CHAPTER 4

CALIBRATION

LEARNING OBJECTIVES

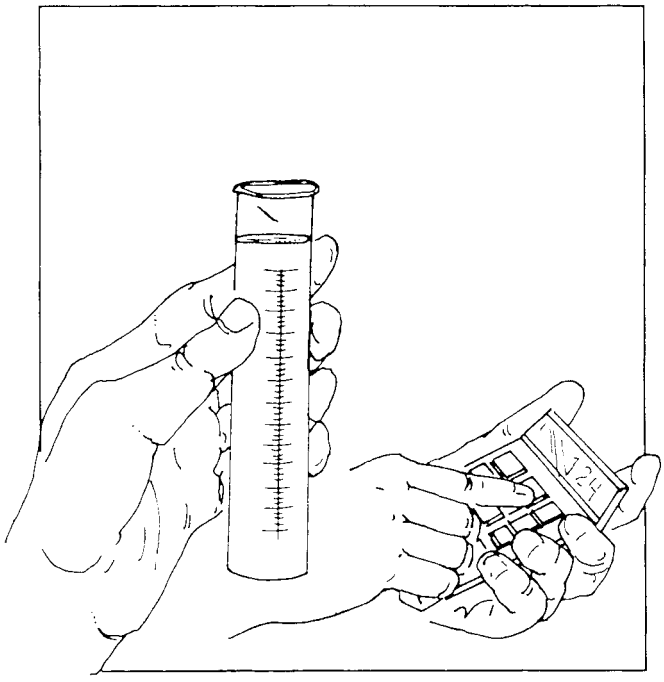
After completely studying this chapter, you should:

- Understand the purpose of calibration and why it is an essential process.
- Know the basic tools needed to calibrate sprayers and the variables that determine spray rate.
- Be able to check for and calculate nozzle output and know the guideline for determining when nozzles are worn out.
- Know what factors affect spray pattern uniformity and how to check for it.
- Understand how to calibrate a sprayer for ***broadcast application.***
- Be able to calculate how much pesticide to add to the spray tank for broadcast application.
- Know how to properly calibrate a hand sprayer on a per acre basis and for a ***band application.***
- Know how to calibrate granular applicators—both drop-through spreaders and rotary spreaders.

INTRODUCTION

The purpose of **calibration** is to ensure that your equipment delivers the correct amount of pesticide uniformly over the target area. Calibration is the step in pesticide application that is most often neglected and misunderstood. Because virtually every sprayer is a unique combination of pumps, nozzles, and other equipment, calibration is an essential process for an applicator to learn.

For proper calibration, you will need a few basic tools, including a stopwatch, a collection container graduated in ounces, a tape measure, and flags or stakes for marking. Unless your sprayer is new, it will contain a certain amount of pesticide residue; therefore, a pair of chemical-proof gloves is also recommended. Additionally, a pocket calculator will help with calculations.



In this chapter, we provide formulas that are designed to make calibration easier for you. In some of these formulas are numbers that are *constants*—that means the number remains in the formula whenever you use that formula. To make calibration easier for you, we provide

you with the constants rather than go through the complicated calculations from which the constants are derived.

CALIBRATION OF SPRAYERS

Calibrating a sprayer will ensure that the sprayer is delivering the intended volume of spray mixture to the target area. You must determine each of the following:

- How much spray mixture the sprayer applies per acre.
- How many acres you can spray per tank.
- The recommended rate of pesticide application.
- The amount of pesticide to add to the spray tank.

Variables That Determine the Spray Rate

Two major variables affect the amount of spray mixture applied per acre (most commonly expressed in gallons per acre): the *nozzle flow rate* and the *ground speed* of the sprayer. You must understand the effect that each of these variables has on sprayer output to calibrate and operate your sprayer properly.

Nozzle Flow Rate

The flow rate through a nozzle varies with the nozzle pressure and the size of the nozzle tip. Increasing the pressure or using a nozzle tip with a larger opening will increase the flow rate (gallons per acre).

Increasing pressure will NOT give you a proportional increase in flow rate. For example, doubling the pressure will not double the flow rate—you must increase the pressure fourfold to double the flow rate.

Sprayer pressure (speed constant)	Sprayer output (gallons per acre)
10 psi	10
40 psi	20
160 psi	40

Pressure cannot be used to make major changes in spray rate, but it can be used to make minor changes. Keep in mind that operating pressure must be maintained within the recommended range for each nozzle type to obtain a uniform spray pattern and minimize drift.

The easiest and most effective way to make a large change in flow rate is to change the size of the nozzle tips. Depending on operating pressure, the speed of the sprayer, and nozzle spacing, small changes in nozzle size can significantly change sprayer output per acre. Use nozzle manufacturers' catalogs to select the proper tip size.

Ground Speed of the Sprayer

Provided the same throttle setting is used, as speed increases, the amount of spray applied per unit area decreases at an equivalent rate. For example, doubling the ground speed of a sprayer will reduce the amount of spray applied by one-half.

