CALIBRATING TURF SPRAYERS AND SPREADERS

Steps to Improved Product Delivery

"Early" Draft copy

Whether you want to improve your pest control, have healthier turf, save money, prevent off-site damage, or reduce customer complaints, investing time in calibrating equipment always pays significant dividends. There is no substitute for having properly calibrated equipment.

Aaron Patton, Fred Whitford, and Glenn Hardebeck

Calibrating Turf Sprayers and Spreaders: Keys to Application Accuracy

The Importance of Calibration

There is no substitute for having properly calibrated equipment. Whether you want to improve pest control, have healthier turf, save money, prevent off-site damage, or reduce customer complaints, investing time in calibrating equipment always pays significant dividends. Precise applications of pesticides and fertilizers allow products to function as intended.

If you apply too little or too much product, it can seriously affect performance and have consequences that are readily seen. An improperly calibrated herbicide applicator can result in poor pest control. Not applying fertilizer properly can lead to turf that is off-color, streaked, uneven in color, and unhealthy. At the other end of the spectrum, you can injure turf if you apply more herbicide or fertilizer than the product label allows. In such cases, improper calibration means you could be violating the pesticide label.

Customers and employers are not the only ones who see the results of poor applications. Every trip your employees make to deal with a misapplication is an unplanned trip and potentially a correcting application. The costs of labor, equipment, and fuel make such correcting applications expensive. Profits increase when there are fewer mistakes.

It might be a subtle point, but improperly calibrated equipment leads to quality issues that customers, clients, or supervisors will notice. When weeds, insects, or diseases are not controlled or turf looks unhealthy, customers and employers question the value of the service. Your truck and the flag you leave behind advertise the quality of your work.

Purdue Extension offers various other publications about calibration:

- *Calibrating the Hose Reel Lawn Care Sprayer* (PPP-85)
- *Calibrating Ride-on Pesticide Sprayers and Spreaders: Keys to Application Accuracy* (PPP-104)
- *Category 3b: Turf Pest Management* (PPP-3B) and six other training manuals cover the calibration of sprayers

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Don't Assume Factory Calibration Is Correct

Application equipment manufacturers provide instructions about calibrating their equipment. The instructions usually describe how much area the sprayers will treat. On new equipment, manufacturers provide an approximate calibration by equipping their sprayers with a specific nozzle to deliver a target application volume at a target application speed. If that preset output does not meet your needs (too high or low), you will have to change the speed, pressure, or nozzle type. Any modification or change you make will require recalibrating the equipment.

And, as with any newly purchased equipment, you should ensure that everything is working well and double-check the manufacturer calibration values through a true calibration. It is important to realize that no two sprayers or spreaders are identical even when they are new — and they become less so as they age. That means you will need to calibrate each piece of equipment independently.

You also need to precisely calibrate spreaders after you purchase them. Manufacturers provide a starting point from which to work. You will need to adjust the spreader opening and distribution pattern depending on the size of the fertilizer granule you use and the rates you apply.

Sprayer Calibration

Whether you purchase equipment new, used, recently repaired, or updated with new add-on equipment, you need to calibrate it. You also need to remember that equipment naturally wears over time, so you should recalibrate periodically.

One firm rule is that you should calibrate sprayers before using them at the start of each growing season. How often you will need to check the calibration after that varies by personal preferences and amount of use. Many grounds and turf professionals calibrate them daily or weekly. These frequent calibration checks help ensure consistent application results.

Something as simple as a partially clogged screen (left) can undermine any calibration by altering the flow of water. Clean screens (right) can help keep sprayer output consistent. Remember to clean any filters between the spray tanks and nozzles.

It is important that you know the exact size of the areas you are treating so that you can validate the accuracy of your sprayer and spreader calibration. If you have not measured these areas recently, take advantage of newer GPS tools and services or re-measure these areas by hand to ensure that you know the size of your treatment area.

Another steadfast rule is that you should always calibrate sprayers after any mechanical work is performed on them. Check nozzles for wear each time you calibrate the sprayer, and frequently clean screens. Many companies clean their screens daily.

Before you calibrate your equipment, always inspect it to make sure it is in good working condition. Be sure the tires are properly inflated and the axles are properly greased.

Two Primary Types of Sprayers

There are two general sprayer designs: boom and boomless. A boom sprayer has a set of nozzles along the length of a boom. A boomless sprayer clusters a bank of different nozzles under the front center of the sprayer. This publication covers the steps for calibrating each design separately.

What You'll Need to Calibrate Sprayers

Here's a checklist of things you'll need to calibrate a sprayer.

