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Calibrating Single Nozzle Boom-less Sprayers

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Introduction

Sprayer calibration is an essential part of pesticide application. Accurate application of pesticides is possible only when the application volume is known. Adequate application volume along with nozzle selection, travel speed and swath width are the keys to the uniform spray coverage needed for effective pest control. Boom-less sprayers are best used in situations where a high degree of precision is not critical. While less accurate than boom sprayers, boom-less sprayers are more maneuverable in hilly terrain, cheaper and require less maintenance.

Equipment Speed

Tractor speedometers may vary in their accuracy. Verify the accuracy of the tractor speedometer using one of the two methods below.

Nozzle Output

Capturing the output or flow from a boom-less nozzle is necessary for calibration but often challenging because of the 180° spray pattern (Fig. 1). One way to measure this output is to construct a deflector that will funnel the flow from the nozzle into a bucket. Figure 2 shows an example deflector made from a one gallon container. As illustrated, two holes are cut in the container, one on the side near the bottom and the other enlarges the already open top to ensure no flow restriction while measuring.

In addition to this deflector, you will also need a 5 gallon bucket, stopwatch, and a marked or graduated container that measures fluid ounces or milliliters. It is important to note that calibration procedures like

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 a 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 similar to 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:

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

Result = MPH

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Figure 1. 180° spray pattern of boom-less nozzle.

performing catch tests should be completed using water alone.

Swath Width

Swath width can be described in two ways. Many nozzle manufactures list the "observed swath" in their literature, which is the width a nozzle can spray (Figure 4). More important is the "effective swath" which is the width that provides sufficient coverage for pesticides to be effective. The spray volume of boom-less nozzles decreases on the outer edges of the swath or spray pattern. Less volume results in lower pesticide rates and less coverage,

Step 2. Performing a Catch Test

1. Clean filters and the nozzle to ensure that flow rates can be measured accurately.
2. Secure the deflector on the nozzle so that the open end is pointed at the ground (Figure 3).
3. Set the RPM used in step 1 to measure speed.
4. With water in the tank, turn on the sprayer and adjust the pressure to be between 30 and 40 PSI. (note the exact PSI)
5. Use a stopwatch and a 5 gallon bucket to catch the nozzle's flow for 1 min.
6. Repeat measurement checking for consistency.
7. Convert measurement to GPM if necessary.
   - ounces per min / 128 = GPM
   - milliliters per min / 3785 = GPM

Result = GPM

Figure 2. (left) Deflector used in catch test.
Figure 3. (right) Secure deflector to nozzle.

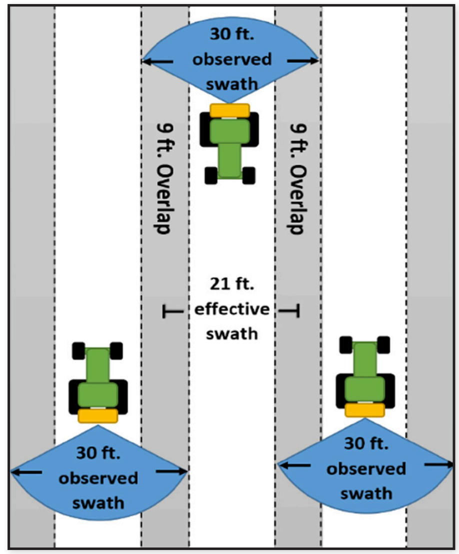

Figure 4. Observed swath vs effective swath. Showing 30% overlap.

which may lead to strips of poor control (Figure 5). Streaking can be avoided by overlapping the swaths by a minimum of 30 percent. Use the effective swath width for calibration.

Figure 5. Skips caused by inadequate overlap.

