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## Calibration of Pesticide Spraying Equipment

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Photo courtesy of Erdal Ozkan

# CALIBRATION

## *of Pesticide Spraying Equipment*

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### **Why calibrate?**

That's an easy question to answer. Calibration of pesticide equipment ensures that the correct amount of pesticide is applied. If too little is applied, you may not control the targeted pest. If too much is applied, your chemical costs increase, you may be in violation of the law, and there may be negative effects on humans, livestock, and the environment.

So why not calibrate?

That's a much harder question for many applicators to answer. Common replies are, "It takes too much time." "It was calibrated when I bought it." "It's too complicated." "I have a rate controller so I don't need to calibrate."

But it doesn't take as much time as you think. The equipment wears and application rates change. Calibration doesn't need to be complicated. Rate controllers contain mechanical sensors that can wear or become sticky, so they need to be checked to ensure that they function properly.

Calibration and maintenance of spraying equipment needs to be a part of your total pesticide program.

### **Preparation for Calibration**

No matter what approach you take to calibration, the first step should be to walk around the sprayer equipment and check to see that booms are straight, braces and springs are intact, shields are in place, hoses are in good shape and not rubbing over metal edges, fittings are not cracked, and clamps are tight. Next add water and check pumps, valves, and gauges for proper operation. Flush your sprayer over a site labeled for the last pesticide used.

Check over anything that may possibly fail during the peak of the spraying season. Downtime can be expensive and frustrating, but preventing equipment failure that causes a major pesticide spill makes the time you spend now in checking and maintaining equipment a very good investment.

Before working on your sprayer, always put on proper protective clothing, particularly chemical-resistant gloves. There will be pesticide residues that have collected on all surfaces.

If at all possible, wash the residues from the sprayer, especially if you need to do any welding, since the heat can vaporize pesticides that can be easily inhaled.

After repairing or replacing worn and broken parts, clean the strainer, the nozzle screens, and nozzles. Use a nozzle brush or an old worn-out toothbrush to clean the nozzles. Don't use anything hard, such as a wire or knife blade, since most nozzles are easily deformed.

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Clean all strainers and nozzle screens before calibrating.



Check nozzles for uniform pattern. This nozzle was damaged while cleaning.

Now fill the sprayer with clean water and park it at the end of a field. Start the sprayer and adjust the pressure to an approximate pressure that you intend to use. Catch the output from each nozzle for an equal amount of time, using a measuring cup marked in ounces.

Total the output from all nozzles and divide by the number of nozzles to determine the average nozzle output. Each nozzle should be no more than 5% off the average output. If output is higher or lower, you will probably need to replace all nozzles.

Pay particular attention to the spray pattern to ensure that the output appears uniform across each nozzle. If possible, run the sprayer over a concrete pad or a hard-packed driveway, then watch as the water dries to see if you have any heavy or light areas due to worn or partially plugged nozzles. Be certain that you have flushed the sprayer and are using clean water.

If you find a worn or damaged nozzle, it is recommended that you replace the entire set. Why? Because all nozzles wear and a replacement nozzle will likely have less output than the old ones.

To determine nozzle wear on your sprayer, replace one nozzle with a new nozzle of the same brand, type, and size as the old nozzles. Turn the sprayer on (again filled with water only), catch the water coming out of the new nozzle for a given time, and compare the output with your old nozzles. If the difference is greater than 5%, you should replace the entire set and recalibrate.

How do you determine a starting pressure?

The best place to start is by using a nozzle chart.

Unfortunately, some people stop here and assume that, if they have a certain size nozzle and set the pressure gauge for the recommended pressure, they will be calibrated to apply the desired amount at a given speed. The problems are that (1) parts wear and (2) the intended speed may not be the actual speed.

Unless the nozzles you are using are new, there will likely be a higher flow rate than indicated in the nozzle chart because of wear. How long has it been since the pressure gauge was checked for accuracy? How much pressure loss is there between the gauge and the end nozzle? Is your speed the same in soft ground and packed ground? Unless you have a radar or GPS speed indicator, your actual speed may be quite different than you may think. There are numerous reasons why calibration based on a nozzle chart could be far from accurate.