- Pencil
- Paper
- Calculator
- 100-foot (or longer) tape measure or measuring wheel
- Marking or pin flags
- A watch or cell phone that can measure time in seconds
- Containers marked in ounces to collect liquid from nozzles
- Calibration worksheets in this publication

STEPS TO CALIBRATE BOOM SPRAYERS

There are many different methods to calibrate liquid sprayers. One of the easiest and quickest is the "ounces to gallons" method developed by Erdal Ozkan in Boom Sprayer Calibration (Ohio State University Extension publication AEX-520-92, available from Ohioline, ohioline.osu.edu). This method (which is the one used in this publication) is excellent because it greatly simplifies the math.

Before calibrating any equipment, always answer the question, "How much water do I want to apply per 1,000 square feet or acre?" Product labels often have minimum spray volume requirements per acre or 1,000 square feet. Read labels first to make sure you are applying sufficient volume. After that, follow these 11 steps for calibrating boom sprayers.

Step 1

Measure the distance (in inches) between nozzles. The distance between nozzles may differ between manufacturers, but for each unit the distance between nozzles should be equally spaced.

Step 2

Determine the length of the course you'll need for calibration. Consult Table 1 to determine the distance you will need to travel for calibration. For example, if you have a sprayer with 20-inch nozzle spacing, then Table 1 shows you will need a calibration course that is 204 feet long. Use a measuring tape or wheel to measure the length of a calibration course.

Table 1. Calibration distance for each nozzle to spray 1/128 acre.

Nozzle spacing (in.)	Travel distance (ft.)	Nozzle spacing (in.)	Travel distance (ft.)
10	409	22	185
12	341	24	170
14	292	26	157
16	255	28	146
18	227	30	136
20	204	32	127

When you establish a calibration course, pick an area that has terrain that will be similar to the turf you treat. Place a flag at the beginning of the course and another at the end. Do not set a calibration course on a hard surface because the speed will be different than on turf.

Step 3

Fill the tank at least halfway with water to provide a realistic weight for the test. At this stage, you will not use any pesticides.

Step 4

Time how long it takes to travel the calibration course. Have a second person use a stopwatch to time how long it takes to cover the calibration distance from the beginning flag to the ending one. Be certain to cover the entire calibration course at the speed you will be travelling when treating turf. Keep the speed constant from the time you drive over the start line until you pass the finish line.

Repeat the process by going back over the course in the opposite direction. Add both course completion times together and divide by 2 to get an average speed of travel.

If the sprayer has a speedometer, record the speed (in MPH) when running the calibration course. Otherwise, record the gear and engine rpm so you can repeat the speed of the sprayer during actual applications. You can use MPH or the gear/engine RPM for this — one is not necessarily better than the other.

Record the nozzle pressure used during the initial calibration steps. Although changing speed or nozzle size is the best way to adjust your calibration volume, you can also modify nozzle pressure on some models to make small adjustments to output.

Step 5

Collect water from each nozzle for the same amount of time (average time) it took you to travel the calibration course in Step 4. Collect the water, not while the sprayer is moving, but when it is parked and running at the same engine speed (RPM) so the spray pressure is the same that it was used on the calibration course. For example, if it took 32.5 seconds to cover the calibration course, collect water for 32.5 seconds.

Collect water twice and divide by 2 to get the average output. Also be sure to write down the nozzle type and operating pressure you used for the test run.

Record the output (in fluid ounces) from each nozzle. Use a measuring container that has printed markings for each fluid ounce — ideally it should have markings for each half-ounce, too.

If your container measures in milliliters, simply divide the amount of water you collect by 29.57 to convert the metric output to the more familiar fluid ounces.

Step 6

Add up the total amount of water you collect from the sprayer and divide that amount by the number of nozzles. This will give you the average output per nozzle. For example, if the sprayer has four nozzles that applied 13.5, 16, 16, and 14.5 fluid ounces, then the average output is 15 fluid ounces per nozzle: 13.5 + 16 + 16 + 14.5 = 60. Therefore, the average output is 15 (60 ÷ 4).

Step 7

Check the nozzle output. If any nozzle varies by more or less than 10 percent of the average output, then there may be a problem with the nozzle. If none of the nozzles varies by more than 10 percent, proceed to Step 8.

If a nozzle has a lower than average output, then it may be plugged or have a plugged screen. A nozzle with a higher than average output is likely worn out and needs to be replaced.

After you clean any screens or replace any nozzles, go back to Step 5 and rerun the volume check on all the nozzles. It is important to check all nozzles again in case your adjustments affected the output of the other nozzles. Recalculate the average nozzle output, and double-check that all nozzles are within the 10 percent of the average output. If half the nozzles are out of range, replace the entire set.

