SECTION II - SPRAYER CALIBRATION

Proper sprayer calibration is an extremely important step in the application of herbicides. Often, sprayers are not calibrated properly, which results in poor weed control from under application, or crop damage from over-application. To know how much chemical to add to the sprayer tank, you need to know the capacity of the spray tank whether it is one gallon or 500 gallons. With this information you will know how many acres the pesticide mix in your tank will spray. You also need to be familiar with nozzles, boom width, pressure setting, pumping arrangement, and operating speed. These are all part of proper sprayer calibration.

There are several methods of sprayer calibration: the refill or field trial methods are probably the best known. However, the 1/128th method is probably one of the simplest. Numerous other methods not discussed here may be just as accurate or easy. However, it is important to pick a method you understand and use it for your sprayer calibration.

PRE-CALIBRATION PREPARATION

Before you go to the field, service the entire sprayer and determine exactly how much liquid the sprayer tank holds. Clean all lines and strainers, and make sure all strainers are the correct size and properly placed. Check pressure gauges against one known to be accurate. Check nozzles to be sure they are the same. Flat fan nozzles should be used for broadcast applications and even fan nozzles should be used for band applications. Check the flow from each nozzle. To check nozzle flow, collect the flow from each nozzle for 30 seconds into a calibrated container such as a measuring cup marked in ounces. Or use a tip tester; it quickly helps identify worn spray tips. Tip testers are available from Spraying Systems Company or other agricultural outlets that carry pesticide application equipment. Clean or replace nozzles when the flow varies ±5 percent from the flow from a new nozzle. Nozzles should only be cleaned with a soft-bristled brush such as a toothbrush, never with a metal object. Even a toothpick can damage plastic nozzles.

REFILL METHOD

The refill method of calibration is simple and easy to understand. This should always be done in the field on terrain similar to where you plan to make the chemical application. Field surface conditions can seriously affect sprayer speed, which in turn affects spray rate. The basic steps for the refill method are as follows:

1. Fill the spray tank with water.
2. Adjust for pressure within the recommended range for nozzles used.
3. Select an easily maintained speed that fits field conditions.
4. Spray a measured area.
5. Return to the filling point.
6. Measure the amount of water required to refill the tank.
7. Calculate the spray rate.

Calibration of a Boom Sprayer

Calibration of a boom sprayer by the refill method follows the steps outlined above.

1. Park the sprayer on level ground, then fill the spray tank with water to an easily determined point. It may be a mark on the spray tank, the top of the tank fill hole, or some other point.
2. Adjust the pressure to the recommended level. Most nozzles used on field sprayers work best between 20 and 40 pounds per square inch pressure (psi). When spraying below 20 psi the spray pattern may be distorted, while pressures above 40 psi tend to increase spray drift. The manufacturer’s handbook gives recommended pressures for each nozzle tip.

Slight increases or decreases in spray rate can be made by changing the pressure within the recommended range. Nozzle discharge varies with the square root of pressure. For example, doubling the pressure will only increase the nozzle delivery by 1.4 times, not twice. Large delivery rate changes should be made by changing the nozzles or adjusting the speed, not by increasing or decreasing the pressure outside recommended limits.

3. Select an easily maintained speed that fits field conditions. Field conditions can have a considerable effect on speed and may seriously affect spray delivery. A sprayer calibrated at 4 mph but driven at only 3 mph will over-spray by 33 percent, enough of an error to cause significant crop injury.

4. Spray a measured area. First you must determine the area to be sprayed. This can be done by measuring the swath width. This is the width of the spray pattern on the ground. Use a long tape measure or multiply the nozzle spacing on the boom by the number of nozzles (divide by 12 to get the answer in feet if nozzle spacing was measured in inches). For example, if your boom has 18 nozzles spaced 20 inches apart, the swath width is: 20 inches x 18 nozzles ÷ 12 inches per foot = 30 feet. To determine the area to be sprayed for calibration, divide 43,560 square feet (the number of square feet in one acre) by the swath width. This will equal the number of feet that must be traveled in the field in order to spray one acre. If the distance is too long for convenience, any known distance can be used and the spray rate calculated. For example, 43,560 square feet = 30 feet by 1,452 feet. In other words, 1,452 feet must be traveled by a spray rig, with a 30-foot swath width, to spray one acre. If you travel 145.2 feet, you spray 0.1 acre.

