

# Calibration of Equipment for Applying Fertilizers and Pesticides to Turfgrass

Concerns for the preservation of our environment and conservation of resources, as well as the costs associated with pesticides and fertilizers, make it imperative that pesticides and fertilizers be precisely applied. Accurate calibration of sprayers and spreaders allows precise application of pesticides and fertilizers at recommended rates in accordance with local, state, and federal regulations.

Recommended use rates listed on product labels have been determined through extensive research and testing. These rates have been determined to be the most effective to accomplish the purpose for which a product is applied. Using less of a product than recommended may not accomplish that purpose and may make a second or repeat application necessary, which is more expensive than doing it right the first time. Using more of a product than recommended may cause damage and definitely will be more expensive. The *performance* of any product can be no better than the manner in which it is applied! In addition, proper calibration of application equipment is now a legal requirement for applying restricted-use pesticides.

You can spend hours in the field calibrating your sprayer and spreader to achieve accuracy, but your efforts will be wasted if you don't know how much of a product to put in the tank. Surveys have shown that approximately 40 percent of the people who use liquid pesticides fail to add the correct amount of product to the tank. As a turfgrass manager or homeowner, how often have you been in a hurry to get something put out and you just guessed or estimated the proper spreader setting or volume of a product to add to the sprayer? Guessing, estimating, and carelessness must be eliminated from pesticide and fertilizer applications!

Today more than ever, the application rate and uniformity of application are as important as the pesticide or fertilizer selected for use. Calibrating application equipment, whether sprayer or spreader, takes little time but does require that you know a few principles. However, the effort put into calibrating this equipment will be returned manyfold.

The objective of calibrating sprayers and spreaders is to ensure accurate and efficient distrib-

ution of pesticides and fertilizers. Today, it is a violation of federal law to apply pesticides at rates other than those specified on the product label. Violators are subject to fines and are liable for any damage to plants or the environment caused by the careless application of pesticides and fertilizers. Therefore, calibration of application equipment should be of utmost importance to turfgrass managers.

## Liquid Applicators (Sprayers)

Sprayers are used to apply pesticides and water-soluble fertilizers. Hand-held backpack sprayers, hose-end sprayers, and boom sprayers are all used to apply these types of products. All of these types of liquid sprayers operate on the same basic principles, and all should be properly calibrated before they are used.

### Backpack or Hand-Pressurized Sprayers

A 1- to 3-gallon backpack sprayer with a single hand-held nozzle is generally used to spray ornamental plants with fungicides and insecticides, to spot-treat weeds, or to chemically edge along fences and buildings. Recommendations for mixing and spraying these products, using a backpack sprayer usually suggest adding a specific weight or volume of product per gallon of water and spraying the foliage to the point of runoff.

Backpack sprayers are not recommended for broadcast applications to turfgrass unless they have a pressure regulator to maintain a constant pressure. Backpack sprayers that use compressed air or carbon dioxide (CO<sub>2</sub>) as a pressure source and have a pressure regulator can be used for broadcast applications of chemicals.

To calibrate a backpack sprayer for broadcast applications, the operator must determine the volume of water that the sprayer applies per 1,000 square feet at a given pressure and speed. For example, an operator determines that he can cover 200 square feet with 1 quart of water if he walks or moves at a comfortable pace and has the sprayer nozzle set at 30 pounds per square inch (psi). In

this case, the operator will need to apply 5 quarts of water to cover 1,000 square feet. He may want to decrease the pressure slightly, walk or move at a slightly faster pace, or change nozzles so he can apply 1 gallon of water per 1,000 square feet. Then, if he has a 2-gallon sprayer, he adds enough product to cover 2,000 square feet and fills the sprayer to the 2-gallon mark.

Another procedure used to calibrate hand-held backpack sprayers is to determine the effective swath (width) the operator makes as he walks with the sprayer and use the following procedure to calculate the volume of water applied per 1,000 square feet.

**Step 1.** Measure the effective spray width in feet. This is most effectively measured on concrete or dry soil where the spray pattern is clearly visible and can be measured.