In the example above, the average output was 15 ounces, so 10 percent is 1.5 fluid ounces.

Subtract and add 1.5 to the average to get the acceptable range: 13.5 to 16.5 ounces. Because the output from each nozzle in our example is within this range, none of them need to be replaced yet.

Make a pass over pavement to double-check that the spray pattern appears uniform. Spray the pavement at the same speed (gear), engine RPM, and pressure you used while going over the calibration course. Watch the pavement dry and observe any irregularities that may exist in the spray pattern.

Step 8

Determine the sprayer's output in gallons per acre. This should be easy because of the conversion factors that were used in Step 2 to determine the length of the calibration course. The average nozzle flow measured in fluid ounces is equal to the sprayer's output in gallons per acre. This helps make the math easy.

For example, the average nozzle output of 15 fluid ounces over the application course is equal to 15 gallons of spray per acre for the entire sprayer.

Step 9

If you need to determine sprayer output for 1,000 square feet, then divide the gallons of water per acre from Step 8 by 43.56 (43,560 square feet = 1 acre). For example, divide 15 by 43.56 to get 0.34 gallon per 1,000 square feet.

Step 10

Determine whether the sprayer output meets your specifications. If it does, then the equipment is calibrated and ready to be put in service. If the amount of water per acre or per 1,000 square feet is higher or lower than what you wanted, then you will need to adjust the nozzle pressure (small adjustment), nozzle size (large adjustment), or speed (medium adjustment).

Step 11

If you make any adjustments in Step 10, repeat the calibration process until the sprayer is calibrated to your specifications.

Calibration Worksheet for Sprayers with Booms *(make copies for future use)*

Sprayer information: Make: _______________ Model: ______________ Year: _________
Gear: _____________ and engine RPM _____________ Speed: _____________ (if available)
Pressure: _____________ Nozzle type/model: _____________

Step 1 Measure the distance (in inches) between nozzles

Nozzle spacing: _____________ in

Step 2 Determine the length of the course you'll need for calibration (see Table 1)

Distance to travel:

_________________ ft

Step 3 Fill the tank at last halfway with water.

Step 4 Time how long it takes to travel the calibration course.

First Pass	Second Pass	Average time
__________	__________	__________

Step 5 Collect water from each nozzle for the average time measured in Step 4.

Nozzle		
1	__________________	fl oz
2	__________________	fl oz
3	__________________	fl oz
4	__________________	fl oz
5	__________________	fl oz
6	__________________	fl oz
7	__________________	fl oz
8	__________________	fl oz
9	__________________	fl oz
10	__________________	fl oz
11	__________________	fl oz
12	__________________	fl oz
13	__________________	fl oz
14	__________________	fl oz
Total	_____________	fl oz

Remember: some booms may have less than fourteen nozzles. If your container measures in milliliters, convert to fluid ounces by dividing by 29.57

Step 6 Add up the total amount of water you collect over the calibration course and divide that amount by the number of nozzles. Average output:

_____________ fl oz

Step 7 Check the nozzle output. Did any individual nozzle output vary by more than 10 percent of the average? If no, proceed to Step 8. If yes, check to see if the nozzles or screens are partially plugged. After cleaning or replacing, go back to Step 5, and recalculate the average nozzle flow.

Step 8 Determine the sprayer's output in gallons per acre. It's the same number from Step 6. ___________ gals/A

Step 9 If you need to determine sprayer output for 1,000 square feet, then divide the number from Step 8 by 43.56.

______ (from Step 8) ÷ 43.56 = _____ gals/1,000 ft^2

If you prefer to know how many fluid ounces to use per 1,000 square feet, multiply the answer above by 128.

______ (gals/1,000 ft2) x 128 = ______ fl oz/1,000 ft^2

Step 10 Determine whether sprayer output meets your specifications. If not, change your nozzle size, pressure, or travel speed.

Step 11 If you make any adjustments in Step 10, repeat the calibration process until the sprayer is calibrated to your specifications.

ST LE BOOMLESS SPRAYERS

Boomless sprayers like PermaGreen® lawn care, ride-on sprayers often have a cluster of nozzles under the front center of the unit, but only one is used at a time. Calibrate each nozzle for the gear it will operate in, because speed affects the amount of water applied per acre.

PermaGreen® style sprayers can have as many as four combinations that affect the spray volume (two FloodJet® nozzles plus two speeds). There are a similar number of combinations that affect the spray volume of the trim nozzles (two flat-fan nozzles plus two speeds). Whichever combination is used, each will need to be calibrated.