Now you're ready to calibrate. You have some choices of method. Pick one that best fits your situation.

### The "complicated equation" method

The "complicated equation" method is probably the most commonly recommended method for calibration. It is a fairly simple equation:

$$\text{Gallons per acre} = \frac{5,940 \times \text{gpm}}{\text{Width} \times \text{mph}}$$

gpm = gallons of spray delivered per minute per nozzle

mph = miles per hour of actual travel speed in the field

W = width of nozzle spacing in inches



What makes this method “complicated” is the number 5,940. It simply converts inches and feet and minutes and hours to gallons and acres. You must calculate the gallon per minute output per nozzle, determine the actual speed in miles per hour, and measure the nozzle spacing in inches.

To determine the gpm output of the nozzle, catch the output from each nozzle for 1 minute (or for 30 seconds, then double the amount) and use the equation below:

$$\text{_____ oz per minute} / 128 \text{ ounces per gallon} = \text{_____ gpm}$$

To determine speed, measure out a known distance, measure the seconds needed to travel that distance under field conditions, and use the equation below:

$$\begin{aligned} \text{_____ ft} / \text{_____ seconds} &= \text{_____ ft / sec} \\ \text{_____ ft / sec} / 1.467 &= \text{_____ mph} \end{aligned}$$

**1/128 Acre Method**

This method sounds complicated, but it is really one of the simplest and quickest. It doesn’t even require the use of a calculator. The objective is to see how much water is collected from one nozzle in the time that it takes for that nozzle to cover 1/128 of an acre as you travel down the field.

Why 1/128 acre?

Since there are 128 ounces in a gallon, and you are collecting the amount of water that would have been sprayed over 1/128 acre, each 1 ounce you collect is equal to 1 gallon per acre.

Figure 1	
Nozzle spacing in inches	Feet to travel to cover 1/128 acre
10	408
20	204
30	136
40	102

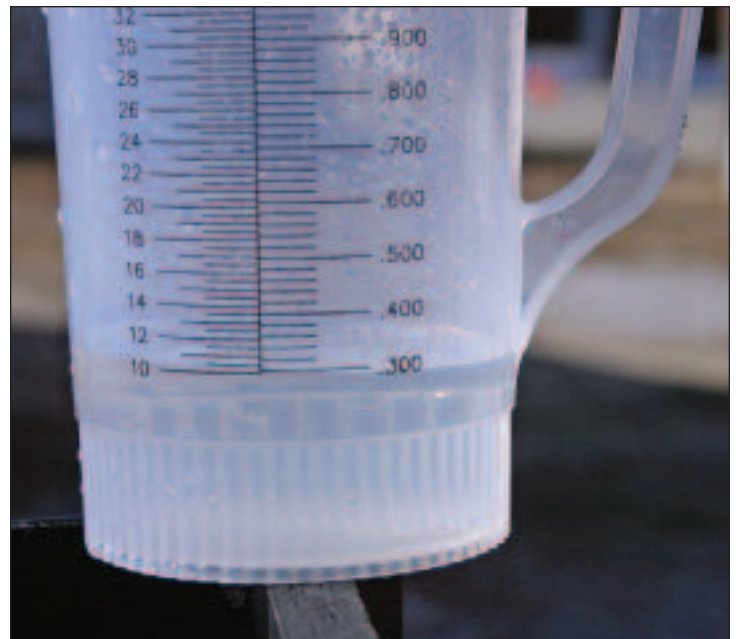
Here’s what you do:

First, determine the time it will take to cover 1/128 acre with one nozzle. Refer to the chart (Fig 1). If you have a sprayer with 20-inch nozzle spacing, you will have to travel 204 feet to cover 1/128 acre with one nozzle. Set up two flags 204 feet apart under field conditions (not a packed surface), and time how long it takes your sprayer to travel between the flags at the speed you intend to use. Be sure you are up to speed before passing the first flag to get an accurate indication of your speed.