**Step 2.** Determine the length of the calibration course, using the spray width determined in Step 1 and the numbers in Table 1.

**Step 3.** Determine the amount of time required to walk the length of the calibration course.

**Step 4.** Catch the water output from the nozzle(s) for the length of time required to walk the calibration course.

**Step 5.** Measure the volume of water caught in pints. The pints of water caught equal the gallons of water applied per 1,000 square feet. To adjust the volume of water applied, the operator can change the nozzle size, walking speed (pace), or operating pressure of the sprayer.

**Table 1.** Calibration Course Length for Hand-Held Sprayers Based on Effective Spray Width

Effective Sprayer Swath Width (in Feet)	Length of Calibration Course (in Feet)
2	62.5
3	42
4	31
5	25
6	21
7	18
8	15.5
10	12.5

*Calibration Example:* An operator using a hand-held sprayer with a single nozzle covers a spray width of 4 feet.

Using information from Table 1, the operator measures out a calibration course that is 31 feet long. The operator measures the time it takes to walk the calibration course with the sprayer. The time required is 60 seconds. The operator then catches the water volume output of the sprayer for 60 seconds. A total of 12 ounces of water is collect-

ed during the 60-second time frame. The operator then converts the 12 ounces to pints by dividing by 16 (16 ounces = 1 pint) and determines that he collected 0.75 pints (12 divided by 16) over the calibration course. Therefore, 0.75 gallon of water per 1,000 square feet is required. When the operator uses the sprayer to apply a product, he must apply enough product to spray 1,000 square feet for each 0.75 gallon (3 quarts) of spray solution or water.

### **Hose-End Sprayers**

Hose-end sprayers are used to apply fungicides, insecticides, herbicides, and liquid fertilizers. Since hose-end sprayers operate off of water pressure, they need to be calibrated at the water outlet from which they will be operated. Hose-end sprayers should be calibrated on concrete or dry pavement where the spray pattern is clearly visible.

**Step 1.** Add either a pint or quart of water to the reservoir of the hose-end sprayer.

**Step 2.** Turn on the water, and walk at a constant pace, spraying the concrete or pavement uniformly until the sprayer reservoir is empty.

**Step 3.** Measure the width of the spray pattern.

**Step 4.** Multiply the width of the spray pattern by the length of the wet surface to calculate the area that is covered or wet by the sprayer.

**Step 5.** Using the recommended rate on the label, add enough product to cover the area with a quart of water, fill the reservoir to 1 quart, and make the application.

*Calibration Example:* A homeowner wants to apply a herbicide to her lawn, using a hose-end sprayer. She determines that 1 pint of water will cover 300 square feet at a normal walking pace. The herbicide label recommends a rate of 4 ounces of product per 1,200 square feet, so she adds 2 ounces of the herbicide and fills the sprayer reservoir to 1 quart (2 pints) with water (2 x 300 square feet = 600 square feet). Each quart in the sprayer reservoir should cover 600 square feet of lawn.

### **Boom Sprayers**

Boom sprayers are used to make broadcast applications of pesticides and fertilizers to large turf-grass areas such as fairways. Boom sprayers can be precisely calibrated to apply products uniformly at a recommended rate. As with other sprayers, operating pressure, nozzle size and spacing, and operating speed determine the volume of water applied per 1,000 square feet or per acre. For most products, 1 to 2 gallons of water per 1,000 square feet is a desirable application rate. For some herbicides, the application or delivery rate may be only 0.5 gallon of water per 1,000 square feet. Remember,

the higher the spray volume of water applied, the more frequently the spray tank must be refilled.

To calibrate a boom sprayer, the operator must determine the volume of water per 1,000 square feet or per acre that the sprayer applies at a given pressure and speed. There are several methods that can be used to measure this volume. The following procedure simplifies the process and can be used for most boom sprayers.

**Step 1.** Measure the distance in inches between the nozzles on the boom.

**Step 2.** Determine the length of the calibration course, using the distance determined in Step 1 and the numbers in Table 2.