The steps you take to calibrate single-nozzle boomless sprayers are similar (but different) to those of boom sprayers and require the same supplies described previously. As with boom sprayers, your goal is to determine how much water you want to apply over an acre or over 1,000 square feet.

Step 1

Select the nozzle you want to use.

Step 2

Measure a calibration course on turf that is 100 feet long. As with boom sprayers, pick an area that has terrain that is similar to the turf you treat. Place a flag at the beginning of the course and another at the end. Do not set a calibration course on a hard surface because the speed will be different than on turf.

Step 3

Fill the tank at least halfway with water to provide a realistic weight for the test. At this stage, you will not use any pesticides.

Step 4

Time how long it takes to travel the calibration course. Cross the start and finish lines at the same speed (gear and RPM) you will use when you treat turf. Keep the speed constant from start to finish.

Repeat the process by going back over the course in the opposite direction. Add both course completion times together and divide by 2 to get the average time it took to travel 100 feet.

For example, it took a ride-on sprayer an average of 13.6 seconds to travel the 100-foot course in high gear at 3,450 RPM.

Step 5

Collect water from the nozzle for the same amount of time (average) it took you to travel the calibration course in Step 4. Collect the water, not while the sprayer is moving, but when it is parked and running at the same engine speed (RPM) so the spray pressure is the same that was used on the calibration course. For example, if it took 13.6 seconds to cover the calibration course, collect water for 13.6 seconds.

Record the amount of water you collect (in fluid ounces). Use a measuring container that has printed markings for each fluid ounce — ideally it should have markings for each half-ounce, too. Collect water twice and divide by 2 to get the average output.

For example, for one calibration we collected 22 and 23 fluid ounces in 13.6 seconds. The average output was 22.5 fluid ounces.

Step 6

Check the nozzle distribution pattern. Do this while the sprayer is parked over pavement and spraying at the same engine RPM and pressure from Step 4. Adjust the nozzle if the pattern is uneven.

Step 7

Determine the effective width of the spray pattern. To do this, fill the tank only with water and make a pass over pavement. Spray the pavement using the speed (gear), engine RPM, and pressure you used over the calibration course, and then watch the pavement dry.

The edge of the spray pattern (where little water was applied) will dry and disappear quickly. Some call this the feathered edge.

To determine the effective width, you want to measure where the nozzle applies most of the water. Measure the width (in feet) where most of the water is applied and exclude the feathered edge. This is the effective spray width.

In our example, we measured an effective spray width of 7 feet. That means there should be 7 feet between passes.

Step 8

Calculate how many square feet were treated. To do this, multiply the effective spray width (from Step 7) by 100 (the length of the calibration run). That will give you the area (in square feet) that you treated.

For example, if the effective spray width is

7 feet, then the sprayer treated 700 square feet.

Step 9

Calculate the volume applied per 1,000 square feet. This requires a two-step process:

(a) determine the ounces of water per square foot, and then (b) determine the ounces of water per 1,000 square feet.

a. Determine the ounces of water per square foot. Take the average fluid ounces you collect from the nozzle in Step 5 and divide it by the total area treated in Step 8. For example:

22.5 fl oz ÷ 700 ft^2 = 0.03214 fl oz/ft^2

b. Determine the ounces of water per

1,000 square feet. Multiply the fluid ounces per square foot by 1,000. For example:

0.03214 fl oz/ft^2 x 1,000 = 32.14 fl oz/1,000 ft^2

Step 10

Calculate the number of gallons applied per 1,000 square feet or per acre. This also is a two-step process.

a. Determine the number of gallons applied per 1,000 square feet. Divide the fluid ounces per 1,000 square feet (from Step 9b) by 128. Remember, there are 128 fluid ounces in one gallon. For example:

32.14 fl oz/1,000 ft^2 ÷ 128 = 0.25 gal (1 qt)/1,000 ft^2

b. Determine the number of gallons applied per acre. Multiply the number in Step 10a by 43.56. Remember, there are 43,560 square feet in an acre. For example:

0.25 gal/1,000 ft^2 x 43.56 = 10.9 gals/A

Step 11

Determine whether the sprayer output meets your specifications. If it does, then the equipment is calibrated and ready to be put in service. If it does not meet your expectations, adjust the nozzle pressure (if it is an option on your sprayer) or speed (gear and RPM), or replace nozzles. Note: changing nozzles or speed is the best way to change sprayer output; increasing pressure increases the possibility of drift.