5. Return to the filling point. Return to the same point that you filled the sprayer.

6. Measure the amount of water required to refill the tank. Use a calibrated pail to measure the amount of water required to refill the spray tank to the original level. The measured area should be sprayed two or three times to check the consistency of the sprayer output.

7. Calculate the spray rate. The final step is to determine the spray rate; in this case it will be in gallons per acre (gpa). Use one of the following formulas:

\[
gpa = \frac{\text{gallons sprayed} \times 43,560 \text{ sq ft/acre}}{\text{swath width (ft) \times swath length (ft)}}
\]

or,

\[
\text{acres sprayed} = \frac{\text{swath width (ft) \times swath length (ft)}}{43,560 \text{ ft/acre}}
\]

therefore,

\[
gpa = \frac{\text{gallons sprayed}}{\text{acres sprayed}}
\]
These formulas can be used to calibrate any type of spray or granular application equipment, including aerial, where the amount of material applied on the calibration course is measured.

EXAMPLE: A field sprayer with a 30-foot swath width is operated for a distance of 1/4 mile (1,320 feet). Twenty (20) gallons of water are needed to refill the tank. What is the spray rate in gal/A? Answer: 22 gpa.

\[
gpa = \frac{20 \times 43,560}{30 \times 1,320}
\]

\[
gpa = 22
\]

**Boom Height**

Boom height is dependent on the type of nozzle you are using. For proper boom height the spray catalog should be consulted. However, if you are using flat fan spray nozzles with an 80-degree spray angle, the minimum boom height should be whatever the nozzle spacing is. For example, if your nozzles are set at 20-inch spacing, your nozzle tips should be set at a minimum of 20 inches apart above your target. The target is whatever you are spraying. It may be the bare ground or the top of the weed canopy. For example, when spraying weeds set your nozzle tips 20 inches above the top of the tallest weeds to ensure adequate coverage. If the tallest weeds are 18 inches high, then set the nozzle tips 38 inches above the ground (18 + 20 = 38 inches).

**Band Applications**

Unless otherwise stated, label rates are for broadcast application. For band application, specified rates will be applied only to a portion of the area that would be covered in a broadcast application. For example, if you have a boom with 6 nozzles spaced 40 inches apart, with each nozzle spraying a 10-inch band, the area sprayed = 6 nozzles x 10 inches, or 60 inches.

Band spraying can be performed the same as broadcast. However, remember that only a portion of the area is treated. The desired band width can be attained by adjusting the height of the nozzles above the target. It is important to distribute the spray evenly across the band. This can be achieved by using “even” fan spray nozzles.

The following formula can be used to calculate the spray rate for band application:

\[
gpa = \frac{\text{gallons sprayed} \times 43,560 \text{ sq ft/A}}{\text{total treated band width (ft)} \times \text{length (ft)}}
\]

**EXAMPLE:** A six-row planter is equipped to spray 10-inch bands centered over 40-inch rows. The planter is run 1,320 feet through a field and uses 5 gallons of water. What is the application rate? Answer: 33 gpa on the bands.

There are 6 rows x 10-inch bands = 60 inches, divided by 12 inches per foot = 5 feet of total treated band width. The gallons sprayed = 5. The length = 1,320 feet. Entering these values into the formula gives:

\[
33 \text{ gpa} = \frac{5 \text{ gal sprayed} \times 43,560 \text{ sq ft/A}}{5 \text{ ft total treated band width} \times 1,320 \text{ ft}}
\]
Therefore, you need to add enough chemical to spray an acre to each 33 gallons of water in the tank. A 150-gallon tank can treat 4.6 acres of bands (150 ÷ 33 = 4.55). Note that the total field acreage covered by the planter in this example would be 4.6 x 4 = 18.4 acres. The rows are on 40-inch spacing. However, only 1/4 of the area is being treated (10 inches ÷ 40 inches = 1/4). Therefore, the actual area covered is four times the area treated, or 18.4 acres.

### 1/128 METHOD OF CALIBRATION

**Calibrating Hand Sprayers and High Pressure Hand Guns**

This is an easy method of calibration that involves very little math or formulas. It is based on the following principle:

Because a gallon = 128 ounces and the test area to be sprayed is 1/128th of an acre, ounces collected = gallons per acre.