**Step 3.** Measure out the length of the calibration course.

**Step 4.** Determine the amount of time required to drive or walk the length of the calibration course.

**Step 5.** While the sprayer is stationary and at the operating pressure to be used for the application, collect the water from one nozzle for the length of time that was required to drive or walk the calibration course. The sprayer must be maintained at the operating pressure to be used for the application.

**Step 6.** Measure the volume of water caught in ounces. The number of ounces equals the gallons of water applied per acre.

**Step 7.** Adjust the pressure, speed, or nozzle size to achieve the desired volume. Repeat the procedure until you are close to the desired volume.

**Step 8.** Check the volume of several nozzles. The volumes from different nozzles should be within 10 percent of each other.

**Table 2.** Calibration Course Length for Boom Sprayers Based on Nozzle Spacings

Nozzle Spacing (in Inches)	Length of Calibration Course (in Feet)
12	340
14	291
16	255
18	227
20	204
25	163
30	136
40	102
60	68

*Calibration Example:* A golf course superintendent wants to apply MSMA herbicide to a fairway to control escape crabgrass. He purchases

Daconate 6, which is an MSMA formulation that contains 6 pounds of MSMA (active ingredient) per gallon. The label recommends applying 3 pounds of MSMA per acre in 50 gallons of water. The superintendent has a 12-foot sprayer boom with nozzles spaced 18 inches apart and a 50-gallon tank. Using the 18-inch measurement and the corresponding number in Table 2, he marks off a 227-foot calibration course, adjusts the pressure to 20 psi, and drives the length of the calibration course. He determines that it takes 65 seconds to travel the 227 feet. He adjusts the tank pressure to 20 psi as a starting point and then collects the water output from one nozzle for 65 seconds. The volume caught is found to be 35 ounces, or 35 gallons of water per acre. He therefore increases the operating pressure to 25 psi and catches the output from the nozzle again for a 65-second duration. This time, he catches 48 ounces, or 48 gallons per acre. He then measures the water volume output for all the nozzles and gets a range between 46 and 53 ounces, or gallons per acre. The volumes from the nozzles are all within 10 percent of one another; therefore, the sprayer is calibrated at 50 gallons of water per acre. The superintendent then adds 2 quarts of Daconate 6 (3 pounds of MSMA) to the tank and fills it to 50 gallons. His tank should then cover or spray 1 acre.

## Granular Applicators (Spreaders)

There are fewer types of equipment for applying granular fertilizers or pesticides than there are for applying liquids. Granular spreaders are used for applying granular fertilizers and granular pesticides, such as fungicides, herbicides, and insecticides, and for broadcast seeding and overseeding of turfgrass. There are a number of disadvantages to using granular application equipment. For example, the carrier volume cannot be adjusted as it can be in liquid applications; therefore, individual calibration is required for each granular product, and the actual product must be used during calibration. Also, fewer products are available in granular form than in liquid form, and some granular products, especially postemergence herbicides, can be less effective than their liquid counterparts. In spite of these disadvantages, many turfgrass managers use only granular products because granular application does have some advantages over liquid application. One advantage is less exposure to the product during its handling, mixing, and application.

The methods for calibrating granular application equipment are somewhat similar to those for liquid application equipment except for a few subtle differences. For example, granular pesticides and fertilizers are formulated with an inert carrier,

so the concentrations are fixed and cannot be adjusted. This requires that calibration be performed for every different granular product used and that the actual fertilizer or pesticide granules be used during calibration. Each granular product has a suggested spreader setting for specific brands of spreaders; however, this setting is only to be used as a starting point! Spreaders should still be calibrated before each application. One reason for this is that relative humidity can affect the dispersion of granular products. Therefore, it is recommended that calibration be repeated under relative humidity conditions similar to the conditions expected or present during application.

There are basically two types of granular applicators: drop spreaders (gravity flow) and rotary or centrifugal spreaders.

