HORTICULTURAL

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Calibrating Sprayers and Spreaders for Athletic Fields and Golf Courses

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Calibrating sprayers and spreaders is one of the most important steps in proper application of pesticides for turf pest control. Without knowing how much spray or granular product is being applied by a sprayer or spreader, an applicator cannot confidently control a pest with maximum efficacy. The desired level of control will not be achieved if too little spray solution is applied, and this results in the need for a second application and additional cost in time and money. Applying too much spray solution may cause turf injury or present certain environmental hazards.

This guide will discuss the calibration of hand-held pump-up or knapsack sprayers, large self-propelled or pull-behind sprayers, drop spreaders and rotary-type spreaders.

Two basic components of calibration

The two basic components of calibration, for both sprayers or spreaders, are *speed* and *flow rate*. By knowing both of these components and calculating the proper amount of pesticide needed, the applicator will consistently get the desired results of good pest control.

Speed

Speed is simply determined by keeping track of the time it takes to travel a measured distance. It is best to measure speed in an area that is similar to the area being treated (e.g., turfgrass with low mowing vs. high mowing). This is particularly important when the applicator's pace determines the speed with a hand-held pump-up sprayer, knapsack pump sprayer or spreader. The applicator should wear the knapsack sprayer half-filled with water or carry a half-filled hand-held sprayer when calculating speed. The applicator can measure 50 or 100 feet and record the time it takes to walk the distance at a normal pace. Applicators who use the large-volume handgun sprayers typical of lawn care firms, need to know their speed also. Use the following formula for calculating speed:

$$\text{Speed (mph)} = \frac{\text{Distance (ft)} \times 60}{\text{Time (seconds)} \times 88}$$

The speed of an applicator pushing a spreader is not as critical to determine because the speed is automatically taken into account when setting the flow rate. However, because different applicators walk at different speeds, applicators should calibrate their own spreaders. Some products list spreader settings on the label. Many of these products require that the applicator walk at a specified speed (e.g., Product M in Brand X spreader at Setting H applied at 3 mph). In that case, you will need to get some idea of your normal walking pace in miles per hour. With a spreader (in the closed position) half filled with granular material, measure the time required to walk a measured distance as described above.

On self-propelled or pull-behind sprayers, speed is critical for accurate spraying. Speedometer gauges or electronic LED devices on sprayers and tractors can give inaccurate readings because of wheel slippage, worn tires or improper tire pressures. Measure and mark a distance of 100 to 200 feet in level turf (avoid hills) similar to that being sprayed, and check the time required to travel the distance. Most accurate measurements will be made with the sprayer half full of water. Be sure the sprayer is moving at the desired speed when measuring the time it takes to travel the distance between the starting and ending markers. The operator can select a gear and throttle setting that are safe and proper (maintaining minimum boom bounce) and determine what that speed is. The other option is to select a speed and through trial and error determine the gear and throttle setting required to achieve that specific speed. Keep in mind the throttle should be set to full on some equipment for proper operation of power takeoff equipment. Make several runs and measurements to determine your speed as accurately as possible.

Flow rate

Flow rate is the amount of solution sprayed through a spray tip in one minute. The amount of solution, usually measured in gallons per minute (GPM), is determined by the pressure and the type of spray tip selected. Pesticide labels will usually recommend spray volumes as gallons per acre (GPA) or gallons per 1,000 square

feet. Flow rates can be calculated by using one of the following formulas:

$$GPM = \frac{GPA \times mph \times \text{nozzle spacing (in.)}}{5{,}940}$$

or

$$GPM = \frac{\text{gal/1,000 ft}^2 \times mph \times \text{nozzle spacing (in.)}}{136}$$

Selecting spray tips: Hand-held and knapsack sprayers most often have a factory-installed nozzle. The applicator is then required to calibrate the sprayer with the factory tip. Some knapsack sprayers have interchangeable standard tips.

Spray tips come in numerous types, angles and materials. Flat fan spray, full or hollow cone and flood tips are the more common spray tips used in turfgrass spraying. A flat fan is the most widely used tip and under varying ranges of pressure is a good selection for many contact and systemic pesticides. Flat fans (specifically designed for low pressures) offer good spray drift control when operated at low pressures.

