inches	26-28 inches	Not recommended
Wide angle flat-fan*	110 degrees	16-18 inches	20-22 inches	Not recommended
Flooding flat-fan **	120 degrees	14-16 inches	15-17 inches	18-20 inches

*50 to 60 percent overlap required to achieve uniform coverage

**100 percent overlap required to achieve uniform coverage mined amount. Check several other nozzles to determine if their outputs fall within 5 to 7 percent of the desired ounces per minute.

8. If it becomes difficult to obtain the desired output within the recommended range of operating pressures, select a different nozzle size or a new ground speed, then recalibrate. The range of operating pressures listed for a nozzle indicates the pressure *at the nozzle orifice*. Line losses and nozzle check valves will likely require the main pressure gauge at the boom or controls to read much higher than these pressures to achieve the desired pressure at the nozzle. Remember, spray nozzles must be operated within the recommended pressure range.
9. From the label, determine the amount of pesticide needed for the acreage to be sprayed. Add the pesticide to a tank partially filled with carrier (water, fertilizer, etc.). Then, while continuously agitating, add additional carrier to reach the desired level. Be sure to follow all the label mixing instructions.
10. Operate the sprayer in the field at the ground speed measured in Step 2 and at the pressure determined in Step 7. Spray at the application rate selected in Step 1. After spraying a known number of acres, check the liquid level in the tank to verify that the application rate is correct. If using an electronic rate controller, be sure it has been properly set up and calibrated according to the manufacturer's instructions. While using the rate controller, check the monitored output to see if it matches the desired results. Recalibrate the electronics regularly.
11. Check the nozzle flow rate frequently. Nozzle wear or other variations can cause changes in nozzle output, so the operating pressure may need to be adjusted. Replace the nozzle tips and recalibrate when the output has changed 5 to 7 percent or more from that of a new nozzle or when the spray pattern has become uneven.

Measuring Ground Speed

Remember, proper ground speed must be maintained to apply pesticides accurately. Because speedometers do not always provide an accurate measure of speed, accuracy of the speedometer should be checked with a timed distance measurement, an electronic kit, or radar gun. If the sprayer does not have a speedometer or it is not accurate, ground speed at all of the planned settings must be measured. If ground speed is measured and recorded at several gear and throttle settings, speed does not need to be remeasured each time the settings are changed.

Helpful Equations

These simple equations can help with the calibrating process.

Key terms:

gpa = gallons per acre

gpm = output per nozzle in gallons per minute

mph = ground speed in miles per hour

opm = ounces per minute

W = effective width sprayed per nozzle in inches

5,940 = a constant to convert measurement units

Equation 1

Use this equation to determine the gallons of spray applied per acre:

$$\text{gpa} = \frac{\text{gpm} \times 5{,}940}{\text{mph} \times \text{W}}$$

Equation 2

Use this equation to determine the gallons per minute required for the spraying conditions:

$$\text{gpm} = \frac{\text{gpa} \times \text{mph} \times \text{W}}{5{,}940}$$

Equation 3

Use this equation to convert gallons per minute to ounces per minute:

opm = gpm × 128 (1 gallon = 128 ounces)

From Example 1 on p. 7, the required flow rate = 0.34 gpm

opm = 0.34 × 128 = 43.5

From Example 2 on p. 7, the required flow rate = 0.23 gpm

opm = 0.23 × 128 = 29

Equation 4

Use this equation to determine ground speed:

$$\text{Speed (mph)} = \frac{\text{distance (feet)} \times 60}{\text{time (seconds)} \times 88}$$

1 mph = 88 feet per 60 seconds

Equation 5

Use this equation to determine a speed in miles per hour (mph) for a specific nozzle flow rate in gallons per minute and a required gallons sprayed per acre (gpa):

$$\text{mph} = \frac{\text{gpm} \times 5{,}940}{\text{gpa} \times \text{W}}$$

To measure ground speed, stake out a known distance in the field intended for spray or another field with similar surface conditions. Suggested distances are 100 feet for speeds up to 5 mph, 200 feet for speeds from 5 to 10 mph, and at least 300 feet for speeds above 10 mph. Using the engine throttle setting and the intended gear for spraying, determine the travel time between the measured stakes. Average these speeds and use Equation 4 to determine ground speed.

Example: On a 200-foot course, 22 seconds are required for the first pass and 24 seconds for the return pass.

$$\text{Average time} = \frac{22 + 24}{2} = 23 \text{ seconds}$$

$$\text{mph} = \frac{200 \times 60}{23 \times 88} = \frac{12{,}000}{2{,}024} = 5.9 \text{ mph}$$

Once a particular speed has been decided on, record the throttle setting and drive gear used.