Sprayer speed (pressure constant)	Sprayer output (gallons per acre)
1 mph	40
2 mph	20
3 mph	13.3
4 mph	10

To determine the new output after changing speed:

$$\text{New output} = \frac{\text{old output x old speed}}{\text{new speed}}$$

Some low-pressure sprayers are equipped with control systems that maintain a constant application rate over a range of travel speeds, provided the same gear setting is used. Pressure is automatically changed to vary the nozzle flow rate in proportion to changes in ground speed. Even so, do your calibration at a set ground speed. In the field, travel speed must be kept within certain limits to keep the nozzle pressure within the recommended range.

Precalibration Check of Nozzle Output

After making sure the system is clean, fill the tank approximately half full with water. Fasten a graduated container under each nozzle and operate the sprayer at a pressure within the recommended pressure range. Check to see that the flow rate from each nozzle is approximately the same; replace or clean any nozzle whose output differs by more than 5 percent from the average for all of the nozzles and again check the flow rates.

For example, if the following flow rates are obtained for six nozzles:

Nozzle	Output (ounces per minute)
1	40.0
2	43.0
3	39.5
4	40.5
5	37.5
6	39.5
	Total 240.0 ounces

The average nozzle output is 40 ounces.

Five percent of 40 ounces is (40 x 0.05) is 2 ounces. Any nozzle whose output differs from 40 ounces by more than 2 ounces should be cleaned or replaced; that is, any nozzle whose output is greater than 42 or less than 38. Therefore, nozzle #5 should be either cleaned or replaced. The flow rate of nozzle #2 is too high. This indicates that the nozzle is worn and should be replaced.

When the average nozzle output varies by more than 10 percent from the manufacturer's specifications, the nozzles are worn enough to justify the purchase of a new set. This is particularly important when using flat-fan or flood nozzles because proper spray overlap becomes difficult to maintain with worn nozzles.

Spray Pattern Uniformity

A uniform spray pattern is crucial for an effective pesticide application. It's not enough to apply a pesticide only in its correct amount—you also must apply it uniformly over the target area. The effects of non-uniform application are most obvious when herbicides are applied and streaking results. Spray pattern uniformity is affected by boom height, spacing and alignment of nozzles on the boom, condition of nozzles (worn, damaged), and operating pressure. Check that all nozzles are of the same type. Also, a frequent cause of poor spray patterns is using nozzles with different spray angles on the same boom.

To check the uniformity of the spray pattern, adjust the boom height for the spray angle and nozzle spacing being used. Align flat-fan nozzles at a slight angle to the boom. Using water, operate the sprayer at the desired speed and pressure on clean, dry pavement or on another smooth surface. Observe the spray pattern as the water evaporates. Clean or replace nozzle tips that produce a poor spray pattern; if necessary, readjust boom height and recheck the spray pattern. If you replace any nozzles, recheck the flow rates.

Broadcast Sprayer Calibration

There are a number of equally effective calibration methods that vary in their basic approach and degree of difficulty. For the purposes of this manual, we have chosen a simple method that will allow you to calibrate quickly.

1. Fill the sprayer tank approximately half full with water.
2. Determine the nozzle spacing or band width in inches and stake out the appropriate distance in the field according to the following table:

Broadcast nozzle spacing or band width (inches)	Travel distance (feet)
8	510
10	408
12	340
14	291
16	255
18	227
20	204
22	185
24	170
26	157

For other nozzle spacings or band widths, determine the appropriate travel distance using the following formula:

$$\text{Travel distance (feet)} = \frac{4{,}080}{\text{Nozzle spacing or band width (inches)}}$$

In this formula, 4,080 is a constant.

For example, if your nozzle spacing is 38 inches:

$$\text{Travel distance} = \frac{4{,}080}{38} = 107 \text{ feet}$$

Measuring the appropriate travel distance is a critical step in calibration. To determine what volume your sprayer is delivering for some land area (i.e., gallons per acre), you must relate the average nozzle output to a unit area of land. You could determine the volume output by physically spraying an entire acre, but this would be very time consuming. Therefore, we use a fraction of an acre.

