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Calibrating Boom Sprayers

Jason A. Davis, Ph.D
Assistant Professor of Remote Sensing and Pesticide Application, Extension Specialist

Ples Spradley
Extension Pesticide Assessment Specialist

Courtney Spinks
Program Associate - Pesticide Safety Training

Michael Paskewitz
County Extension Agent - Staff Chair, Izard County

Introduction

Boom sprayers are composed of a series of fixed nozzles that are equally spaced, equally sized, and plumbed together. These configurations generally minimize variation across the application area, producing a relatively uniform distribution of pesticides. For this reason, boom sprayers are commonly used for many applications, particularly when uniform and accurate pesticide rates are a priority.

Sprayer calibration is an essential part of any pesticide application. Accurate application is possible only when the application volume is first known, followed by mixing pesticides at proper ratios. Application volume can be determined using nozzle flow rates, travel speed, and nozzle spacing. Once application volume is calculated, proper mixing ratios of pesticides to carrier solution can be determined.

Equipment Speed

Many speedometers vary in their accuracy. Verify the accuracy of the speedometer using one of the two methods below prior to calibration.

Nozzle Output

Accurately capturing the output or flow rate from a boom nozzle is essential for sprayer calibration (Figure 1). To perform a catch test, you will need a stopwatch and a container with graduated marks of ounces or milliliters. It is important to note that calibration procedures like performing catch tests should be completed using water alone. Additionally, prior to performing the test, make sure that all screens, strainers, and filters are free from obstructions to ensure a uniform flow rate between nozzles. With clean fil-

Step 1 (Option 1): Speed from GPS

GPS units for tractors report field speed, and this value is accurate enough to use in calibration.

If GPS is not available, but a smart phone is, there are several free apps that use cellular and GPS technology. Search your app store for "speedometer" and select one to download.

Use the speed values to check your speedometer or to calibrate. Speeds from these apps are accurate enough for calibration.

Result = MPH

Step 1 (Option 2): Speed by Calculation

Calculating your equipment's speed requires a tape measure, stopwatch, and two markers (example: flags, fence posts, buckets).

1. Mark a distance (ex. 100 or 200 ft.) on terrain like where you will spray.
2. Fill the spray tank half full of water.
3. Use gear and RPM that will be used for spraying.
4. Traveling at full anticipated application speed, traverse the distance while timing in seconds.
5. Insert distance and time into this formula:

$$\textbf{MPH} = \frac{\text{Distance Traveled (ft.)} \times 60}{\text{Time to cover distance (sec)} \times 88}$$

Result = MPH

Figure 1. Catch test on a boom nozzle using a catch container.

Step 2. Performing a Catch Test

1. Clean filters and the nozzle to ensure that flow rates can be measured accurately.
2. Set the RPM used in step 1 to measure speed.
3. Catch the flow from a single nozzle for 1 minute using a graduated cylinder and stopwatch.

Step 3: Determining Nozzle Spacing (in.)

1. Use a tape measure to measure the distance between nozzles in inches.
2. Measure all distances between nozzles to ensure uniformity.
3. When deviations are found, make adjustments if possible.

tration components and water in the tank, engage the pump and set the tractor to desired RPM. With the nozzles on, verify and adjust the pressure according to nozzle specifications or recommendations. Also, inspect each nozzle pattern for irregularities, and remedy as necessary. Next, use the stopwatch and catch container to determine each nozzle's gallon per minute flow rate.

Simultaneously, start to catch all the flow from a single nozzle and start the stopwatch. Ideally, catch the flow for one-minute and repeat for each nozzle on the boom. Make sure that all nozzles have a flow rate that is within 10% of the average of the entire boom. It can be helpful to write down each reading to both determine the average flow rate, as well as those that deviate more than 10%. If an individual nozzle has a flow rate lower than 10% of the average flow rate, check to ensure that it is the same nozzle size and that it does not have an obstruction. If an individual nozzle has a flow rate higher than 10% above the average flow rate, check that it is the same size as the rest of the nozzles. If so, it is possible that it is worn out and needs to be replaced.

Figure 2. Catch test on a boom nozzle using a catch container.

Nozzle Spacing

Consistent spacing between nozzles is critical for uniform pesticide applications. To determine nozzle spacing, measure the distance from the center of one nozzle to the center of the adjacent nozzle in inches (Figure 2). Determining the distance between nozzles is simple; however, many times this measured distance is not consistent across the boom. It is important to correct these deviations, when possible, before mixing and applying pesticides.