Spray tip material determines the life of the tip, depending on the solutions sprayed. Brass, nylon, stainless steel, hardened stainless steel and ceramic offer a selection of spray tip materials with performance ratings that range from poor to superior, respectively. Keep in mind that superior wear tolerance usually implies a higher initial price.

Spray angles of 65, 80 and 110 degrees are commonly used in turfgrasses. Depending on the nozzle type and size, the operating pressure can have a significant effect on spray angle and quality of spray distribution. Proper nozzle spacing and height of the boom help achieve optimum spray angles. See your manufacturer's recommendations for nozzle spacing and boom height.

When selecting a spray tip, find one that will deliver the desired spray volume and will be the most effective for the type of pesticide application you are making. Check pesticide labels for recommended spray volumes. Make sure that all spray tips in the spray boom are of the same pattern, angle and size. A damaged tip can cause irregular patterns in the spray and should be replaced. Damaged or worn tips will usually be located when checking the flow rate. If several tips are damaged or worn, replace all tips with new ones.

Pressure: The applicator is in control of pressure when using hand-held or knapsack sprayers. The applicator is required to pump the sprayer with air to maintain adequate spray pressures. The spray pressure on larger spray units is controlled by pump speed, throttling valve or pressure regulator. Pressures can be regulated up or down to get the desired flow rate. Higher pressure increases the flow rate through the nozzle, decreases spray particle size (higher potential for drift), and increases the rate of tip wear. Therefore, follow the manufacturer's pressure recommendations for tips selected.

When spray volume and tip selection are determined, the applicator is ready to start the sprayer and adjust the flow rate.

Calibrating sprayers

Hand-held and knapsack sprayers

It is important to maintain a constant walking speed and spray height when using a hand-held or knapsack sprayer. Use a left-to-right sweeping motion with little overlap of the spray for single nozzle wands. Apply just enough solution to wet the leaf tissue. ***Do not*** *saturate leaf tissue or make dripping wet. This is the biggest mistake made when using hand-held or knapsack sprayers. Turfgrass injury can result.*

To calibrate a hand-held or knapsack sprayer for applying pesticides, first fill your sprayer with a known amount of water. Spray an area of known size (e.g., 20 ft $\times$ 50 ft = 1,000 ft^2). Be sure you keep your spray pressure up by regularly pumping your sprayer (perhaps a single pump of the handle per step). After spraying the area, measure the amount of water remaining in the sprayer. Subtracting the remaining amount of water from the initial amount of water in the sprayer equals the spray volume per 1,000 ft^2 (usually measured in gallons). Then calculate the amount of pesticide required per 1,000 ft^2 (many labels give rates in ounces of product per 1,000 ft^2) and add that amount of pesticide to the calibrated amount of water to cover 1,000 ft^2. If spray area is less than 1,000 ft^2, adjust spray mixture accordingly.

Self-propelled or pull-behind sprayers

Check your spray boom to make sure all strainers are clean and of the same type. Make sure all tips are the same type, angle and size. Most tips are now color coded to make this task a little easier. Make sure the tank filter is clean and free of any blockages.

Fill your spray tank with an adequate amount (half tank) of water to check flow rate and set pressure. First, turn on your sprayer and check for leaks. Now is the time to make sure your spray system is working properly and make repairs as needed. If everything is operating properly, you are now ready to measure the flow rate.

We will put together an example problem to simplify this procedure. **Use Worksheet 1 for calibrating your sprayer's flow rate.**

Example: If the pesticide label recommends 1 gallon of spray solution per 1,000 ft^2 or 44 GPA, you can calculate the flow rate in GPM required from each tip, assuming a speed of 4 mph and a nozzle spacing of 20 inches.

$$GPM = \frac{44 \text{ GPA} \times 4 \text{ mph} \times 20 \text{ inches}}{5{,}940}$$

$$= 0.59$$

Looking at a table for flat fan tips (Spraying Systems, Inc.), you will find an 8008 tip that delivers 0.57 GPM at 20 pounds per square inch (psi) and 0.69 GPM at 30 psi. The first two digits of the number code on this tip tell you the angle of the tip is 80 degrees; the last two digits, "08," signify that 0.80 GPM is delivered at a standard pressure of 40 psi.