To adjust the effective spray width, reposition the nozzle to widen or narrow the pattern, and/or adjust nozzle pressure (if it is an option on your sprayer). Any change will require you to recalibrate the unit.

Step 12

Repeat the calibration process if any action is taken in Step 11.

Calibration Worksheet for Single-Nozzle Boomless Sprayers *(make copies for future use)*

Sprayer information: Make: ______________ Model: _____________ Year: ________
Gear: ____________ and engine RPM ____________ Speed: ____________ (if available)
Pressure: ____________ Nozzle type/model: ____________

Step 1 Select the nozzle you want to use.

Step 2 Measure a calibration course on turf that is 100 feet long.

Step 3 Fill the tank at least halfway with water.

Step 4 Time how long it takes to travel the calibration course.

First Pass	Second Pass	Average Time
_________	_________	_________

Step 5 Collect water from the nozzle for the same amount of time (average time) it took you to travel the calibration course in Step 4. Do this twice and take the average.

Pass 1: _______ fl oz

Pass 2: _______ fl oz

Average: _______ fl oz

If your container measures in milliliters, convert to fluid ounces by dividing by 29.57.

Step 6 Check the nozzle distribution pattern. Adjust as necessary.

Step 7 Determine the effective width of the spray pattern. Spray over concrete and measure the spray area (in feet). Do not measure the feathered edge.

Effective spray width: _______ ft

Step 8 Calculate how many square feet were treated.

_______ (effective spray width from Step 7)
× 100 ft = _______ ft^2 treated

Step 9 Calculate the volume applied per 1,000 ft^2.

a. _______ average output (from Step 5) ÷
_______ total area treated (from Step 8) =
_______ fl oz/ft^2

b. _______ fl oz/ft^2 (from Step 9a) x 1,000 =
_______ fl oz/1,000 ft^2

Step 10 Calculate the number of gallons applied per 1,000 square feet or per acre.

a. _______ fl oz/1,000 ft^2 (from Step 9b) ÷ 128 =
_______ gals/1,000 ft^2

b. _______ gals/1,000 ft^2 (from Step 10a) x 43.56 =
_______ gals/A

Step 11 Determine whether the sprayer output meets your specifications. If not, change your nozzle size, pressure, or travel speed.

Step 12 Repeat the calibration process if any action is taken in Step 11.

SCREEN AND NOZZLE EVALUATIONS

For sprayers, it is a good idea to change the nozzles once a year or if the spray pattern is no longer uniform. If a nozzle on a boom sprayer varies by more than 10 percent from the average spray output, then replace it. Sometimes, changing all the nozzles on a boom sprayer might be an advantage when you want a lower or higher output. You also can change the output of a boom sprayer by changing the speed and, to a lesser degree, its pressure.

Spray nozzles have a uniform coding system that manufacturers use to describe the spray droplet size, spray angle, and opening size.

For example, if you have a nozzle coded AVI ISO 110025, then you know the following information:

- AVI: This indicates it is an air induction spray nozzle that uses the Venturi system.
- ISO: This indicates that the manufacturer used the International Standards Organization (ISO) color- coding system to indicate the nozzle's opening size. For example, a red nozzle typically has the same opening size regardless of who manufactured it.
- 110: This number tells you that the spray angle is 110 degrees. When you replace nozzles, always choose nozzles with the same spray angle because the angle is specific to your sprayer's nozzle spacing and boom height.
- 025: This indicates the nozzle's spray output (in gallons per minute at 40 psi). In this case, 0.25 gallon per minute.

To change your sprayer output, you can use the nozzle coding system to help select nozzles that have different opening sizes, spray patterns, or output per acre.

The system allows you to select the appropriate nozzle whether you have a boom-type or boomless sprayer.

FIELD VALIDATION OF THE CALIBRATION

After you do the hard part (calibrating the sprayer), you need to put the sprayer to the test to make sure that your calibration works under field conditions.

To complete a field validation:

1. Predict how many acres you expect to cover

2. Determine the width between passes

3. Validate the calibration

Predict How Many Acres You Expect to Cover

First, calculate how many acres a given spray tank will cover. Use the same formula whether the sprayer has booms or is boomless.

tank capacity (gals) ÷ gals/A from Step 8 (boom) or Step 10b (boomless)
= acres the spray tank should cover

A boom sprayer example: say you have a boom sprayer that has an 250-gallon tank, and its predicted output is 50 gallons per acre (based on Step 8 of the calibration process). You should have enough product in the sprayer tank to cover 5.0 acres (218,150 square feet).