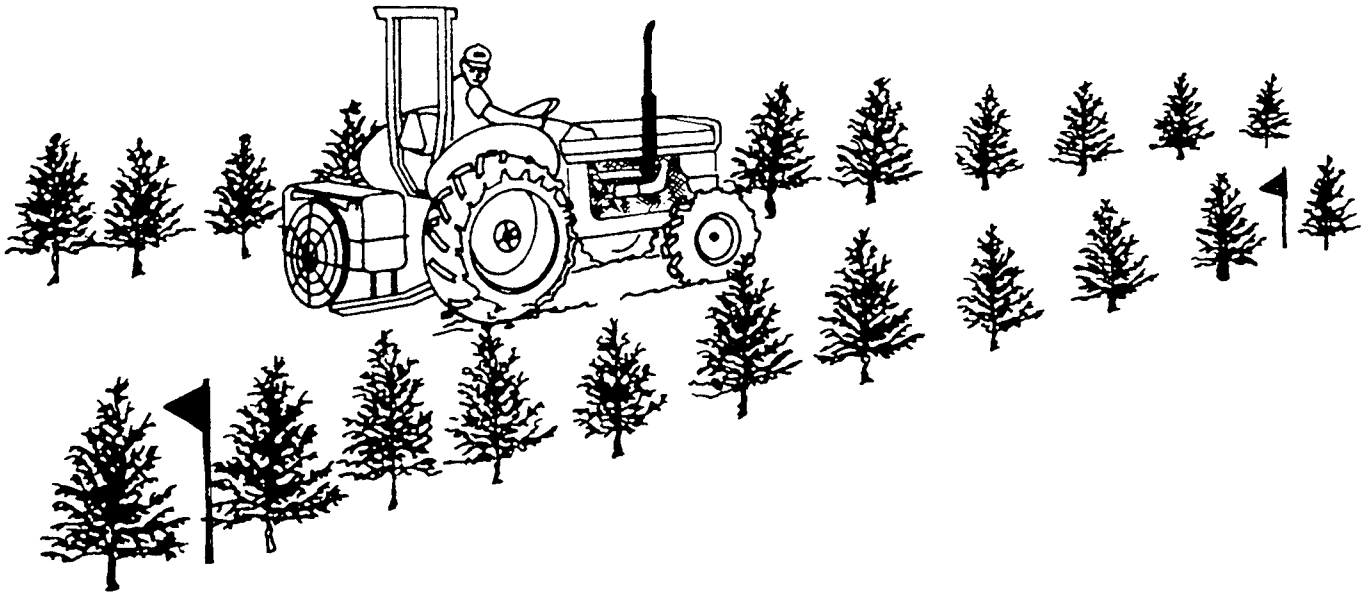


Figure 4.1. For calibration, drive the designated distance using the exact throttle setting and gear that are planned for the broadcast spray application.

3. In an appropriate site, drive the designated distance using the exact throttle setting and gear you plan to use during spraying. Be sure to note the throttle setting and gear: don't rely on a speedometer. Start the spray rig (sprayer turned off) about 25 feet behind the starting point so that you will be at typical field speed at the beginning of the measured distance. Record your travel time in seconds.
4. Adjust the pressure to the desired setting. Use slightly higher pressure when you use nozzle check valves and nozzle strainers.
5. With the sprayer stationary, collect and record the output from any of several nozzles (e.g., four) in ounces for the recorded travel time. Because we already have determined that the output of all nozzles is within 5 percent of one another in the precalibration check, it is not necessary to collect again from each nozzle.
6. *Determine the average nozzle output in ounces.*
7. The spray rate in gallons per acre is equal to the average nozzle output in ounces. For example, if the average nozzle output for the recorded travel time is 20 ounces, the spray rate will be 20 gallons per acre.
8. If the spray rate is not reasonable for your particular spraying job, you can change output by one of three methods: adjust pressure, change speed, or replace nozzle tips. If only a minor change in output is needed, simply make an adjustment in pressure and determine the new average nozzle output. (Remember that operating pressure must be kept within the recommended range for the nozzle type you're using so that he spray pattern is not distorted.) If a large change in output is necessary and you change travel speed, you will need to drive the designated field distance and determine the new travel time before calculating the average nozzle output. If it is impossible to obtain the desired output at an appropriate pressure and ground speed, you will need to change nozzle tips; in this case, you must repeat the precalibration check of nozzle output.

The sprayer is now calibrated. When operated at the designated speed and pressure, it will deliver the desired spray volume. You should occasionally remeasure output and determine if changes in flow rate have occurred as a result of nozzle wear or other variations. If you continue to use the same travel speed used during initial calibration, it will take only a few minutes to recheck your sprayer's output.

Example: You want to make a postemergence broadcast application of a herbicide at a spray volume of 20 to 30 gallons per acre using regular flat-fan nozzles spaced 40 inches apart on the boom:

1. Fill the sprayer tank approximately half full with water.
2. The appropriate travel distance for 40-inch nozzle spacing is 102 feet; measure and mark this distance in the field.
3. Using the throttle setting and gear you plan to use during spraying, you find that it takes 14 seconds to drive 102 feet.
4. Adjust the pressure to the desired setting within the recommended pressure range of 15 to 30 psi for regular flat-fan nozzles; your chosen setting is 25 psi.
5. With the sprayer stationary, you collect the following outputs from four nozzles in 14 seconds:

Nozzle	Output (ounces per 14 seconds)
1	15.5
2	16
3	15.5
4	16
	Total = 63 ounces

6. The average output of the nozzles for 14 seconds is

$$\frac{63 \text{ ounces}}{4 \text{ nozzles}} = 16 \text{ ounces.}$$

7. The spray rate, therefore, is equal to 16 gallons per acre.
8. The spray rate is lower than the recommended range of 20 to 30 gallons per acre stated on the label. The major change in output required should not be attempted by increasing pressure. You'll need to either decrease travel speed, in which case you'll also need to determine the new travel time, or increase nozzle tip size. Then determine the new average output.