### Drop Spreaders

Drop spreaders operate by “dropping” or distributing granular products via gravity flow between the wheels of the spreader as it is pushed or pulled across the turfgrass. The rate of application is controlled by the width of the opening at the bottom of the drop spreader and by the walking speed of the operator. Measurements needed to calibrate a drop spreader include the distance the operator covers and the weight of the product applied, so you will need a scale to weigh the granular products.

To calibrate a drop spreader, the operator must determine the amount of product or granular material that is dispersed per unit area at a specific spreader setting and constant speed. The operator who will make the actual application should be pushing the spreader or driving the tractor so that the speed during the actual application is the same as the speed used during the calibration. Calibration is a trial-and-error process and must be repeated until the desired results are obtained. If the spreader initially applies too much product, the setting or opening must be decreased, and if the spreader applies too little product, the setting or opening must be increased.

Calculations should be kept simple and consistent to reduce the chances of error. If the recommended rate for a given product is expressed in ounces per 1,000 square feet, measure the required distance needed to provide 100 or 200 square feet so that it can be easily converted to 1,000 square feet. For example, if the spreader has a 3-foot width (swath), measure 33 $\frac{1}{3}$  feet or 66 $\frac{2}{3}$  feet for 100 or 200 square feet, respectively. Refer to Table 3 to determine the appropriate distance to measure for a given spreader width.

**Table 3.** Distance to Measure to Cover 100 Square Feet or  $\frac{1}{100}$  Acre

Width of Spreader (in Feet)	Distance to Measure to Cover Specified Area (in Feet)	
	100 Square Feet	200 Square Feet
2	50	—
3	33 $\frac{1}{3}$	—
4	25	—
6	16 $\frac{2}{3}$	72 $\frac{1}{2}$
8	—	54 $\frac{1}{2}$
10	—	43 $\frac{1}{2}$
12	—	36 $\frac{1}{3}$

To calibrate a drop spreader, make several passes over the distance to establish a consistent and practical speed, and then load the spreader with the actual product to be applied and make a pass, being sure to go over both the starting and ending lines that mark the distance. Be sure to travel at a consistent speed when crossing the starting and ending lines. Do not begin walking at the beginning line and stop at the ending line—walk at a constant speed, and simply open the spreader at the beginning line and close the spreader at the ending line.

Some drop spreaders have a calibration pan or tray that attaches beneath the opening at the bottom of the spreader. In this case, the operator simply connects the pan or tray to the spreader, fills the spreader with the actual granular product, and makes a pass over a given distance with the spreader open. The collected product in the pan or tray is then weighed. If there is no calibration pan or tray, the operator must weigh the product initially put into the spreader and then spread the granular product over a clean surface such as plastic or a concrete floor. The product is then collected and weighed, and that weight is subtracted from the initial weight to determine the amount that was applied over a given area. Use one of the following equations to calculate the rate of application, and compare that to the targeted rate.

$$(1) \frac{\text{oz. product collected per 100 sq. ft.}}{16} \times 10 = \frac{\text{lb. product}}{\text{per 1,000 sq. ft.}}$$

$$(2) \frac{\text{oz. product collected per 200 sq. ft.}}{16} \times 5 = \frac{\text{lb. product}}{\text{per 1,000 sq. ft.}}$$

**Calibration Example:** A lawn care operator wants to apply a 15-5-9 fertilizer at a rate of 10 pounds per 1,000 square feet, using a 3-foot drop spreader. He measures a distance of 33 $\frac{1}{3}$  feet based on Table 3 and marks the starting and

ending lines with stakes. After establishing a consistent walking speed, he loads the spreader, moves the spreader setting to 5, attaches the calibration tray, and prepares to make a pass along the calibration distance. He begins walking several feet before the starting line stake so that he is "up to speed" when he opens the spreader at the beginning line stake. He closes the spreader at the ending line stake and takes several steps past the stake. The operator collects the product from the tray and weighs the contents. He finds that 12 ounces of the 15-5-9 fertilizer were collected. Using equation 1, he calculates that 7.5 pounds of 15-5-9 were applied per 1,000 square feet. Therefore, he increases the spreader setting to 6.5 and makes another pass across the trial path. This time he collects 16 ounces of 15-5-9. Using equation 1, he calculates that 10 pounds of 15-5-9 were applied per 1,000 square feet.

