Boom Sprayer Calibration Steps Worksheet

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Applying the correct amount of pesticide is crucial for high quality pest control results, and proper calibration, or adjustment, of the sprayer is essential for accurate chemical application. Ongoing routine calibration is necessary because abrasive pesticides can damage nozzle tips, cause wear, and slowly increase the orifice size. As a result, nozzle flow rate increases and poor spray patterns develop, leading to faulty pesticide performance. A thorough sprayer calibration procedure is essential to avoid misapplication.

Variables Affecting Application Rate

Three variables affect sprayer output: (1) nozzle flow rate, (2) ground speed of the sprayer, and (3) width sprayed per nozzle.

1. Nozzle Flow Rate

Nozzle flow rate increases when a nozzle has a larger orifice, the nozzle pressure is increased, or the density of the spray liquid is decreased. Manufacturer flow rate charts are based on water's ability to flow, so adjustments are necessary when using materials other than water, such as 28 percent nitrogen fertilizer, as the main carrier.

To increase nozzle output, multiply the pressure by the square of the desired increase in flow rate. In other words, simply doubling the pressure does not double the nozzle flow rate. To double the flow rate, the pressure must be increased 4 times. For example, to double the flow rate of a nozzle (with an "04" orifice) 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).

Pressure changes should not be used for major adjustments in the flow rate, but pressure can be changed to remedy 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.

2. Ground Speed

Spray application rate varies inversely with ground speed, so doubling the ground speed of the sprayer reduces the gallons of spray applied per acre (gpa) by one 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. To apply pesticides accurately, proper ground speed must be maintained and measured accurately.

3. Width Sprayed Per Nozzle

The effective width sprayed per nozzle affects the spray application rate. Doubling the effective width sprayed per nozzle decreases the applied gpa by one half. For example, when applying 20 gpa with flat fan nozzles on 20-inch spacings, flooding nozzles with the same flow rate on 40-inch spacings will decrease the application rate from 20 gpa to 10 gpa. A larger spray width means a smaller gpa application rate when combined with a constant flow rate.

Worksheet

The gallons of spray material applied per acre and nozzle output in gallons per minute are determined with the following spray equations:

Equation 1

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

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

Equation 2

Use this equation to determine the gallons per minute required for the spraying conditions and the nozzle orifice size needed:

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

or

$$gpm = \frac{\text{gallons/1,000 square feet} \times mph \times W}{136}$$

Where:

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 (136) = a constant to convert measurement units

Steps to select the correct size of nozzle orifice:

1. Using the label, select the spray application rate in gallons per acre or gallons per 1,000 square feet.
2. Select or measure an appropriate ground speed in mph (see Equation 4).
3. Determine the effective width sprayed per nozzle (W) 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,

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

4. Using Equation 2, determine the flow rate required from each nozzle in gpm.
5. Select a nozzle orifice size that gives the determined flow rate when operated within the recommended pressure range as stated in the manufacturer's catalog or Web site.
6. Using Equation 3, convert the required flow rate for each nozzle to ounces/minute (opm).
7. Collect the output from one nozzle by spraying into a container marked in ounces for one minute. Adjust the pressure until the collected opm is the same as the previously determined amount.
8. 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.).
9. Operate the field sprayer at the ground speed measured in Step 2, the pressure determined in Step 7, and the application rate selected in Step 1. After spraying a known number of acres or square feet, check the liquid level in the tank to verify that the application rate is correct.
10. Check the nozzle flow rate frequently because nozzle wear or other conditions can cause changes in nozzle output. Replace the nozzle tips and recalibrate when the output has changed 5 to 7 percent or more from a new nozzle or when the spray pattern has become uneven.

Equation 3

To convert gallons per minute (gpm) to ounces per minute (opm), use the following equation:

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

Equation 4

Use the following 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

Reviewed June 2014 by John W. Slocombe, professor, ag and forage machinery safety, K-State Department of Biological and Agricultural Engineering. Contact him at slocombe@ksu.edu with any questions. Grateful acknowledgment to the original author, Robert E. Wolf, professor emeritus, K-State Department of Biological and Agricultural Engineering.

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