Amount of Pesticide to Add to the Tank

Your next step is to determine the amount of pesticide to add to the spray tank. To do so, you need to know:

- The recommended rate of chemical application.
- The capacity of the spray tank.
- The calibrated output of the sprayer.

The rate of chemical to apply is determined from the label. Rates are expressed either as the amount of pesticide product to be applied per acre (or area) or as the amount to mix with a certain volume of water (or other carrier).

Example: Broadcast Application. Pesticide A is recommended as a broadcast application of 2 quarts of product per acre for site preparation. Your sprayer has a 200-gallon tank and is calibrated to apply 20 gallons per acre. How much Pesticide A should you add to the spray tank?

1. Determine the number of acres you can spray with each tank, using the following formula:

$$\text{Acres per tank} = \frac{\text{tank capacity (gallons per tank)}}{\text{spray rate (gallons per acre)}} = \frac{200}{20} = 10 \text{ acres}$$

2. Determine the amount of pesticide to add to each tank, using the following formula:

   Amount per tank = acres per tank x rate per acre.

   With each tank, you will cover 10 acres and you want to apply 2 quarts of product per acre:

   Amount per tank = 10 x 2 = 20 quarts.

   You will need to add 20 quarts (5 gallons) of Pesticide A to each tank load.

Example: Broadcast Application. Pesticide B is an 80 percent wettable powder formulation. After reading the label, you decide to apply 12 pounds per acre for perennial weed control. The area to treat is 150 feet wide and 180 feet long. Your backpack sprayer is equipped with a three-nozzle boom, has a 4-gallon tank, and is calibrated to apply 40 gallons per acre of spray solution. How much water and product do you add to the tank? (43,560 sq. ft. = 1 acre)

1. Calculate the area to be treated as follows:

   150 x 180 feet = 27,000 square feet, which is equal to 0.62 acre (27,000 ÷ 43,560)

2. Calculate the amount of water needed with this formula:

   $$\frac{40 \text{ gallons}}{1 \text{ acre}} = \frac{Y \text{ gallons}}{0.62 \text{ acre}}$$

   which is read as "40 gallons is to one acre as Y gallons is to 0.62 acre."

   Y = (40 x 0.62) = 24.8 gallons to treat 0.62 acre

3. With a 4-gallon tank, we will need more than 6 tanks full of solution; let's plan to mix 7 loads.

   $$\frac{24.8 \text{ gallons}}{7 \text{ loads}} = 3.54 \text{ gallons per load}$$

4. We need 12 pounds of Pesticide B to mix in each 40 gallons of water (the output of our sprayer); the formula to use is as follows:

   $$\frac{12 \text{ pounds}}{40 \text{ gallons}} = \frac{Y \text{ pounds}}{3.54 \text{ gallons}} =$$

   $$Y = \frac{12 \times 3.54}{40} = 1.06 \text{ pounds of Pesticide B in each tank load of 3.54 gallons}$$

Hand Sprayer Calibration

The calibration of a hand sprayer can be easily accomplished by following a few important steps.

1. Measure a suitable test area (an area similar to that which you will be spraying). A minimum area of 10 feet by 25 feet (250 square feet) for the test area is suggested.
2. Fill the sprayer with water and record the level.
3. Spray the premeasured area using the same pressure and technique that you will use when applying the pesticide.
4. Refill the tank to the original water level. Be sure to note the exact amount of liquid needed to refill the tank.
5. Assuming a 250-square-foot area was sprayed, either multiply the volume used to refill the tank by 4 to get the volume per 1,000 square feet, or multiply the volume used to refill the tank by 175 to get the volume per acre.
6. Check the label for the recommended volume to apply per 1,000 square feet or per acre. Adjust nozzles, speed, or pressure, and recalibrate if necessary.
7. Determine the amount of pesticide needed for each gallon of water and the amount of spray mixture needed to cover the intended spray area.

Example: product rate and spray volume expressed per 1,000 square feet. Your sprayer delivered 0.5 gallon of water over 250 square feet. The label recommends that 1.5 fluid ounces of herbicide be mixed in enough water to cover 1,000 square feet. The sprayer tank holds 3 gallons.

