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Calibrating Boom Sprayers for Turf Applications

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Calibrating application equipment is something many people avoid because they believe it is too time consuming or that the math involved is too confusing. Calibration, however, is critical. Applying too little pesticide can result in poor pest control and can lead to pesticide resistance; over-applying can be bad for the environment, damage the grass, and waste money.

Calibration Methods

Several methods can be used for calibrating sprayers. Choose the one that makes the most sense to you. Three different methods are described below. All these methods are reliable and will provide very similar application accuracy.

Note: Check the output from each nozzle for the same amount of time to be sure they are all consistent. There should be very little difference between the nozzles (ideally, within +/- 5 percent of each other). If nozzles differ more than this, consider replacing them.

1/128th Acre Method

The first calibration method is called the 1/128th method because there are 128 fluid ounces in a gallon (1 fluid ounce = 1/128th of a gallon), and the calibration method covers 1/128th of an acre (340 square feet). (In other words, one acre is 43,560 square feet; 43,560 square feet divided by 128 is 340 square feet.)

To calibrate using the 1/128th method, you need only very simple equipment:

- Boom sprayer
- Measuring tape
- Measuring container (fluid ounce increments)
- Stopwatch

Use the following steps to calibrate a boom sprayer using the 1/128th acre method:

1. Measure the nozzle spacing in inches from the center of one nozzle to the center of the next nozzle (width or W) (Figure 1).

Figure 1. Measuring nozzle spacing in inches from the center of one nozzle to the center of the next nozzle.

Figure 2. Timing how long it takes to drive a pre-determined distance.

Figure 3. Collecting nozzle output for same length of time as it took to travel the pre-determined distance.

2. Determine calibration run distance (D). This is the distance you will drive or walk the sprayer. There are two ways to mathematically determine the distance. In the first equation, 4084 is a constant (12 inches/feet x 340 square feet ≈ 4084).

a. $$\frac{4084}{\text{W (nozzle spacing)}} = \text{D (distance in feet)}$$

b. $$\frac{\text{W}}{\text{12 inches/feet}} = \text{spacing in feet}$$

$$\frac{\text{340 square feet}}{\text{spacing in feet}} = \text{D}$$

3. Fill the spray tank about half full with water and time how long it takes you to drive or walk the distance determined above (Figure 2).
4. Spray from one nozzle into a measuring container for the same amount of time as it took to travel the calibration distance (Figure 3).
5. The amount collected in the container from a single nozzle, measured in ounces, is the gallons per acre (GPA) the sprayer will apply. If you collected 40 fluid ounces in your measuring container, then the application rate is 40 GPA; if 30 fluid ounces were collected it would equate to 30 GPA, etc.

Alternatively, if you know the speed of your sprayer and the nozzle spacing in inches, you can find the distance to travel and the time required to measure the output of your nozzles from Table 1. The only concern with using the calculated time in seconds instead of actually traveling the distance with your spray equipment over your turf is that, occasionally, travel times can vary slightly due to turf and terrain conditions. Ideally, use the time in the table for reference only. As above, the amount of liquid collected in the measuring container (in ounces) is equal to the GPA.

Table 1.

Nozzle spacing (in)	Calibration distance (ft)	Speed of travel (mph)			
		2	3	4	5
		Time (s) to travel calibration distance			
5	817	281	186	139	112
6	681	235	155	115	93
7	583	201	133	99	80
8	511	176	116	87	70
9	454	157	103	77	62
10	408	141	93	69	56
11	371	128	84	63	51
12	340	117	77	58	47
14	292	101	66	50	40
16	255	88	58	43	35
18	227	78	52	39	31
20	204	70	46	35	28
22	186	64	42	32	26
24	170	59	39	29	23
26	157	54	36	27	22
28	146	50	33	25	20

Output over Area Method

Output over area is very simple in that all we are determining is how many gallons are actually being applied over a pre-determined area.

Determine the test area:

Measure the width (W) of your spray boom.

Assume (as in Figure 1) that the nozzle spacing is 20 inches and that there are 8 nozzles:

20 inches x 8 nozzles = 160 inches

Convert inches (above) to feet:

160 inches ÷ 12 inches = 13.333 feet

W = 13.333 feet

Measure and mark the length (L) of the distance you intend to travel.

Assume (as in Figure 2) that this distance is 100 feet:

L = 100 feet

Area is defined as L times W:

100 feet x 13.333 feet

Test area = 1,333.3 square feet

Record the time:

Fill the sprayer tank half-full of water, engage the pump, and set the engine RPMs at a repeatable level. Use a stopwatch and record the time it takes to travel the length of the test area.Repeat the test three times and take the average time for the three runs:

Assume that it takes an average of **20 seconds** to travel this distance.