250 gals ÷ 50 gals/A = 5.0 acres product in tank should cover

5.0 A x 43,560 = 218,150 ft^2

A boomless sprayer example: say you have a sprayer with a 12-gallon tank, and its predicted output is 10.9 gallons per acre (based on Step 10b of the calibration process). You should have enough product in the sprayer tank to cover 1.1 acres (47,956 square feet).

12 gals ÷ 10.9 gals/A = 1.1 acres product in tank should cover

1.1 A x 43,560 = 47,916 ft^2

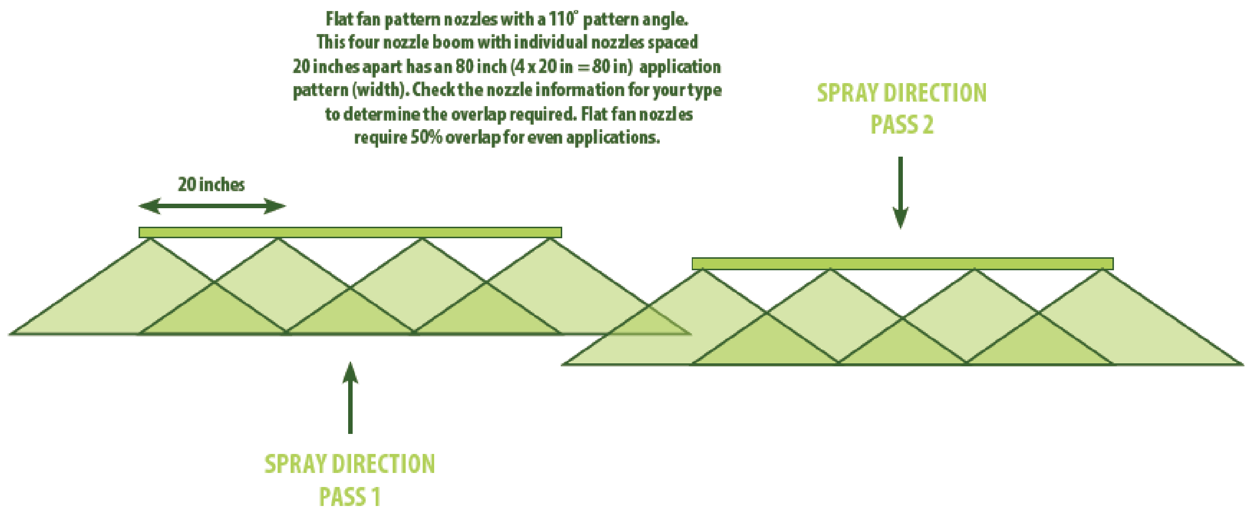
Just because a tank says it holds a certain volume, doesn't mean it does. Always check tank capacities for accuracy. For more information, see Measuring Pesticides: Overlooked Steps To Getting the Correct Rate (PPP-96) available from the Purdue Extension Education Store: www.the-education-store.com, (888) EXT-INFO (396-4636).

Determine the Width Between Passes

To spray an area uniformly you have to have the correct distance between passes.

For a boom sprayer, the effective spray width is the distance between nozzles multiplied by the number of nozzles. For example, if you have a boom sprayer with four nozzles that are spaced 20 inches apart, the sprayer has an effective spray width of 80 inches (6.7 feet). To spray an area uniformly, you will need to make application passes that are 6.7 feet apart. That is, make the center of your wheel tracks 6.7 feet apart on each pass to make a uniform application.

Another way to look at this is that the spacing between the nozzles at the end of the boom should always match the spacing of the nozzles along the boom. For example, let's say you have a boom with nozzles spaced 20 inches apart. Space your passes so that the nozzle on the end of the boom of the current pass will travel over a spot that is 20 inches away from where the nozzle on the end of the boom was during the previous pass.



Experienced applicators will be able to approximate this through practice. Sometimes, you can identify where you have already sprayed by the wetness of the leaf. New applicators can practice by spraying turf with a spray dye indicator in the tank. The dye will help you see where you have sprayed. A spray foam marker may also be useful.

For a boomless sprayer, use the effective spray width measured in Step 7. For example, say you have a sprayer with an effective spray width of 7 feet. To spray an area uniformly, you will need to make application passes that are 7 feet apart from one another. That is, make the center of your wheel tracks 7 feet apart on each pass to make a uniform application.

Again, experienced applicators will be able to approximate this through practice. Just like with a boom sprayer, you can look for wet leaves or use a spray dye indicator.

Validate the Calibration

A simple way to validate a calibration is to run the sprayer over turf that you know is about an acre (43,560 square feet). Use an acre of turf that is flat and contains no obstructions such as trees or buildings.