1. What is the volume of application per 1,000 square feet based on the test area sprayed?

   Volume per 1,000 square feet = volume per 250 square feet x 4 = 0.5 gal x 4 = 2 gallons

2. How many fluid ounces of product are needed per gallon of water?

   $$\text{Amount needed per gallon} = \frac{\text{amount needed per 1,000 square feet}}{\text{volume sprayed per 1,000 square feet}}$$

   $$= \frac{1.5 \text{ ounces}}{2 \text{ gallons}}$$

   = 0.75 ounces per gallon

3. How many fluid ounces of herbicide must be added to a full tank of water?

   Amount per tank = tank capacity x amount needed per gallon

   $$= 3 \text{ gallons} \times \frac{0.75 \text{ ounce}}{\text{gallon}}$$

   = 2.25 ounces per tank

4. How much area will one tank (3 gallons) of spray cover? Remember, the sprayer was calibrated for 2 gallons of water per 1,000 square feet. In other words:

   If 2 gallons covers 1,000 square feet, then 3 gallons will cover what fraction of 1,000 square feet?

   $$\frac{2 \text{ gallons}}{1{,}000 \text{ square feet}} = \frac{3 \text{ gallons}}{Y}$$

   Solve for Y by cross multiplying:

   $$2Y = 1{,}000 \times 3$$

   $$Y = \frac{3{,}000}{2}$$

   Y = 1,500 square feet

Example: rate and volume expressed per acre. Suppose your sprayer delivered 0.5 gallon of water over a 500-square-foot test area. The label recommends that 3 pints of herbicide be applied per acre. The sprayer capacity is 4 gallons.

1. What is the sprayer output per acre, based on the test area sprayed?

$$\frac{0.5 \text{ gallon}}{500 \text{ square feet}} = \frac{Y \text{ gallons}}{43{,}560 \text{ square feet}}$$

$Y = 43.6$ gallons per acre

2. How many fluid ounces of herbicide are needed per gallon of water?

$$\text{Amount per gallon} = \frac{\text{amount needed per acre}}{\text{volume sprayed per acre}}$$

$$= \frac{48 \text{ ounces*}}{43.6 \text{ gallons}}$$

$= 1.1$ ounces per gallon

*3 pints = 48 ounces (3 pints x 16 ounces per pint)

3. How many fluid ounces of herbicide must be added to a full tank of water?

Amount per tank = tank capacity x amount per gallon

= 4 gallons x 1.1 ounce / gal

= 4.4 ounces per tank

4. How much area will one tank (4 gallons) of spray cover? Remember, the sprayer was calibrated for 43.6 gallons of water per acre. In other words:

If 43.6 gallons cover 1 acre, then 4 gallons will cover what fraction of an acre?

$$\frac{43.6 \text{ gallons}}{1 \text{ acre}} = \frac{4 \text{ gallons}}{Y}$$

By cross multiplying:

43.6 gallons Y = 1 acre x 4 gallons

$$Y = \frac{4 \text{ acres}}{43.6}$$

= 0.092 acres (4,008 square feet)

Example: Band Application for Hand Sprayers

You have a 3-gallon tank and want to band apply a product at the rate of 2 quarts per acre.

1. Measure and mark the calibration distance that coincides with your band width (*see the table at bottom of page*).

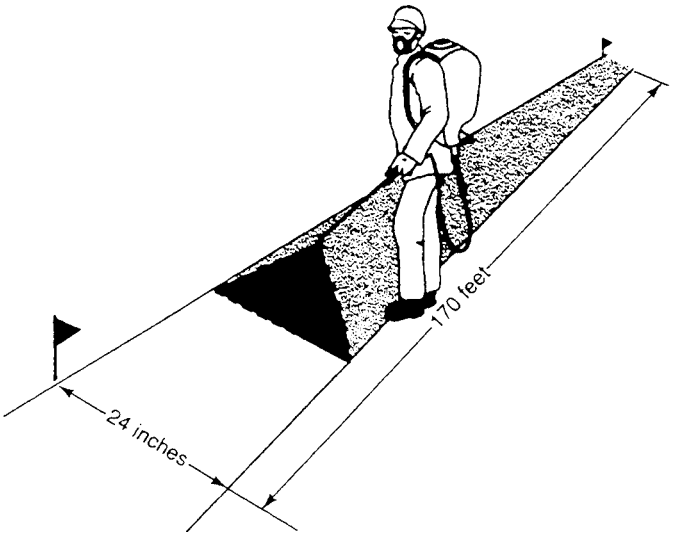


Figure 4.2. Calibration course of a 24-inch band application.

2. Fill the sprayer with water only and record the number of seconds required to walk the calibration distance at a comfortable, steady speed while spraying and pumping to maintain a uniform pressure.

3. While pumping to maintain the selected application pressure, collect the spray output from the nozzle for the same number of seconds needed to travel the calibration distance. The number of ounces collected equals the gallons per acre (GPA) applied. For example, if 16 ounces are collected from the nozzle, the gallons per acre equals 16.

4. To determine the amount of chemical to add to the spray tank, divide the capacity of the tank by the number of gallons per acre. This determines the fraction of an acre that can be covered with a tankful of spray. If your tank has a 3-gallon capacity:

$$\frac{3 \text{ gal. tank}}{16 \text{ GPA}} = 0.188 \text{ acre covered per tank}$$

(gallons per acre)

Select the calibration distance to be used on band width			
Band width	**Calibration distance**	**Band width**	**Calibration distance**
10 inches	408 feet	24 inches	170 feet
12 inches	340 feet	28 inches	146 feet
16 inches	255 feet	32 inches	127 feet
18 inches	227 feet	36 inches	113 feet
20 inches	204 feet	40 inches	102 feet

5. Multiply the application rate of the product per acre times the fraction of the acre covered per tank and add that amount of chemical to the sprayer tank.