Turn your spray boom on and adjust the pressure to 20 psi. You can see the pressure needs to be higher than 20 psi and significantly lower than 30 psi to achieve the desired flow rate. Keep in mind that the flow rate will increase as pressure increases, and vice versa. Collect spray from one tip for one minute in a graduated cup marked in fluid ounces. We can calculate fluid ounces per minute by multiplying 0.59 GPM by 128 fluid ounces / gallon to equal 75.5 fluid ounces / minute. Adjust the pressure of the sprayer and continue checking the flow rate until you achieve the desired rate of 75.5 fluid ounces per minute.

By determining the speed of your sprayer and setting the proper flow rate, your sprayer is now calibrated to deliver the proper amount of spray solution per acre. If you are spraying 1 acre of turfgrass, add about half of the required water to your spray tank. Calculate the correct amount of pesticide required for 1 acre and add this to the spray tank. Now bring the volume of your spray tank to 44 gallons and agitate for several minutes.

Driving your spray vehicle at 4 mph will deliver the proper amount of pesticide at the rate of 44 GPA.

Calibrating spreaders

When calibrating spreaders, it is recommended to calibrate the spreader for half the rate desired. Applications of fertilizers or pesticides will be more evenly distributed if applied in two directions (x or + pattern). This also helps in preventing the striping patterns evident in poor application techniques where proper overlap was ignored. Therefore, calibrating for half the rate allows for applications in two directions giving a full rate of fertilizer or pesticide.

Drop spreaders (Worksheet 2)

Calibrating drop spreaders can be completed two different ways. Some drop spreaders have collection pans for catching dropped material, usually attaching to the bottom of your spreader. If your drop spreader does not have a collection pan, it is easy to make one and attach it with bungee cords. The collection pan should be oversized to collect all material dropped, but not very deep. This allows the pan to hang between the bottom of the spreader and the ground.

Method #1: First, determine from the product label the amount of granular pesticide, granular fertilizer, or a combination product you require per 1,000 ft^2. Measure the width of your spreader in feet. Divide 100 by the width of your spreader and measure this distance with markers. (Example: 100 divided by 1.5 feet [18" wide] = 66.67 feet). The area measured represents 100 square feet, or one-tenth of the 1,000 square feet for one swath. Fill your spreader with the material you wish to calibrate. Set your spreader to the manufacturer's recommended setting or a midsize opening. Push the spreader at a normal pace in an area similar to that being treated, turning the spreader on and off for the distance marked. Weigh the material collected, which should equal one-tenth of the material required for 1,000 ft^2. Adjust spreader and make several runs until the desired amount is collected.

Method #2: The second method requires the applicator to push the spreader over a collection pan or box (1' by the width of the spreader) on a smooth surface. A spreader that drops an 18-inch swath will require a collection box 1' x 1.5' (1.5 ft^2). The applicator needs to know the amount of material required for one square foot. Set your spreader to the manufacturer's recommended setting or a midsize opening. You can make several passes over the collection box, in the same direction, to collect enough material to weigh. Check the distribution of material in the collection box to make sure an even amount of material is dropping across the entire width of the spreader. If material is falling unevenly, make sure there are no blockages in the bottom of your spreader. Divide the weight of the collected material by the number of passes, then divide by the number of square feet in the collection box. The result should be the amount of material required for one square foot. Adjust spreader and make several runs until the desired amount is collected. Be sure to clean-up all materials that fall outside of the collection box.

Rotary-type spreaders (Worksheet 3)

Some cyclone spreaders have collection pans that can be attached around the spreader to collect all material thrown. Follow the first procedure for drop spreaders, if you have a collection unit. However, this does not allow you to determine the effective swath and overlap required. The following procedure calibrates the spreader for the material being used and determines how much overlap is needed.