Fill your spray tank with the amount of water that should cover an acre. This is your gallons per acre calibration. Next, spray the acre with only water, and then check how much remains in the spray tank. What is left should correspond to what you had predicted from your calibration.

If you added the volume calibrated to cover an acre, then your tank should be empty (or nearly empty) by the time you finish covering that test area. If a small amount of water remains in the tank or if you run out just before you finish treating the area, then your calibration is accurate.

However, if there is a lot of water in your spray tank or you run out way too soon, then there may be a problem.

If the spray tank has more water than expected, then the causes might be that you:

- Went faster than you did over the calibration course
- Did not overlap your passes
- Used a lower pressure than you used over the calibration course
- Made a math error in your calibration steps

If you ran out of water long before expected, then the causes might be that you:

- Went slower than you did over the calibration course
- Overlapped your passes too much
- Used a higher pressure than you used over the calibration course
- Made a math error in your calibration steps

CALCULATING HOW MUCH PRODUCT TO ADD TO THE TANK

Here are some examples to illustrate how to calculate how much product to add to the tank. In these examples, we have used small tank-sizes similar to ride-on sprayers.

Boom Sprayer – Smaller tank and spray volume

Let's say you have a calibrated boom sprayer that has an 18-gallon capacity that applies 0.34 gallon per 1,000 square feet. The label for the pesticide you are applying calls for 1.1 fluid ounces per 1,000 square feet. How much chemical should you add to the 18-gallon tank?

Use this formula:

(tank size (gals) ÷ gals of water/1,000 ft^2) × rate (fl oz/1,000 ft^2 — from product label)
= amount of product to add to tank (fl oz)

Using our example:

(18 gals ÷ 0.34 gal/1,000 ft^2) × 1.1 fl oz/1,000 ft^2 = 58.2 fl oz
In this example, add 58.2 fluid ounces of product to the sprayer tank.

Boom Sprayer – Larger tank and spray volume

Let's say you have a calibrated boom sprayer that has a 250-gallon capacity that applies 50 gallons per acre. The label for the pesticide you are applying calls for 1.1 fluid ounces per 1,000 square feet. How much chemical should you add to the 250-gallon tank?

Use this formula:

(tank size (gals) ÷ gals of water/acre) × rate (fl oz/1,000 ft^2 — from product label) × 43.56
= amount of product to add to tank (fl oz)

Using our example:

(250 gals ÷ 50 gal/acre) × 1.1 fl oz/1,000 ft^2 × 43.56 = 239.6 fl oz
In this example, add 239.6 fluid ounces of product to the sprayer tank which is equal to 7.5 quarts of product (1 quart = 32 fl oz).

Boomless Sprayer

Let's say you have a boomless sprayer that has two 6-gallon tanks and applies 0.25 gallon per 1,000 square feet (Step 10b, Page 21). The label for the pesticide you are applying calls for 1.1 fluid ounces per 1,000 square feet. How much chemical should you add to fill up 12 gallons?

Use the same formula provided for boom sprayers above:

(12 gals ÷ 0.25 gal/1,000 ft^2) × 1.1 fl oz/1,000 ft^2 = 52.8 fl oz

In this example, add 52.8 fluid ounces of product to the sprayer tanks.

SPRAYER ACCESSORIES

Manufacturers constantly add new accessories for sprayers. For example, you can equip your sprayer with a foam marking system that allows you to see the outside edges of what you have sprayed. Such systems allow you to make more uniform applications because you can see where you need to overlap.

Many sprayers have speedometers to help you keep the unit moving at a more uniform speed over large turf areas. You can also add a hose and lawn gun attachment to reach small lawns and tight places. Spray rate controllers also are available to help maintain a constant spray output during small changes in travel speed. These controllers modulate the pump to increase pressure when you speed up and to decrease pressure when you slow down.

Calibrating a Lawn Gun

Calibrating a lawn care gun is difficult because every applicator will walk at slightly different speeds as well as using slightly different spray techniques. Therefore it is important to calibrate each individual with each gun. A lawn gun delivers the majority of the material directly in front of the applicator as he/she walks and sprays with a rapid side-to-side shoulder/arm motion. Therefore, less material is applied on the applicator's right or left compared to directly in front of the applicator. Therefore, lawn guns require 100% overlap on subsequent passes (50% overlap on right and 50% overlap on left) to ensure uniform application. When determining the effective spray width while calibrating the lawn gun the effective spray width should be calculated as one-half of the area covered in one pass. In over words if a 10 foot width of spray is applied in one pass, then the effective spray width would be 5 feet. Use the following worksheet to calibrate a lawn gun.