   Application rate per acre x acre(s) per tank = amount of chemical to add to the spray tank

   2 quarts per acre x 0.188 acre per tank = 0.376 qts per tank (multiply 0.376 qts x 32 ounces per qt to get 12 fluid ounces per tank)

Liquid Application on a Percentage Basis

Occasionally pesticide recommendations are expressed as a given amount of product in a specified volume of water. Such recommendations are expressed as "volume/volume" recommendations or as a percentage of product in the spray solution. The following example illustrates the method.

Example: Rate expressed as volume per volume. Pesticide C is recommended as a cut-stump treatment to prevent sprouts from developing on tree trunks. Four gallons of product are recommended to be mixed with 100 gallons of diesel fuel or other oil carrier. You want to prepare 75 gallons of solution. How much Pesticide C do you mix with the 75 gallons of diesel fuel?

$$\frac{\text{4 gallons Pesticide C}}{\text{100 gallons diesel}} = \frac{\text{Y gallons Pesticide C}}{\text{75 gallons diesel}}$$

By cross multiplying:

$$100Y = 75 \times 4$$

$$100Y = 300$$

Y = 3 gallons of Pesticide C per 75 gallons of diesel fuel

GRANULAR APPLICATOR CALIBRATION

Occasionally, granular or pelleted pesticides are used for weed control. The need for accurate calibration is just as great for granular applicators as for sprayers.

The application rate of granular applicators depends on the size of the metering opening, the speed of the agitator or rotor, travel speed, the roughness of the site, and the flowability of the granules. The flow rate of granules depends on particle size, density, type of granule, temperature, and humidity. Product manufacturers' suggested setting should be used only as the initial setting for verification runs by the operator prior to use. A different applicator setting may be necessary for each pesticide applied; variations in flow rate also can occur with the same product from day to day or from site to site. It is, therefore, important to calibrate frequently to maintain the proper application rate.

Apart from the actual setting of the metering opening, ground speed is the most significant factor affecting the application rate. You must use the same ground speed during calibration that you intend to use during the application, and the speed must remain constant. Even though gravity-flow applicators use a rotating agitator whose speed varies with ground speed, the flow of granules through the opening is not necessarily proportional to speed. A speed change of 1 mile per hour may cause a significant variation in the application rate.

Drop-through Spreaders

Drop-through spreaders usually are calibrated using catch pans. Chain or wire catch pans beneath the spreader to collect granules as they are discharged. After traveling a distance based on the width of the spreader (swath width), weigh the granules collected in the catch pan to determine the application rate. Use the table listed below to select the appropriate distance to travel for your spreader. The entries in the table are based on the following computations:

1/50 acre = 0.02 x 43,560 square feet = 871 square feet

$$\text{Travel distance} = \frac{\text{871 square feet}}{\text{Swath width}}$$

Swath width (feet)	Travel distance to cover 1/50 acre (linear feet)
1.5	581
2	436
3	290
4	218
5	174
6	145
7	124
8	109
9	97
10	87
11	79
12	73
15	58

If your spreader has a different width, use this formula to calculate the distance to travel:

$$\text{travel distance in feet} = \frac{871}{\text{Swath width in feet}}$$

For example, if you have a spreader that covers a 6.5-foot swath, the distance to travel is:

$$\frac{871}{6.5} = 134 \text{ feet}$$

The step-by-step procedure is:

1. Before starting, calculate how much material should be applied in the calibration area. You need to know only the recommended rate per acre and multiply this value by 1/50 (the area you will cover in the calibration exercise).
2. Measure out the distance to travel as determined by the swath width of the spreader.
3. Securely attach a collection pan to the spreader.
4. Set the feeder gate control to the setting recommended in the owner's manual or on the product label.

5. Mark the hopper and fill it evenly with granules to this mark. Calibration must be done with the same granules you intend to use during application.
6. Operate the spreader in the premeasured calibration area at the speed you intend to use during application.
7. Weigh the amount of granules in ounces in the collection pan. Be sure to use a scale that can accurately measure to the nearest ounce.
8. Compare the amount of product collected in the calibration area with the amount calculated in Step 1 above. If they are within 5 percent of each other, the applicator is properly calibrated; if not, you need to adjust the feeder gate control and recalibrate.

Example: A broadcast application of Pesticide D is to be made at a rate of 60 pounds of product per acre. Your equipment broadcasts granules in a 15-foot swath width. After covering a distance of 58 feet, you collect 16 ounces of granules. Is your applicator properly calibrated?