Another method of calibrating a drop spreader does not involve pushing or pulling the spreader. Instead, the diameter of the wheel is measured in feet, and the length or given distance is determined by the number of revolutions that the wheel is turned to collect the product. For example, the wheel diameter for a drop spreader is 2 feet, and the width between the wheels (swath) is 4 feet. Therefore, if the spreader wheels are turned for a total of 20 revolutions, the distance is 40 feet. While turning the wheels, collect the granular product. Weigh the amount of product collected, and calculate the rate of application over the given distance of 160 square feet (4 feet swath x 40 feet = 160 square feet).

It is important to remember that the operator must calibrate the spreader for each formulation or brand of granular product used. A different brand of 15-5-9 fertilizer may have granules of different particle size or density, thus requiring a different spreader setting.

### **Rotary or Centrifugal Spreaders**

The calibration procedure for rotary or centrifugal spreaders is the same as for drop spreaders; however, it may be more convenient to weigh the product remaining in the spreader instead of trying to collect the product after it is dispersed. In this case, the operator weighs the product that was initially placed in the rotary spreader and subtracts the amount of product remaining in the spreader after a trial pass to determine the amount of product applied.

The swath width of a rotary or centrifugal spreader must be measured for each product to be applied since it will vary according to the size and density of the individual particles. The swath width

is controlled by the speed of the centrifugal disc and can be changed by adjusting the ground speed of ground-driven spreaders or the motor speed of powered centrifugal spreaders. Coverage for these spreaders is, therefore, variable and must be determined for the speed to be used in the actual pesticide or fertilizer application.

To determine the swath width of a rotary spreader, line up a series of collection trays or containers 1 foot apart and perpendicular to the line of travel of the spreader. These containers can be boxes, pie tins, or any type of similar containers. It is recommended to find some calibration trays that have a dimension of 1 square foot. Each container used, however, should have the same dimensions.

Load the rotary spreader with the actual granular product to be applied, and set the opening of the spreader on a medium setting. With the spreader open, run the spreader over the collection trays at the speed to be used in actual operation. Check the amount and distribution of granular product in the collection trays in order to make a reasonable estimate of the spreader swath. If the product in each container is also weighed, distribution can be checked and, if necessary, adjustments made.

Coverage is determined by multiplying the swath width by the calibration distance. Use Table 4 to determine the calibration distance to travel. Since rotary spreaders cover a relatively larger area, a 250- to 500-square-foot trial area can be used instead of the 100-square-foot area recommended for drop spreaders. For example, a rotary spreader with a swath width of 10 feet traveling a distance of 25 feet has a coverage of 250 square feet (10 feet x 25 feet = 250 square feet).

**Table 4.** Distance to Measure to Cover 250 or 500 Square Feet

Spreader Swath Area (in Feet)	Distance to Measure to Cover Width Specified (in Feet)	
	250 Square Feet	500 Square Feet
5	50	—
6	42	—
7	35½	—
8	31	—
9	28	—
10	25	50
12	—	42
13	—	35½
16	—	31
18	—	28
20	—	25

Next, the operator must determine the amount of product required to deliver the proper rate of pesticide or fertilizer. To make calibration easier and to avoid unnecessary waste of pesticide or

fertilizer, the quantity is reduced to a much smaller area. This is done by setting up a ratio or proportion problem and solving for the unknown. In this example, the rate of recommended product is 180 pounds per acre (43,560 square feet).

$$\frac{180 \text{ lb.}}{43,560 \text{ sq. ft.}} = \frac{x \text{ lb.}}{250 \text{ sq. ft.}}$$

In this case,  $x$  equals 1.03 pounds ( $43,560 \times x = 180 \times 250$ ; therefore,  $x = 1.03$ ), which is the amount of product required to deliver 180 pounds per acre based on the previously determined coverage.

