



Citrus Herbicide Boom Sprayer Calibration¹

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Herbicide application equipment calibration is an essential component of any weed control or weed management program. Proper calibration will assure even distribution of material over the treated surface, thereby maximizing application efficiency.

Improperly adjusted equipment will result in uneven distribution of spray material, delivering questionable application rates which may result in poor weed control and/or possible tree damage due to potentially high rates. Incorrect application rates may result in increased weed control costs as a result of over application of herbicide material or the need to repeat application due to poor weed control.

All citrus herbicide application systems have the following components: tank, pump, agitation, strainers or screens, pressure regulator(s) with gauge(s), boom and nozzles. Material application rate can be controlled by adjusting the nozzle type and size, operating pressure or the ground speed of the equipment.

When calibrating the equipment, the first factor that needs to be determined is the equipment speed through the application site. Most herbicide applicators choose a speed between 2 and 4 miles per hour when the application is being made in a citrus

grove. Actual desired ground speed will be based upon the type of equipment and the conditions within the grove.

To determine the ground speed, measure and stake off a distance of 200 to 300 feet in conditions similar to the actual application site. Longer test run will increase accuracy. Fill the sprayer tank half-full with water. Equipment will travel slower through soft sand than in a field where the soil is covered by vegetation so the selection of the site to determine ground speed is important. The equipment will also be slower when completely full and faster when empty. Select a gear which will give you the desired speed and record the selected gear number and engine speed in RPM (revolutions per minute is displayed on the equipment tachometer). When making the test run, get the equipment up to the desired speed prior to crossing the starting line, i.e. a running start. Measure the time required to cover the measured distance in seconds using a watch with a second hand or stop watch.

For this calibration example, use the following information.

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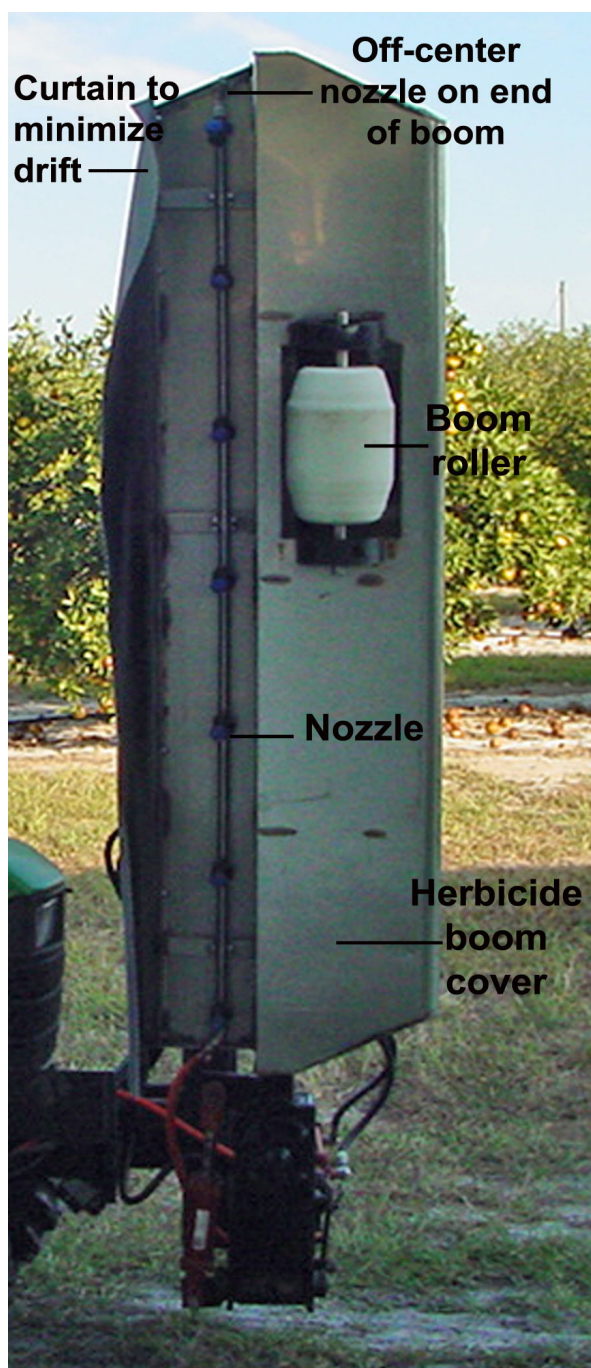


Figure 1. A standard herbicide boom.

Step 1. To determine the equipment speed, use the following equation:

$$\text{Speed (MPH)} = \frac{\text{Distance}}{\text{Time}} \times 0.682$$

where, distance is in feet and time is in seconds.

$$0.682 = \left[\frac{60 \text{ s}}{1 \text{ min}} \right] \left[\frac{60 \text{ min}}{1 \text{ h}} \right] \left[\frac{1 \text{ mile}}{5,280 \text{ ft}} \right]$$

For example, assume you covered the 300-foot test distance in 58 seconds, your travel speed would be:

$$\text{Speed (MPH)} = \frac{300}{58} \times 0.682$$

$$\text{Speed} = 3.53 \text{ MPH}$$

Alternative equation to calculate speed:

$$\begin{aligned} \text{Speed (MPH)} &= \frac{\text{Distance} \times \text{number seconds per hour}}{\text{Time in seconds} \times \text{number of feet per mile}} \\ &= \frac{\text{Distance} \times 3,600}{\text{Seconds} \times 5,280} \end{aligned}$$