1. Determine the amount of product in ounces that should be applied to the calibration area:

   (60 pounds) x (1/50) = 1.2 pound x 16 ounces per pound = 19.2 ounces

2. Determine if the amount actually applied (16 ounces) is within 5 percent of the recommended rate (19.2 ounces):

   19.2 ounces x 0.05 (5%) = .96 ounces

If your applicator was properly calibrated, it should have applied between 18.2 and 20.2 ounces of product to the calibration area. It actually applied less. You will, therefore, need to adjust the feeder gate control to apply more material and then recalibrate.

Rotary Spreaders

Hand-pushed whirlwind spreaders are small, with swath widths ranging from 6 feet to 12 feet. The method of calibration is similar to the one described above, except catch pans are not used. To determine the output, first you must place 10 pounds of the product into the spreader. If your spreader has a swath of 6 feet, your travel distance would be 145 feet (871 square feet ÷ 6 feet).

To determine how much product was discharged, subtract the amount of product that remains in the spreader from the original load of 10 pounds. The difference should correspond to the target output. If it doesn't, readjust the spreader and repeat the calibration procedure.

Rotary spreaders must not be used when non-selective herbicides are applied to sites adjacent to desirable plant species. In these situations, a drop applicator is preferred. It has more precision in pesticide placement and less chance for the pesticide to be distributed beyond the target boundaries.

CONVERSION TABLES

Area

144 square inches . . . . . 1 square foot
9 square feet . . . . . 1 square yard
43,560 square feet . . . . . 1 acre
4,840 square yards . . . . . 1 acre
160 square rods . . . . . 1 acre
640 acres . . . . . 1 square mile
2.5 acres . . . . . 1 hectare

Length

1 inch . . . . . 2.54 centimeters . . 25.5 millimeters
1 foot . . . . . 12 inches
1 yard . . . . . 3 feet
1 rod . . . . . 5.5 yards . . . . . 16.5 feet
1 mile . . . . . 320 rods . . . . . 1,760 yards . . . 5,280 feet
1 meter . . . . . 39.4 inches . . . . . 1.09 yards
1 kilometer . . . . . 1000 meters . . . . . 0.62 miles

Volume

1 tablespoon (tbs or T) . . . . . 3 teaspoons (tsp or t)
1 fluid ounce. . . . . 2 tablespoons
8 fluid ounces . . . . . 16 tablespoons . . . . . 1 cup
16 fluid ounces . . . . . 2 cups . . . . . 1 pint
32 fluid ounces . . . . . 4 cups . . . . . 1 quart
128 fluid ounces . . . . . 4 quarts . . . . . 1 gallon
1 liter . . . . . 33.9 ounces . . . . . 1.06 quarts

Weight

1 ounce . . . . . .28.3 grams
1 pound . . . . . 16 ounces . . . . . .453.6 grams
2.2 pounds . . . . . 1 kilogram . . . . . .1,000 grams
1 ton . . . . . 2,000 pounds . . . . . 907 kilograms
1 metric ton . . . . . 1,000 kilograms . . . . . 2,205 pounds

CHAPTER 4

Review Questions

Chapter 4: Calibration

Write the answers to the following questions and then check your answers with those in the back of the manual.

1. Why is calibration of various spray systems essential?

2. Calibration ensures that the correct amount of pesticide is delivered uniformly over the target area.
   A. True
   B. False

3. What happens to the flow rate if you increase the nozzle pressure or use a larger nozzle tip opening?
   A. Has no effect of the flow rate.
   B. Increases the flow rate.
   C. Decreases the flow rate.

4. To double the flow rate, you must increase the pressure:
   A. Twofold.
   B. Threefold.
   C. Fourfold.
   D. Fivefold.

5. If the throttle setting remains constant, and the speed doubles, the amount of spray per acre:
   A. Remains constant.
   B. Doubles.
   C. Is reduced by half.
   D. Is reduced by one quarter.

6. Measuring and comparing the output of each nozzle to the average output of all the nozzles allows you to determine if:
   A. The pump is functioning properly.
   B. Any nozzle is worn or clogged.
   C. It is the right nozzle for the job.
   D. The pressure is accurate.

7. If the spray pattern is not uniform, you should:
   A. Check the boom height.
   B. Check the spacing and alignment of the nozzles on the boom.
   C. Check the operating pressure.
   D. Do all of the above.

8. You determine the distance to travel for calibration by:
   A. Using a formula with a constant and the nozzle spacing.
   B. Reading it from the pesticide label.
   C. Reading it from the tractor handbook.
   D. Setting an arbitrary distance based on the type of pesticide.

9. Why is there an operating pressure range for each type of nozzle?
   A. To prevent nozzle clogging.
   B. To relieve strain on the pump.
   C. To keep the spray pattern from distorting.
   D. To calculate the travel distance.

10. In a broadcast sprayer calibration, if the nozzle spacing is 30 inches, what is an appropriate distance to stake out in the field?
    A. 101 feet
    B. 136 feet
    C. 256 feet
    D. 1 acre

11. In Question 10, it took 20 seconds to travel the appropriate distance. What does this travel time tell you?
    A. How long you should measure the output from nozzles.
    B. How long it will take to spray the entire field.
    C. How long it will take to empty the tank.
    D. Whether the sprayer is properly calibrated.