Determining Boom Height

Boom height is not used in calculating an application volume or determining mixing ratios; however, appropriate boom height is critical in making uniform pesticide applications. Optimal boom height is a function of the nozzle spacing and a nozzle's pattern or fan angle. Modern broadcast nozzles commonly used on boom sprayers are typically a tapered flat fan by design. This simply means that the nozzle's rate tapers from its highest near the center of the pattern to its lowest at its outer edges. Uniform applications

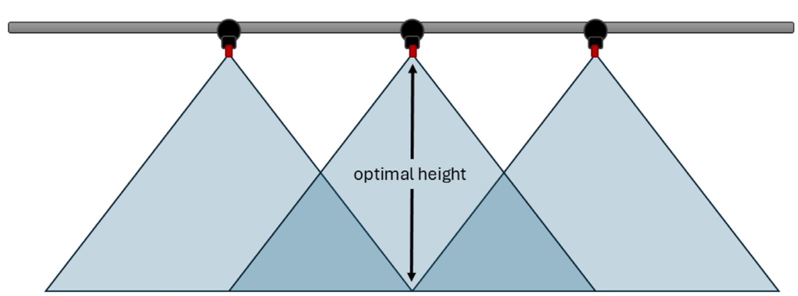

Figure 3. Adjust the boom height so that the two patterns adjacent to any nozzle meet at your targets (weed, insect, pathogen) height.

Step 4: Calculating GPA

Insert the values obtained from the previous steps into the following formula.

MPH = miles per hour
GPM = gallons per minute
W = nozzle spacing in inches
GPA = gallons per acre
5940 = constant

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

Resulting GPA is the gallons applied to each acre assuming speed, nozzle output, and swath width are held constant.

Step 4. (Alternative): Ounce Method

1. Reference Nozzle Spacing (in.) column to determine course length.

Nozzle Spacing (in.)	Course (ft.)	Nozzle Spacing (in.)	Course (ft.)
12	340	26	157
14	291	28	146
16	255	30	136
18	227	32	127
19	215	34	120
20	204	36	113
22	185	38	107
24	170	40	108

2. Traverse & time (sec) course with desired speed & RPM. Repeat and average results.
3. Catch nozzle flow (oz.) for time measured while traversing course (sec.). Repeat and average.
4. Ounces measured = **GPA output**

with tapered flat fan nozzles are achieved by significantly overlapping the patterns between adjacent nozzles. A general recommendation for achieving both the proper boom height and overlap between nozzles is to determine the location where the center of a nozzle's pattern just meets the edges of its adjacent nozzle (Figure 3). The distance between this location and the nozzle is your optimal boom height. Assuming a 20-inch nozzle spacing, this is typically between 20 and 24 inches for a 110˚ nozzle pattern, and 28 to 32 inches for an 80˚ nozzle pattern.

Calculating GPA

After equipment speed, nozzle output, and nozzle spacing have been determined, application volume in gallons per acre (GPA) can be calculated. The gallons of water applied per acre influences coverage and the efficacy of the product applied. Higher spray volumes result in better coverage and generally better control. For boom applications, a minimum of 10 GPA is recommended and volumes of 15 GPA may be beneficial in many applications. If the spray volume needs to be adjusted, changes to nozzle size, equipment speed and/or system pressure can be made to achieve the desired spray volume. Note that each of these variables has their limitations and a typical range for these adjustments has been described in their respective sections. To increase volume (GPA): decrease speed, increase pressure, or increase the nozzle size. To decrease GPA: increase speed, decrease pressure, and/or decrease nozzle size. Your local county extension agent can provide clarification regarding your specific equipment or application needs.

How much product to add to the sprayer tank?

Assume that the application volume is 15 gallons of spray solution per acre. If the spray tank holds 150 gallons, divide the tank volume by the output in gallons per acre to determine the area covered by one tank (Step 5.1). 150 gallons divided by 15 GPA equals 10 acres per tank.

Refer to the product label or contact your county extension office to determine the rate per acre needed. For this example, we'll use the rate of 1 qt. per acre. We know that we can cover 10 acres, and that each acre should receive 1 qt. of product. Therefore, 10 acres times our rate is the amount of product we should put in the tank in quarts (Step 5.2).

Mixing Additives by Percent Volume

Many product labels recommend the addition of a surfactant or adjuvant. These additives are often recommended as a percentage of the volume of spray solution. For this example, we'll use 0.25% surfactant and the same 150-gallon spray tank.