Calibrating a cyclone spreader without a collection unit will require you to construct a series of collection pans or boxes 1' x 1' x 3" high (usually 11 to 13 boxes). This method also requires that the calibration be done on a smooth surface, because the actual material (granular pesticide or fertilizer) must be used. This allows you to cleanup any material that is thrown outside of the collection boxes.

Set the collection boxes in a row, side by side, allowing room in the middle for the spreader to pass over one box and leaving space for the tires to pass by (see Figure 1).

Determine how much material is required per 1,000 ft^2 from the product label. Divide this amount by 1,000 to calculate the amount of material required for one

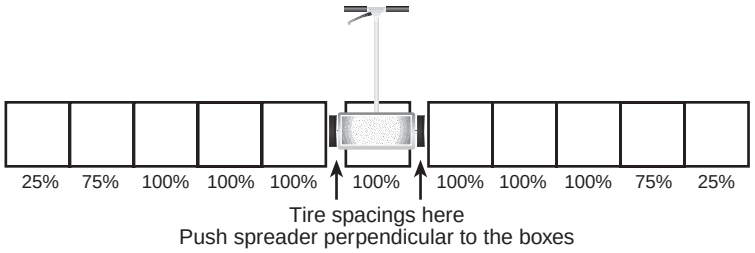


Figure 1. Determine how much material the spreader deposits in each of 11 1-foot-square boxes. Calculate the distribution of material and adjust overlap of successive passes to achieve even coverage. The distribution shown here requires an overlap of 2 feet.

square foot.

Set the spreader to the manufacturer's recommended setting or a midsize opening. Make several passes over the collection boxes, *in the same direction,* to collect enough material in each box for weighing. Divide the weight of the material collected in each box by the number of passes to equal the average amount of material thrown per square foot in each pass. Adjust the spreader and make several runs until the desired amount is collected.

Record the amounts of material from each box to see if you have an even distribution across the swath. Typically, there should be less material in the outer boxes. This determines how much overlap is required. For example, if the boxes contain the percentages of required material shown in Figure 1, then overlap should be 2 feet.

If your spreader throws more material to one side than the other, then the pattern plate at the bottom of your hopper should be adjusted. You may need to adjust your overlap if your spreader does not have a pattern adjustment and make all applications in the same direction. As always, be sure to cleanup all materials that fall outside of the collection boxes.

Again, an additional recommendation we make for spreader calibration, is to calibrate materials for half the amount required per one square foot. Then apply material in two directions (x or + pattern) for better distribution and elimination of striping.

Any applicator who becomes familiar with these calibrating procedures can make proper pesticide and fertilizer applications to achieve the best in pest control and plant growth.

The mention of any spray tip type, spreader type or brand name does not constitute an endorsement of that type or brand. The University of Missouri does not recommend one brand of spreader, spray equipment or parts over another.

For further information

TeeJet Spray Products, Catalog 73, Spraying Systems Company, Wheaton, Illinois.

Calibration of Pesticide Application Equipment for Golf Courses and Recreational Turf, video produced by Marathon Ag / Environmental Consulting, Las Cruces, New Mexico.

Sprayer Calibration (Worksheet 1)

Determine: Gallons desired _____ per acre; _____ per 1,000 ft sq.

mph: _____ Nozzle spacing: _____ inches

Use:

$$GPM = \frac{GPA \times mph \times \text{nozzle spacing (in.)}}{5{,}940}$$

or

$$GPM = \frac{\text{gal}/1000\ ft^2 \times mph \times \text{nozzle spacing (in.)}}{136}$$

GPM = _____

Look to manufacturer's guide for tip selection:

Spray tip selected: _____ GPM: _____ PSI: _____

Check flow rate:

Starting pressure: _____

Trial 1:
Fluid ounces collected _____ per minute
divided by 128 = _____ GPM
Adjust pressure up or down as needed.

Trial 2:
Fluid ounces collected _____ per minute
divided by 128 = _____ GPM
Adjust pressure up or down as needed.

Trial 3:
Fluid ounces collected _____ per minute
divided by 128 = _____ GPM
Adjust pressure up or down as needed.