**STEP 1.** Measure out an area equal to 1/128th of an acre. Approximately 340 ft² or an area 18.5 ft by 18.5 ft.

**STEP 2.** Measure the time it takes to spray the measured area. Repeat several times and take the average time.

**STEP 3.** Spray into a container for the same amount of time it took to spray the measured area. Measure the water collected in ounces. The amount collected in ounces equals gallons per acre.

**EXAMPLE:** Hand sprayer

**STEP 1.** Measure area. 18.5 by 18.5 ft = 340 ft²

**STEP 2.** Time to spray area = 51 seconds

**STEP 3.** Amount collected = 40 ounces. Therefore; 40 ounces = 40 gallons per acre

### DETERMINING HOW MUCH PESTICIDE TO ADD TO THE SPRAY MIXTURE

Recommendation is to apply 1 quart of 2,4-D per acre.

The sprayer is applying 40 gallons per acre. Therefore, you will need to add 1 quart of 2,4-D to each 40 gallons of water (this does not mean 40 gallons of water plus 1 qt of 2,4-D, it means each 40 gallons of water will contain 1 qt of 2,4-D).

Your sprayer only holds 1 gallon of spray mixture. So how much pesticide will you need to add to the gallon of water?

1 quart (32 ounces) divided by 40 gallons = 0.8 ounces
1 fluid ounce = 2 tablespoons. Therefore, you will need approximately 2 tablespoon of 2,4-D per gallon of water.

1 fluid ounce also = 29.57 milliliters (ml). Therefore, if measuring in ml; you would need 0.8 ounces times 29.57 ml per ounce = **24 ml per gallon of water**.

How much area will 1 gallon spray? There are 43,560 ft² per acre. If 40 gallons will spray 1 acre then 1 gallon will spray an area 1/40 that size or 43,560 ft² divided by 40 = **1089 ft²**.

**1/128 METHOD OF CALIBRATION**

**Calibrating Multiple Nozzle Boom-Type Sprayers**

This method is for calibrating sprayers with booms that have many nozzles. However, it is still based on the same principles as the 1/128 method for hand held sprayers listed above.

Because a gallon = 128 ounces and the test area to be sprayed is 1/128th of an acre, ounces collected = gallons per acre.

This method of sprayer calibration gives sprayer output in gallons per acre when nozzle discharge is measured in ounces over a course length (D) determined from Table 1.

**STEP 1.** Adjust the sprayer pressure (30-40 psi for most sprayers) and check for uniformity. Operate sprayer for 1 minute and measure spray from each nozzle. Clean or replace any nozzle tip that delivers 5 percent more or less than the output required for a new nozzle in good working condition.

**STEP 2.** Measure the spray band width or nozzle spacing (W) in inches on the boom to determine the course length (D) in feet as shown in column 2 of Table 1. The area to be sprayed must equal 1/128th of an acre. An acre = 43,560 ft². Therefore, 1/128th of an acre would equal 43,560 divided by 128 = 340 ft². If the nozzle spacing = 20 inches then the distance to travel to equal 1/128th of an acre would be 204 ft. This can be determined by the following formula:

4084 divided by W (nozzle spacing in inches) = D (distance in feet)

or

4084 divided by 20 inches = 204 feet

Or from Table 1. W = 20 inches and D = 204 feet.

**STEP 3.** Catch the spray from one nozzle while operating the sprayer under field conditions or for the time required to travel the needed distance at a desired speed. Time required to travel distance (D) at selected speeds is shown in Table 1. Time required for other speeds may be calculated with the following formula:

\[
time \ (seconds) = 0.682 \times \text{distance} \ (feet) \div \text{speed} \ (miles \ per \ hour)
\]
Table 1. Distance (D) to travel and seconds required for selected speeds when nozzle coverage is (W) inches so that discharge from one nozzle measured in ounces equals gallons per acre.

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<th>W (in)</th>
<th>D (ft)</th>
<th>2 mph</th>
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**STEP 4.** Measure the spray collected in **ounces**. The number of ounces collected is the same as the number of gallons per acre.

**EXAMPLE:**
You have a sprayer that has 15 nozzles on 30 inch spacing. How would you calibrate it using the 1/128th method?

Using the formula from **STEP 2** above:

4084 divided by 30 inches = 136 feet

Or from Table 1. W = 30 inches and D = 136 feet.