Measure the output volume:

Collect the output from each nozzle for an amount of time equal to that found in the step above:

Assume an average of **10 fl oz** was collected from each nozzle in 20 seconds:

10 fl oz x 8 nozzles = 80 fl oz

80 fl oz would have been applied over the 1,333.3 sq ft test area

Convert the output volume (above) to output per acre:

Determine the difference in size between an acre (43,560 sq ft) and your test area:

43,560 sq ft ÷ 1,333.3 sq ft = 32.67

An acre is 32.67 times larger than your test area. So it will take 32.67 times more output volume than was measured above to cover an entire acre:

80 fl oz x 32.67 = **2,613 fl oz** per acre

Convert fluid ounces to gallons:

There are 128 fluid ounces in 1 gallon:

2,613 fl oz ÷ 128 fl oz = 20.4 gallons

equals

20.4 gallons/acre (20.4 GPA)

5940 Method

This method uses a constant number (5940) to determine GPA. The first step is to measure the output from each nozzle for 1 minute. Then you determine the average nozzle output:

$$\frac{\text{Total output from all nozzles (fluid oz)}}{\text{Number of nozzles}} = \text{Average nozzle output (fluid oz)}$$

Gallons per minute (GPM) can then be calculated from the above information:

$$\frac{\text{Average nozzle output (fluid oz)}}{\text{128 fluid oz/gallon}} = \text{GPM}$$

Gallons per acre (GPA) is calculated by plugging the values into the following formula:

$$\frac{\text{GPM x 5940}}{\text{MPH x W}} = \text{GPA}$$

Where

MPH = miles per hour of the sprayer

W = nozzle spacing (inches)

GPM = gallons per minute (calculated above)

5940 = constant value

Determining miles per hour (MPH)

If the spray rig does not have a speedometer, you will need to determine the sprayer speed before using the 5940 method. There are smart phone apps available that will record speed. Check the app you choose with your car's speedometer to insure it is accurate. You can also determine sprayer speed by measuring the time it takes to drive a known distance (Figure 2). To measure sprayer speed, fill the tank half-full of water, engage the pump, and set the engine RPMs at a repeatable and safe level. Drive the measured length and record the amount of time it takes. Ideally run the test three times and take the average of the times to improve accuracy. Once you have the time recorded, simply plug it into the following equation:

$$\frac{\text{Test length (feet) x 60*}}{\text{Time x 88*}} = \text{MPH}$$

**60 and 88 are constants*

Once we determine MPH, we can insert the value into the 5940 method equation above calculate GPA.

From this basic equation, the GPM can also be determined if GPA is known:

$$\frac{\text{GPA x MPH x W}}{5940} = \text{GPM}$$

This calculation can be useful when checking for worn nozzles or in selecting the correct nozzle sizes to use for the desired GPA. Some digital spray tip calibration tools use this value as a quick way to measure individual nozzle output.

Changing the Sprayer Application Rate

Regardless of which sprayer calibration method you choose, you use the same approach to change the application rate if it is more or less than the desired. You must adjust either speed, pressure, or spray tips to change your GPA. However, only use pressure changes for minor adjustments in GPA as it takes major changes in pressure to significantly change output.

How Much Chemical to Add to the Tank

Because everyone's brain works differently when it comes to math, choose the calibration method that makes the most sense to you. Once you have settled on a sprayer calibration method, the final step is to determine how much pesticide to add to the tank to apply the desired rate. Read the pesticide label to determine the desired rate. For example, suppose for a disease we want to control, the fungicide label indicates a one-quart per acre rate is required. We calibrated our sprayer to 20 GPA and our spray tank can hold 200 gallons of liquid. To calculate how much fungicide to add to the tank, we use the following formula:

$$\frac{\text{Spray tank size (gallons) x Pesticide rate per acre}}{\text{GPA}} = \text{Amount of pesticide required in sprayer}$$

Plugging in our numbers, we get the following:

$$\frac{\text{200 gallons x 1 quart per acre}}{\text{20 gallons per acre}} = \text{10 quarts}$$

If we wanted to convert quarts to fluid ounces because the number of quarts does not work out to be a nice whole number, we can do this by multiplying by 32 fluid ounces in a quart.

$$\text{10 quarts x 32 fl oz/quart} = \text{320 fl oz of herbicide to add to the spray tank}$$

This formula also works for dry pesticide formulations like WPs or DGs. Just substitute the desired dry product rate, whether ounces, pounds, or even grams per acre, into the pesticide rate of the equation to calculate how much to add to the tank.

Figuring the GPA of the sprayer is the tough part, and calculating how much product to add is the easy part. You may want to try all methods to find the one that works best for your situation and stick with it. If the calculated amount of pesticide needed is inconvenient or difficult to work with, you can convert it to other units using appropriate conversion factors. You can easily find websites that will do this. Finally, the most important thing is to obtain an accurate spray volume. Sprayers should be recalibrated often to ensure sprayer output is accurate and to avoid use of worn nozzles.

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