Trial 4:
Fluid ounces collected _____per minute
divided by 128 = _____ GPM
Continue until the desired GPM is achieved.

Spreader Calibration (Worksheet 2)

Drop spreader – Method #1

Determine: Amount of product required ___ ounces; ___ lb per 1,000 sq ft

- Take 100 divided by the width (_____ ft) of the spreader and measure this distance (_____ ft) with markers to equal 100 sq ft (one-tenth of 1,000 sq ft).
- Close spreader, attach collection pan, fill spreader with material being calibrated.
- Set spreader on manufacturer's recommended setting or midsize opening.
- Push spreader at a normal pace turning the spreader on and off for the distance marked.

Trial 1:
Material collected ___ ounces or ___ pounds × 10 = ___ oz or lb per 1,000 sq ft.
Adjust opening.

Trial 2:
Material collected ___ ounces or ___ pounds × 10 = ___ oz or lb per 1,000 sq ft.
Adjust opening.

Trial 3:
Material collected ___ ounces or ___ pounds × 10 = ___ oz or lb per 1,000 sq ft.
Adjust opening.

Trial 4:
Material collected ___ ounces or ___ pounds × 10 = ___ oz or lb per 1,000 sq ft.
Continue until the desired amount of product is collected.

Drop spreader – Method #2

Determine: Amount of product required _____ per sq ft.

- Close spreader, put collection box in place, fill spreader with material being calibrated.
- Set spreader on manufacturer's recommended setting or midsize opening.
- Push spreader over the collection box at a normal pace.

Trial 1:

$$\frac{\text{Material collected (lb or oz)}}{\text{Area of collection box (sq ft)} \times \text{Number of passes}} = \frac{\text{____ lb or oz}}{\text{____ sq ft} \times \text{____ passes}} = \text{_____ per sq ft.}$$

Adjust opening.

Trial 2:

$$\frac{\text{Material collected (lb or oz)}}{\text{Area of collection box (sq ft)} \times \text{Number of passes}} = \frac{\text{____ lb or oz}}{\text{____ sq ft} \times \text{____ passes}} = \text{_____ per sq ft.}$$

Adjust opening.

Trial 3:

$$\frac{\text{Material collected (lb or oz)}}{\text{Area of collection box (sq ft)} \times \text{Number of passes}} = \frac{\text{____ lb or oz}}{\text{____ sq ft} \times \text{____ passes}} = \text{_____ per sq ft.}$$

Adjust opening.

Trial 4:

$$\frac{\text{Material collected (lb or oz)}}{\text{Area of collection box (sq ft)} \times \text{Number of passes}} = \frac{\text{____ lb or oz}}{\text{____ sq ft} \times \text{____ passes}} = \text{_____ per sq ft.}$$

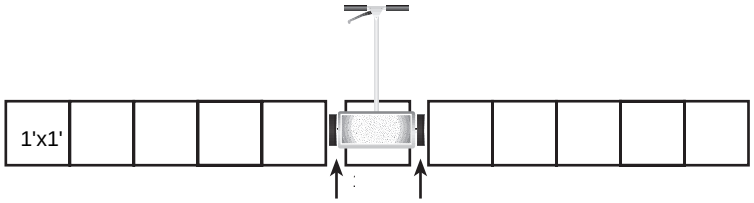
Adjust opening. Continue until the desired amount of product is collected.

Spreader Calibration (Worksheet 3)

Rotary-type spreader

Determine: Amount of product required _____ per sq ft.

- Layout collection boxes side-by-side on smooth surface in the following pattern.



Tire spacings here
Push spreader perpendicular to the boxes

- Set spreader on manufacturer's recommended setting or mid-setting.
- Make several passes over the collection boxes, in the same direction, to collect enough material in each box for weighing.

Trial 1:

Material collected - ounces, grams, etc.

Divide amount collected by the number of passes and record.

Adjust spreader and run again.

Trial 2:

Material collected - ounces, grams, etc.

Divide amount collected by the number of passes and record.

Adjust spreader and run again.

Trial 3:

Material collected - ounces, grams, etc.

Divide amount collected by the number of passes and record.

Continue until the desired amount of product is collected.

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