Let’s assume that the time to cover 204 feet is 28 seconds. Park your sprayer, filled with clean water, at the end of the field, set to the pressure you plan to use, and measure how much water you collect during 28 seconds from one nozzle. If you collect 11 ounces, your application rate would be 11 gallons per acre (gpa). If you really wanted 10 gpa you may be able to slightly decrease your pressure and collect from a nozzle again.



Check all nozzles for uniform output.



In the 1/128 acre method, 10 ounces collected equals 10 gpa application rate.

This is a simple, easy, foolproof method for broadcast or banding equipment and could be done during sprayer preparation when checking nozzle output uniformity.

If you are a long way from the output you desire, you may need to change your ground speed and retime your travel or change nozzle sizes. To manage droplet drift and droplet size you may need to keep your pressure within a fairly small range. To double nozzle output you must increase pressure four times, so only fine adjustments can be made by pressure. Changes in speed are a direct relationship to application rate, doubling speed cuts the application rate in half.

### Fill, Spray, and Refill Method

This method works well for any size sprayer, but particularly well for small boomless or ATV mounted sprayers. To determine effective boom width, fill the sprayer with clean water and spray across a gravel road or driveway and measure the “wetted” distance, allowing for overlap as needed.

Fill your sprayer tank with water in a level area. Determine a known area to spray. Spray the area, then return to the spot where you filled the sprayer and measure the amount of water needed to fill the tank to the original level. Use the equations below to determine your output.

$$\frac{\text{_____ Width X _____ Distance} = \text{_____ sq ft}}{\text{_____ sq ft / 43,560 sq ft per acre} = \text{_____ acres}}$$

$$\text{_____ gallons to refill tank / _____ acres traveled} = \text{_____ gallons per acre}$$

Width = width of boom or sprayed area, in feet

Distance = distance traveled while spraying, in feet

Let's assume you had a boom that was 33 feet, you traveled one-fourth mile (1,320 feet), and it took you 10 gallons of water to refill the tank:

$$\begin{aligned} 33 \text{ feet X } 1,320 \text{ feet} &= 43,560 \text{ sq ft / } 43,560 \text{ sq ft} = 1 \text{ acre covered} \\ 10 \text{ gallons of water / } 1 \text{ acre} &= 10 \text{ gpa application rate.} \end{aligned}$$

### Rate Controllers and Injection Units

Just because you have a monitor on the sprayer that gives you an application rate doesn't mean that it is accurate. Each piece of automated spray equipment has a calibration process. As pieces wear or become sticky, they lose accuracy. Refer to the manufacturer's procedures for determining if the indicated application rate is correct.

### Pesticide Dilution

After determining the carrier rate, the next question is; “How much pesticide do you put in the tank?”

If you are applying a 16 fluid ounce rate at 5 gallon per acre carrier rate, for each 5 gallons you put in the tank, you essentially need to put in 16 ounces of product. Actually you need to add enough water to the 16 ounces of product to make 5 gallons of spray solution. If you have a 500-gallon tank you would be able to cover (500 gallons / 5 gallons per acre) 100 acres with one tankful. That means you would need to add 16 ounces X 100 acres = 1,600 ounces (1,600 oz / 128 oz per gallon) or 12 1/2 gallons of product to the tank and fill with water to mix 500 gallons of spray solution.

### Spot Check Rates

At the minimum, calibrate your sprayer at the beginning of each spraying season, after changing rates, or after changing a pump or nozzles. Then spot check your calibration by determining the amount of spray you should use on an application site and measuring what you actually used.

Let's assume you are applying 10 gpa and spray an 80-acre field with a .5 ounce rate of a pesticide. You should use 10 gpa X 80 acres = 800 gallons of water and .5 ounces X 80 acres = 40 ounces of product. Compare this to what you actually used and recalibrate if necessary.

### Does It Pay?

With just a small amount of wear, it is not uncommon for spraying equipment to be applying 10% more than expected. If you are making an insecticide treatment costing \$20 per acre, that amounts to an additional \$2.00 an acre from overapplication. If you spray 2,000 acres, that equals \$4,000 that have been wasted. That makes the small amount of time spent calibrating your sprayer equipment a very good investment.



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