Calculating GPA

After equipment speed, nozzle output and effective swath width 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-less applications a minimum of 15 GPA is recommended and volumes of 20 to 25 GPA may be beneficial. If the spray volume needs to be adjusted, changes to equipment speed, pressure or

Step 3. Determining Effective Swath Width

1. With the sprayer on, set the system pressure to that used when performing the catch test.
2. Mark the ground at the extreme edges of the pattern (observed swath). Doing this test over dry pavement or gravel provides a handy outline of the pattern.
3. With sprayer off, measure this distance in feet.
4. Multiply this width in feet by 0.7 to account for a minimum 30% overlap (Figure 4).

Result = effective swath in feet.

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 = effective swath in ft.
GPA = gallons per acre
495 = constant

$$GPA = \frac{GPM \times 495}{MPH \times W}$$

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

Step 4. (Alternative): Gallon Method

1. Reference Swath (ft.) column to determine course length. Use your 'effective' swath.

Swath (ft.)	Course (ft.)	Swath (ft.)	Course (ft.)
10	436	26	168
12	363	28	156
14	311	30	145
16	272	32	136
18	242	34	128
20	218	36	121
22	198	38	115
24	182	40	109

2. Traverse & time (sec) course with desired speed & RPM. Repeat and average results.
3. Catch nozzle flow (gal.) for time measured while traversing course (sec.). Repeat and average.
4. Gallons measured **x 10 = GPA output**.

swath width can be made to achieve the desired spray volume. Note that each of these variables have their limitations and a typical range for these adjustments have been described in their respective sections. To increase volume (GPA) — decrease speed, increase pressure (max 45 PSI), increase overlap (30-35 percent or 0.7 to 0.65). To decrease GPA — increase speed, decrease pressure (min 30 PSI), and decrease overlap (maintain recommended 30 percent minimum). 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 percent 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). 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 percent 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.

Step 5. Calculating Mix

1. $\frac{\text{Tank Volume}}{\text{Sprayer Output}}$ **= ac./tank** *example:* $\frac{150 \text{ gal}}{15 \text{ GPA}}$ **= 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.

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, pressure and swath width 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 assist with documenting settings and measurements.

Conclusion

Sprayer calibration is essential to successful pest control. Do a calibration check before every 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.

Single Nozzle Boom-less Sprayer: Calibration Worksheet

Equipment Speed ___________ ***Tractor Range:*** ________ ***Gear*** ________ ***RPM***_________

1. Mark a distance (ex. 100 or 200 ft.) on terrain similar to 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.

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

Nozzle Output (GPM) ___________ ***Sprayer Pressure (PSI):*** ________

4. Catch the nozzle's flow for 1 min in a 5 gal. bucket.
5. Convert measurement to GPM if necessary.
   - **_______ounces per minute / 128 = ______GPM**

   OR
   - **_______milliliters per minute / 3785 = ______GPM**

Effective swath (ft.) _______ ***Observed swath (ft.)*** __________ ***Overlap factor*** ____________

6. Measure total (observed swath) in feet.
7. Multiply to consider overlap (Multiply by 0.7 for a minimum of 30% overlap)
   - **Ex. 30 ft. swath x 0.7 = 21 ft. (effective swath)**
   - **________ft. x _____= ______ft. effective swath**

Gallons per acre (GPA) _______

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

_____________ **GPA =** $\frac{(\_\_\_\_\_\_\_\_ \text{ GPM) x 495}}{(\_\_\_\_\_\_\_\_ \text{ MPH) x (}\_\_\_\_\_\_\_\_ \text{ ft. swath)}}$

Mix = _______________gallons of water and _________________________ product per tank

(If label recommended) + _______________________ surfactant per tank

9. Calculate acres per tank. $\frac{\_\_\_\_\_\_\_\_ \text{ Tank Size}}{\_\_\_\_\_\_\_\_ \text{ GPA}}$ **= ___________ ac./tank**

10. Calculate product per tank. **(_________ac./tank) ×(______rate/ac.)=________product per tank**

11. Calculate surfactant per tank. **Ex. 0.25% (0.0025 x 150 gal.) = 0.375 gal. or 1.5 quarts**

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