To calculate the amount of product applied per 1,000 square feet or per acre, use one of the following equations:

$$(3) \frac{\text{oz. product applied per 250 sq. ft.}}{16} \times 4 = \frac{\text{lb. product}}{\text{per 1,000 sq. ft.}}$$

$$(4) \frac{\text{oz. product applied per 500 sq. ft.}}{16} \times 2 = \frac{\text{lb. product}}{\text{per 1,000 sq. ft.}}$$

$$(5) \frac{\text{oz. product applied per 500 sq. ft.}}{16} \times 87 = \frac{\text{lb. product}}{\text{per acre}}$$

**Calibration Example:** An operator has a rotary spreader that covers a 6-foot-wide swath when applying a granular fungicide. She wants to apply the product at 7.5 pounds per 1,000 square feet of turfgrass. She measures a trial swath that is 42 feet long based on Table 4, puts 5 pounds of product into the spreader, and makes a pass across the trial path. After making a pass, she weighs the product remaining in the spreader and determines that it is 3.9 pounds. Using equation 3, she makes the calculations and finds that the application rate is 4.4 pounds of product per 1,000 square feet. Since her target rate is 7.5 pounds per 1,000 square feet, she has the option of lowering the spreader setting and making twice as many passes over the turfgrass area or increasing the setting and making a single pass. In either case, she must adjust the spreader setting and make more calibration runs.

To avoid skips or overlaps at the full rate of product, it is recommended to calibrate the spreader to apply one-half the recommended use rate and make two passes across the turfgrass at right angles

to one another or parallel to one another at intervals of one-half of the swath width. This will ensure better distribution and uniformity of the granular product over the treated area. In the example above, it would require applying 3.75 pounds of product per 1,000 square feet per pass at intervals of 3 feet.

## Area Calculations

Recent decisions by government agencies have made proper calibration of application equipment more important. Operators must be able to calculate area correctly in order to calibrate application equipment correctly.

There are several different ways to make field measurements of turfgrass areas. The use of geometric figures is one good method to determine a given area. The following area measurements and conversion factors are provided to help you make these calculations.

### Area Measurements

- (1) Square or rectangle—Area = length x width
- (2) Triangle—Area =  $\frac{1}{2}$  x base x height
- (3) Circle—Area =  $\pi$  x radius x radius, where  $\pi$  is a constant and equal to 3.14 and radius is equal to  $\frac{1}{2}$  the diameter of the circle
- (4) Irregular shapes
  - Step 1. Measure the longest axis of the area (length line).
  - Step 2. At every 10 feet along the length line, measure the width at right angles to the length line.
  - Step 3. Total all widths, and multiply by 10 (10-foot intervals).

### Conversion Factors

#### Area Measurements

- 1 acre = 43,560 square feet = 4,840 square yards
- 1 square yard = 9 square feet
- 1 square foot = 144 square inches
- 1 linear foot = 12 linear inches

#### Fluid Measurements

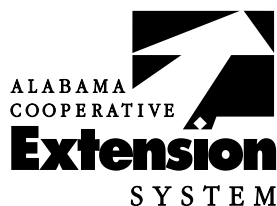
- 1 gallon = 4 quarts = 8 pints = 16 cups = 128 ounces = 3,785 milliliters
- 1 quart = 2 pints = 4 cups = 32 fluid ounces = 946.25 milliliters
- 1 pint = 2 cups = 16 fluid ounces = 473.125 milliliters
- $\frac{1}{2}$  pint = 1 cup = 8 fluid ounces = 236.56 milliliters
- 1 ounce = 2 tablespoons = 29.76 milliliters
- 1 tablespoon = 15 milliliters

#### Weight Measurements

- 1 pound = 16 ounces = 453.6 grams
- 1 ounce = 28.35 grams
- 1 tablespoon = 3 teaspoons = 15 grams
- 1 teaspoon = 5 grams

#### Distance/Speed Measurements

- 1 mile per hour = 88 linear feet per minute



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