Calculate the amount of surfactant per tank by converting the percentage to a decimal by dividing by 100 (0.25 / 100 = 0.0025) and then multiplying by the tank volume (0.0025 x 150 gal. = 0.375 gal. per tank) (Step 5.3).

Step 5. Calculating Mix

1. $\frac{\text{Tank Volume}}{\text{Sprayer Output}}$ **= ac./tank** **example:** $\frac{\textbf{150 gal}}{\textbf{15 GPA}}$ **= 10 ac.**
2. (ac./tank) ×(rate/ac.) **= product per tank**
   Ex. 10 ac./tank × 1 qt./ac.=10 qt. per tank
3. Mix water and product
   Ex. 150 gal of water with 10 qt. of product.

Step 6: Calculating Additives by Percent Volume

1. Divide recommended percentage by 100.
   Ex. 0.25 / 100 = 0.0025
2. Multiply by tank volume.
   Ex. 0.0025 x 150 gal. = 0.375 gal or 1.5 qt. per tank.

Gallons can be converted to quarts for easier measuring by multiplying 0.375 gal. x 4 qt. /gal. = 1.5 qt. surfactant per tank. One way to think about percentage volume is to remember that one gallon in 100 gallons is a 1.0% solution. So, a 0.25% solution would be ¼ gallon in 100 gallons.

Consult the product label for any special mixing instructions including compatibility with additional products. A good general approach to mixing is filling the tank half full, adding the product slowly, while agitating the solution, and then filling the remainder of the tank. Add surfactants last. Maintain consistent speed and pressure to ensure an accurate application. Record the tractor and sprayer settings for future reference. The last page of this factsheet is a worksheet to be used in the field and to assist with documenting settings and measurements.

Conclusion

Sprayer calibration is essential to accurate, uniform, and ultimately successful pest control. Do a calibration check at least once per season and again any time that the sprayer or applied volume is modified to ensure consistent application. Once the desired settings have been determined and recorded, running a check takes very little time. Inspect hoses, tanks, and connections for leaks. Make sure the nozzle is clean and the spray pattern is normal in appearance. Do these checks with only water in the tank. It is much safer and cheaper to correct any problems before adding the pesticide.

Boom Sprayer: Calibration Worksheet

Equipment Speed ____________ **Tractor Range:** _________ **Gear** _________ **RPM**__________

Nozzle Output (GPM) ____________ **Sprayer Pressure (PSI):** _________

Nozzle Spacing (in.) ____________

Gallons per acre (GPA)

Mix = ________________**gallons of water and** __________________________ **product per tank**

(If label recommended) + ________________________ **surfactant per tank.**

1. Mark a distance (ex. 100 or 200 ft.) on terrain like where you will spray.
2. Use gear and RPM that will be used for spraying.
3. Traveling at anticipated application speed, traverse the **distance** while timing in **seconds**.

$$\_\_\_\_\_\_\ \text{MPH} = \frac{\text{Distance in ft. x 60}}{\_\_\_\_\_\_\ \text{Time in sec x 88}}$$

4. Measure the distance between nozzles in inches.
5. Check the spacing of nozzles across the boom for consistency.
6. Adjust, if necessary, before applying.

7. Catch the nozzle's flow for 1 min. (Repeat to check for consistency)
8. Convert measurement to GPM if necessary.
   - _______**ounces per minute / 128 =** ______**GPM**
   - _______**milliliters per minute / 3785 =** ______**GPM**

9. Insert the values obtained from the previous steps into the following formula.

$$\_\_\_\_\_\_\ \text{GPA} = \frac{(\qquad\qquad \text{GPM}) \times 5940}{(\_\_\_\_\_\_\ \text{MPH}) \times (\_\_\_\_\_\_\ \text{in.})}$$

10. Calculate acres per tank.

$$\frac{\text{Tank size}}{\_\_\_\_\_\_\ \text{GPA}} = \_\_\_\_\_\_\ \text{ac./tank}$$

11. Calculate product per tank.

(___________**ac./tank) x (**___________ **rate/ac.) =** ___________ **product per tank**

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JASON A. DAVIS is an assistant professor of remote sensing and pesticide application with the Agriculture and Natural Resources Department and located at the Livestock and Forestry Research Station. **PLES SPRADLEY** is an extension pesticide assessment specialist with the University of Arkansas System Division of Agriculture, Little Rock. **COURTNEY SPINKS** is a program associate - pesticide safety training with the University of Arkansas System Division of Agriculture, Little Rock. **MICHAEL A. PASKEWITZ** is a county extension agent - staff chair in Izard County.

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