If you are using a sprayer with an automatic spray rate controller, the controller will automatically maintain the spray rate (in gallons per acre) you set it to during speed changes. It does so by changing operating pressure, which in turn adjusts the nozzle flow rate. In addition to changing the nozzle flow rate, the change in operating pressure by the automatic spray rate controller also changes the droplet size produced by the nozzle. At certain times during an application, the speed changes you make may require an operating pressure that exceeds the upper or lower pressure limit for the nozzles mounted on your sprayer. To make sure you do not exceed these pressure limits, you need to set minimum and maximum speed limits for your application based on the type and size of nozzle you are using. Use Equation 5 to calculate the speed limits required to make a specific application.

To determine gallons per minute to use in Equation 5, find the minimum and maximum recommended operating pressures for the nozzle you are using. Use these to calculate the minimum and maximum speeds at which you can travel during the application. It is a good idea to actually use a minimum and maximum pressure slightly higher and lower, respectively, than those listed in the catalog. At the low end of a nozzle's pressure range, you can experience reduced overlap and, therefore, skips in your coverage. At the high end of a nozzle's pressure range, an increasingly large portion of the spray volume is expelled in smaller droplets, which may increase the risk of drift. Once you determine the minimum and maximum operating pressures for your nozzle, find the corresponding nozzle flow rates at those pressures; these will be the flow rates (in gallons per minute) you use in Equation 5 to calculate a minimum and maximum speed.

Conclusion/Summary

Accurate application of any pesticide depends on accurate sprayer calibration. Selecting the correct nozzle tip and regularly calibrating the sprayer are essential to ensuring successful application results.

There are many methods for calibrating low-pressure sprayers, but they all factor in the same variables: gallons of spray per acre, ground speed in miles per hour, effective width sprayed per nozzle flow rate, and a constant for conversion. Any technique for calibration that provides accurate and uniform application is acceptable. No single method is best for everyone. However, the calibration method described in this publication has four advantages:

1. It allows you to select the number of gallons to apply per acre and to complete most of the calibration before going to the field.
2. It provides a simple way to frequently adjust the calibration to compensate for changes due to nozzle wear.
3. It can be used for broadcast, band, directed, and row crop spraying. However, to be most effective, this method requires knowledge of nozzle types and sizes and the recommended operating pressure ranges for each type of nozzle used.
4. When using the calibration method described, you will have a better understanding of how each variable will affect the application rate. As each of the variables change, the influence on the rate (gpa) is apparent.

Scenarios

EXAMPLE 1: You want to do a broadcast application of pre-plant incorporated herbicide at 10 gpa (Step 1) at a speed of 10 mph (Step 2) using turbo flat-fan nozzles spaced 20 inches apart on the boom (Step 3). What turbo flat-fan nozzle tip should you select?

The required flow rate for each nozzle (Step 4) is:

$$\text{gpm} = \frac{\text{gpa} \times \text{mph} \times \text{W}}{5{,}940} \dashrightarrow \text{gpm} = \frac{10 \times 10 \times 20}{5{,}940} = \frac{2{,}000}{5{,}940} = 0.34$$

The nozzle you select must have a flow rate of 0.34 gpm when operated within the recommended pressure range of 15 to 90 psi. Table 2 shows the flow rates in gpm at various pressures for several sizes of Spraying Systems flat-fan nozzles. For example, the "04" orifice nozzle has a rated output of 0.34 gpm at 28-29 psi (Step 5) for all three nozzle types listed. Note that the flow rate in the chart is given for 30 psi at 0.35 gpm. You would need to interpolate for the exact flow and pressure. The charts are provided only as a guide. Of course, the only way to be completely sure of the flow rate is to collect the flow in a measuring device marked in ounces while spraying at the selected pressure. In this example, you would want to collect 43.5 ounces in 1 minute (see Steps 6 and 7 or the example in Equation 3). You could select the TT11004 for this application. Actual nozzle type, orifice size, and operating pressure will be selected on the basis of a specified droplet spectrum. This information can be found on the label. Please refer to KSRE publication MF-2869 for more details on selecting a droplet size category.

EXAMPLE 2: You want to apply a pre-emergence herbicide in a 15-inch band over each 30-inch corn row. The desired application rate is 15 gpa and the speed will be 6 mph. What is the required flow rate for the even flat-fan nozzle you need to select?

The required flow rate is:

$$\text{gpm} = \frac{\text{gpa} \times \text{mph} \times \text{W}}{5{,}940} \dashrightarrow \text{gpm} = \frac{15 \times 6 \times 15}{5{,}940} = \frac{1{,}350}{5{,}940} = 0.23$$

The nozzle you select must have a flow rate of 0.23 gpm when operated within the recommended pressure range. Table 4 shows the gpm at various pressures for several sizes of Spraying Systems even or air-induction even flat-fan nozzles. For example, the Spraying Systems TP8003E nozzle has a rated output of 0.23 gpm at 24-25 psi (Step 5). Use the same strategy and procedure as in Example 1 to determine the exact psi. This nozzle could be purchased and used for this application. The AI9502EVS at 55 psi is another choice.