Therefore, you would need to time how long it takes for your sprayer to travel 136 feet. Travel this distance several times in the field and get an average time. Perhaps it takes an average of 31 seconds to cover 136 feet.
You would then collect the spray from one nozzle in a container for 31 seconds. Measure the water collected in ounces. The amount collected in ounces equals gallons per acre. If in 31 seconds you collected 20 ounces your sprayer output would be **20 gallons per acre**.

**DETERMINING HOW MUCH PESTICIDE TO ADD TO THE SPRAY MIXTURE**

The recommendation from the label is to apply 1 quart of 2,4-D per acre. The sprayer is applying 20 gallons per acre. Therefore, you will need to add 1 quart of 2,4-D to each 20 gallons of water. Your sprayer holds 200 gallons. So how much pesticide will you need to add to the 200 gallon spray tank?

200 gallons divided by 20 gallons = **10 quarts of 2,4-D**

How large an area can be sprayed by your 200 gallon tank?

200 gallons divided by 20 gallons per acre = **10 acres**

**COMPUTING CHEMICAL MIXES**

The active ingredient statement on a pesticide label lists the amount of active ingredient (ai) or acid equivalent (ae) contained in the formulation. The actual amount is stated in terms of percentage of active ingredient by weight or pounds of active ingredient per gallon. Herbicide rate recommendations are usually in terms of “volume of formulation per acre.” For example, the recommendation may read, “apply as a broadcast spray on hard-to-control weeds at a rate of 2 quarts per acre.”

To determine the amount of chemical to add to a spray tank, you need to know (1) the spray tank capacity, (2) the sprayer application rate, and (3) the recommended herbicide rate. The spray tank capacity can easily be determined by filling the spray tank with a measured amount of water. Calibration of sprayers determines the sprayer application rate, and the label will give the recommended herbicide rate. Once these variables are known it is a simple matter to determine the amount of chemical to add to the spray tank by following these steps.

1. First determine the number of acres a full tank will spray using the following formula:

   Number of acres a full tank will spray = \( \frac{\text{sprayer tank capacity (gallons)}}{\text{sprayer application rate (gal/A)}} \)

2. Then figure the amount of herbicide required to add to the spray tank with the following formula:

   Herbicide required per spray tank = \( \text{acres sprayed by a full spray tank} \times \text{recommended herbicide rate on the label} \)

   If the recommendation is in lb ai/A rather than volume per acre, use this formula:

   Herbicide required per spray tank = \( \text{acres sprayed by a full spray tank} \times \text{rate (lb ai/A)} \div \text{chemical concentration (lb, % ai/unit)} \)
EXAMPLE A:
A sprayer has a 100 gallon tank and is calibrated to apply 20 gallons per acre. How much 2,4-D concentrate containing 4 lb ai/gallon should be added to each tank if the recommended rate is 2 quarts per acre?

Answer: 2.5 gallons of concentrate per tank.

100 gal tank divided by 20 gal/A = 5 acres can be sprayed per tank

therefore,

5 acres per tank x 2 quarts per acre = 10 quarts (2.5 gal) of spray concentrate per tank

EXAMPLE B:
A sprayer has a 100-gallon tank and is calibrated to apply 20 gallons per acre. How much 2,4-D concentrate containing 4 lb ai/gallon should be added to each tank, if the recommended rate is 1 lb ai/A?

Answer: 1.25 gallons of concentrate per tank.

100-gal tank divided by 20 gal/A = 5 acres can be sprayed per tank

therefore,

5 acres per tank x 1 lb ai/A divided by 4 lb ai/gallon = 1.25 gal of spray concentrate per tank

EXAMPLE C:
You are using the same sprayer but the recommended rate is 2 lb ai/A of an 80 percent wettable powder. How much concentrate should be added to the spray tank?

Answer: 12.5 lb of 80 percent concentrate per tank.

5A/tank x 2 lb ai/A divided by 0.80 ai/lb concentrate = 12.5 lb of 80% spray concentrate per tank

Read the label so that you know what the recommended rate is. As you spray your field, you should also recheck the calibration after the herbicide has been added to the tank. It may be slightly different than it was with plain water. This is especially true when mixing pesticides with liquid fertilizers. If the calibration varies from original figures, a slight adjustment in sprayer speed or pressure may be needed to apply the proper amount of chemical.

If the acreage you plan to treat requires less than a full tank of spray material, add only enough water and chemical to treat the required acreage to reduce the amount of unused chemical mixture. Dispose of any unused chemical mix in a way that will not harm the environment, such as spraying non-cropland areas at recommended field application rates.