Step 2. Next you will need to determine the amount of material needed to apply per nozzle. The equation you will use is:

$$\text{GPM}_n = \frac{\text{GPA} \times \text{MPH} \times W}{5,940}$$

where, GPM_n = gallons per minute per nozzle, GPA = gallons per acre per treated area, MPH = miles per hour, and W = nozzle spacing in inches.

$$5,940 = \left[\frac{43,560 \text{ ft}^2}{\text{acre}} \right] \left[\frac{1 \text{ mile}}{5,280 \text{ ft}} \right] \left[\frac{12 \text{ in}}{1 \text{ ft}} \right] \left[\frac{60 \text{ min}}{1 \text{ h}} \right]$$

Note: When using different nozzle sizes on the same boom, such as off-center nozzles on the boom ends, or larger nozzles at the drip line; use the entire width of the sprayed area as W = width in inches and the GPM as the total gallons per minute of all the nozzles on the boom, collectively. (Add the GPM_n for each nozzle to get the total GPM.)

In this example, we want to apply 30 GPA and calculated our speed in step 1 at 3.5 MPH and our

measured width between nozzles is fixed at 12 inches. Thus, our gallons per minute per nozzle can be determined as follows:

$$GPM_n = \frac{30 \times 3.5 \times 12}{5,940}$$

$$GPM_n = 0.212$$

By knowing the amount of material needed to apply per nozzle, the correct nozzle size can be selected from charts established by the nozzle manufacturer. From the manufacturer's table, select a nozzle type which provides the correct (or close to the desired) gallons per minute at a reasonable application pressure. Remember, as you increase the pressure you could increase the number of small drift-prone spray droplets. Thus, choose a nozzle which will allow the desired gallons per minute at a pressure that will minimize drift-prone droplets while providing the desired spray pattern. Remember to choose a nozzle type that will produce the desired overlap (approximately 30% - 50%) for your particular boom height and nozzle spacing. Nozzles are available in 65 to 140 degree spray angles to accommodate nozzle spacing and boom height.

Step 3. In cases where you know the nozzle flow rate and travel speed, you can determine the amount of material you will apply in gallons per acre (GPA). In most cases, pre emergence herbicides are applied within a range of 20 to 30 GPA with post emergence material being applied at a slightly lower rate of 5 to 20 GPA. To calculate your anticipated GPA and using the GPM determined in step 2, use the following equation:

$$GPA = \frac{5,940 \times GPM_n}{MPH \times W}$$

where, GPA = gallons per acre, GPM_n = gallons per minute per nozzle, MPH = miles per hour, and W = nozzle spacing in inches.

$$GPA = \frac{5,940 \times 0.212}{3.5 \times 12}$$

$$GPA = 29.9 \text{ or round to } 30$$

Step 4. Now that you have determined travel speed, nozzles and the desired pressure in step 2 to give you the desired flow rate that you will use, you need to verify that the actual flow rate from a given nozzle is correct. To verify the flow rate from the nozzle, fill the tank with water and set engine speed to the desired RPM. After the engine speed is set, engage the pump and allow water to be sprayed out the boom. Adjust the spray pressure to obtain the desired pressure level that will be indicated on the equipment's pressure gauge. Once the pressure is correct, measure the flow from each nozzle on the boom making sure all nozzles are performing as desired.

Flow rate can be determined by collecting a volume of the spray in a graduated container and recording the corresponding collection time using a stopwatch or watch with a second hand. The collected volume, measured in ounces (or other units) will be converted to gallon volume. Divide the collected volume (in gallons) by the time (in minutes) to obtain GPM of each nozzle. Repeat this procedure for each nozzle and use the average GPM in the calculation of the GPA. Individual nozzle flow rate between nozzles should not exceed a difference of 10% of the average flow rate of all nozzles, with a lower variation providing a more accurate calibration. Nozzles with greater variation could be worn or defective and should be replaced. If the calculated GPA is different from the desired GPA, adjust the pressure and/or speed to obtain the desired flow rate. The flow rate varies directly with speed and with square root of the pressure. Thus, change the speed for major increase/decrease in flow rate and change the pressure for minor adjustment in GPA. Also, note that all nozzle GPM tabulations are based on spraying water. Heavier or lighter spray solutions will need some flow rate correction.

Remember when calibrating any spray equipment, proper personal protective equipment (PPE) should be worn to minimize personal contact with any chemical residue that may be in or on the



Figure 2. Collecting flow from nozzle during calibration.

equipment. Personal protective equipment, at a minimum, should include at least chemical proof gloves, long sleeve shirt, long pants, shoes and socks. Additional personal protective equipment should be worn if previously applied chemical required additional items to be worn.

Now that the herbicide machine is correctly calibrated, this process should be repeated periodically during the application season to maintain application efficiency.

Calibration Work Sheet

Date: _____

Calibrator name (initials): _____

Sprayer type: _____

Nozzle make/model/size (color): _____

Nozzle pressure (psi): _____

Nozzle output (GPM_n): _____

Nozzle #1 (), #2 (), #3 (),

Average nozzle output (GPM_n): _____

Number of nozzles: _____

Nozzle spacing, W (inch): _____

Tractor make/model: _____

Tractor engine speed (RPM): _____

Gear selection: _____

Calibration course distance (ft): _____

Calibration travel time (sec): _____

Travel speed (mph) = $\frac{ft}{sec} \times 0.682$ = Desired GPM/nozzle (GPM_n): _____

Desired GPA (gpa): _____

Average GPM_n = $\frac{GPA \times MPH \times W}{5940}$ =

or

GPA = $\frac{5940 \times GPM_n}{MPH \times W}$ = **Notes:**