EXAMPLE 3: You want to apply a postemergence herbicide in a 15-inch band over each 30-inch corn row using a drop with three nozzles per row. The desired application rate is 20 gpa, and the speed will be 6 mph. What is the required flow rate for each nozzle on the drop?

Because three nozzles spray each 15-inch band,

$$\text{W} = \frac{15}{3} = 5 \text{ inches}$$

then the required flow rate is:

$$\text{gpm} = \frac{\text{gpa} \times \text{mph} \times \text{W}}{5{,}940} \dashrightarrow \text{gpm} = \frac{20 \times 6 \times 5}{5{,}940} = \frac{600}{5{,}940} = 0.10$$

The nozzle you select must have a flow rate of 0.10 gpm when operated within the recommended pressure range. Table 4 shows the gpm at various pressures for several sizes of Spraying Systems even or air-induction even flat-fan nozzles. For example, the Spraying Systems TP8001E nozzle has a rated output of 0.10 gpm at 40 psi (Step 5). Three of these nozzles could be purchased, placed on the drop, and used for this application.

EXAMPLE 4: From Example 1, you selected the TT11004 nozzles to make your application. According to Table 2, the maximum operating pressure for this nozzle is 90 psi with a corresponding flow rate of 0.60 gpm. The minimum operating pressure for this nozzle is 15 psi with a corresponding flow rate of 0.24 gpm. Next, you need to calculate a minimum and maximum speed using the gpm flow rates for the minimum and maximum pressures:

$$\text{Minimum mph} = \frac{0.24 \text{ gpm} \times 5{,}940}{10 \text{ gpa} \times 20 \text{ inches}} = 7.1$$

$$\text{Maximum mph} = \frac{0.60 \text{ gpm} \times 5{,}940}{10 \text{ gpa} \times 20 \text{ inches}} = 17.8$$

While making your application with an automatic spray rate controller, you would need to keep your speed between 7.1 mph and 17.8 mph. Doing so will ensure that you make the application at the correct rate of 10 gpa while maintaining a pressure within the recommended pressure range for the nozzle. Be aware, however, that spray droplet size will vary considerably between the minimum and maximum pressure. If the label requires a specific droplet size for the application, a narrower speed range may be required.

Table 4. Banding and Directed Application Nozzle Chart, Even Spray

Spraying Systems Orifice Designation		Liquid Pressure (psi)	Capacity	
			gpm	opm
TP8001E		20	0.071	9
TP8001E		30	0.087	11
TP8001E		40	0.10	13
TP8001E		50	0.11	15
TP8001E		60	0.12	15
TP80015E		20	0.11	14
TP80015E		30	0.13	17
TP80015E		40	0.15	19
TP80015E		50	0.17	22
TP80015E		60	0.18	23
TP8002E		20	0.14	18
TP8002E	AI9502E	30	0.17	22
TP8002E	AI9502E	40	0.20	26
TP8002E	AI9502E	50	0.22	28
TP8002E	AI9502E	60	0.24	31
	AI9502E	70	0.26	33
	AI9502E	80	0.28	36
	AI9502E	90	0.30	38
	AI9502E	100	0.32	41
	AI95025E	30	0.22	28
	AI95025E	40	0.25	42
	AI95025E	50	0.28	36
	AI95025E	60	0.32	41
	AI95025E	70	0.33	42
	AI95025E	80	0.35	45
	AI95025E	90	0.38	49
	AI95025E	100	0.40	51
TP8003E		20	0.21	27
TP8003E	AI9503E	30	0.26	33
TP8003E	AI9503E	40	0.30	38
TP8003E	AI9503E	50	0.34	44
TP8003E	AI9503E	60	0.37	47
	AI9503E	70	0.40	51
	AI9503E	80	0.42	54
	AI9503E	90	0.45	58
	AI9503E	100	0.47	60

Spraying Systems Orifice Designation		Liquid Pressure (psi)	Capacity	
			gpm	opm
TP8004E		20	.028	36
TP8004E	AI9504E	30	0.35	45
TP8004E	AI9504E	40	0.40	51
TP8004E	AI9504E	50	0.45	58
TP8004E	AI9504E	60	0.49	63
	AI9504E	70	0.53	68
	AI9504E	80	0.57	73
	AI9504E	90	0.60	77
	AI9504E	100	0.63	81
TP8005E		20	0.35	45
TP8005E		30	0.43	55
TP8005E		40	0.50	64
TP8005E		50	0.56	72
TP8005E		60	0.61	78
TP8006E		20	0.42	54
TP8006E		30	0.52	67
TP8006E		40	0.60	77
TP8006E		50	0.67	86
TP8006E		60	0.73	93
TP8008E		20	0.57	73
TP8008E		30	0.69	88
TP8008E		40	0.80	102
TP8008E		50	0.89	114
TP8008E		60	0.98	125

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