12. When calibrating a broadcast sprayer, you find that the average nozzle output is 25 ounces. What is the spray rate in gallons per acre?

    A. 25 gallons per acre
    B. 30 gallons per acre
    C. 35 gallons per acre
    D. 40 gallons per acre

13. What can you do if your calibrated spray rate is less than the recommended rate stated on the label?

    A. Increase the pressure
    B. Decrease travel speed
    C. Increase nozzle tip size
    D. B and / or C

14. In a broadcast sprayer application, if the spray tank capacity is 150 gallons and the spray rate is 30 gallons per acre, how many acres can be sprayed per tank?

    A. 0.2 acres
    B. 0.5 acres
    C. 3 acres
    D. 5 acres

15. In Question 14, how much pesticide will you need to add per tank if the label recommends 4 quarts of product per acre?

    A. 10 quarts
    B. 20 quarts
    C. 30 quarts
    D. 40 quarts

16. Using a 3-gallon backpack sprayer, you decide to apply 9 pounds of herbicide per acre. Your sprayer is calibrated to apply 30 gallons of spray solution per acre. How many tank loads are needed to treat 1 acre, and how many pounds of herbicide are needed in each tank load?

    A. 5 tank loads with 0.3 pounds of herbicide per load
    B. 5 tank loads with 0.9 pounds of herbicide per load
    C. 10 tank loads with 0.3 pounds of herbicide per load
    D. 10 tank loads with 0.9 pounds of herbicide per load

17. How do you determine what rate of pesticide to apply?

    A. Use a formula.
    B. Read it off the spray tank.
    C. Read the pesticide label.
    D. All of the above.

18. When using a hand sprayer:

    A. Maintain the pressure as evenly as possible.
    B. It's not necessary to calibrate.
    C. The speed at which you walk should vary.
    D. It is not possible to do band applications.

19. When calibrating your hand-held single-nozzle sprayer, you found that it delivered 1 gallon of water per 250 square feet. The label recommends that 2 fluid ounces of herbicide be mixed in enough water to cover 1,000 square feet. The spray tank holds 3 gallons. How many fluid ounces of herbicide must be added to a full tank of water, and how much area will one tank of spray cover?

    A. 1 ounce of herbicide and 500 square feet per tank
    B. 1.5 ounce of herbicide and 500 square feet per tank
    C. 1.5 ounce of herbicide and 750 square feet per tank
    D. 2 ounces of herbicide and 1,000 square feet per tank

20. You calibrated your handheld single-nozzle sprayer to spray 0.5 gallon of water over a 300-square-foot test area. What is the sprayer output per acre based on the test area sprayed?

    A. 32.3 gallons per acre
    B. 72.6 gallons per acre.
    C. 108.3 gallons per acre
    D. 123 gallons per acre

21. In Question 20, how many ounces of herbicide are needed per gallon of water if the label recommends 4 pints of herbicide be applied per acre?

    A. 0.88 ounce per gallon
    B. 1.08 ounce per gallon
    C. 1.23 ounce per gallon
    D. 2.1 ounce per gallon

22. If you are using a hand sprayer to apply pesticide in a band 20 inches wide, how far should you walk to calibrate your sprayer and record the number of seconds?

    A. 170 feet
    B. 204 feet
    C. 255 feet
    D. 408 feet

23. In calibrating a hand-held sprayer for a band application, you collected 15 ounces from the nozzle in the time it took to travel the calibration distance. Your spray tank holds 3 gallons. How much chemical should be added to the tank at an application rate of 3 quarts per acre?

    A. 3 fluid ounces per tank

    B. 6.3 fluid ounces per tank

    C. 12.8 fluid ounces per tank

    D. 19.2 fluid ounces per tank

24. The flow rate of dry granular pesticide products:

    A. Varies because of many factors such as particle size and humidity.

    B. Remains constant from product to product.

    C. Prevents accurate calibration.

    D. Allows for less frequent calibration than liquid products.

25. Which is NOT the same between drop-through spreaders and rotary spreaders?

    A. They are used in granular applications.

    B. Their calibration depends on factors such as travel speed and particle size.

    C. They can be used in weed control.

    D. They use catch pans.

26. A broadcast application of granular pesticide is to be made at the rate of 30 pounds of product per acre. Your equipment broadcasts granules in a 10-foot swath. How many feet do you travel to calibrate your spreader?

    A. 218 feet

    B. 145 feet

    C. 87 feet

    D. 58 feet

27. In Question 26, a pesticide application is to be made at the rate of 30 pounds of product per acre. What amount of product should be applied to the calibration area?

    A. 9.6 ounces

    B. 12 ounces

    C. 15.3 ounces

    D. 19.2 ounces

28. You collected 12 ounces of granules when calibrating the spreader in Question 26. This means that your spreader is properly calibrated.

    A. True

    B. False

29. Rotary spreaders are more precise than drop-through spreaders in placing pesticides.

    A. True

    B. False