Individual 1: Test 1

Step 1 Lay out a rectangular area 50 ft long by 20 ft wide (1000 ft^2).

Step 2 Record the amount of time it takes for an applicator to uniformly apply water to this area.

_______________ seconds

Step 3 Spray into a five gallon bucket for the amount of time recorded in Step 2. Measure the amount of water collected in the bucket in fluid ounces.

_______________ fl oz

Step 4 Divide the water collected in step 3 by 128 (1 gallon = 128 fluid ounces) to calculate spray volume in gallons/1000 ft^2.

a. __________ fl oz ÷ 128 oz/gallon = _____ gallons/1000 ft^2

To convert from gallons/1000 ft^2 to gallons/acre, multiply by 43.56.

b. _____ gallons/1000 ft^2 × 43.56 = _____ gallons/acre

Step 5 Divide the spray tank capacity by the answer in Step 4a to calculate the area that can be covered with one tankful.

________ gallons in spray tank × 1,000 ÷ ________gallons/1000 ft^2 = _______ft^2/tank

OR

________ gallons in spray tank × ÷ ________gallons/acre = _______acres/tank

Individual 1: Test 2

Step 1 Lay out a rectangular area 50 ft long by 20 ft wide (1000 ft^2).

Step 2 Record the amount of time it takes for an applicator to uniformly apply water to this area.

_______________ seconds

Step 3 Spray into a five gallon bucket for the amount of time recorded in Step 2. Measure the amount of water collected in the bucket in fluid ounces.

_______________ fl oz

Step 4 Divide the water collected in step 3 by 128 (1 gallon = 128 fluid ounces) to calculate spray volume in gallons/1000 ft^2.

a. __________ fl oz ÷ 128 oz/gallon = _____ gallons/1000 ft^2

To convert from gallons/1000 ft^2 to gallons/acre, multiply by 43.56.

b. _____ gallons/1000 ft^2 × 43.56 = _____ gallons/acre

Step 5 Divide the spray tank capacity by the answer in Step 4a to calculate the area that can be covered with one tankful.

________ gallons in spray tank × 1,000 ÷ ________gallons/1000 ft^2 = _______ft^2/tank

OR

________ gallons in spray tank × ÷ ________gallons/acre = _______acres/tank

Calibrating a Backpack Sprayer

This easy to use backpack sprayer calibration procedure is designed to reduce the amount of steps needed to determine your final answer. Since each person's walking speed is different, the final answer will vary from person to person.

1. Lay out a calibration plot that is 18.5 ft by 18.5 ft. (this equals about 1/128th acre).

2. Spray that area uniformly with water and note how many seconds are required. Maintain a comfortable steady pace while keeping the tank pressure uniform.
   Run 1: ___________________ seconds

3. Repeat step 2 and average the two values.

   Run 2: ___________________ seconds
   Average: ___________________ seconds [Average= (Run 1 + Run 2) ÷ 2]

4. Collect output from the nozzle in a measuring cup for the average number of seconds (step 3).
   Write that answer here in fluid ounces ________________

5. Fluid ounces collected (step 4) equals gallons per acre.
   Gallons per acre = ________________ (step 4 answer)

6. Divide by 43.56 to determine the gallons applied per 1000 ft^2.

   Gallons per acre _____________(step 4) divided by 43.56 = _______________ (gallons per 1,000 ft^2)

7. Next, determine the total area you can treat with your sprayer. Divide the capacity of the sprayer by the gallons applied per 1000 ft^2 (step 6) and multiply by 1,000.

   Sprayer capacity in gallons _____________ divided by gallons per 1,000 ft^2 _________________ (step 6) multiplied by 1,000 = _______________ (square feet treated by sprayer)

Double checking your answer

Here are some steps to use to double check the accuracy of your calibration.

1. Mark of an area of turf 1,000 square feet in size. The easiest way to do this would be to mark off an area 20 ft by 50 ft. (20 ft × 50 ft = 1000 ft^2)

2. Fill an empty sprayer with the same calibrated spray volume per 1,000 ft^2 as determined in step 6 of the calibration exercise.

3. Spray the 1,000 square feet of turf in the same manner that you calibrated your sprayer. If your calibration is correct, you should run out just as you finish spraying the turf.

   If you have a small amount left in the tank when you finish treating the area or if you run out just before you finish treating the area then the calibration you did is working.

   But what happens if there is a lot left over or you ran out way too soon?

   If there is a lot left in the tank then you either
   - went faster than you travelled over the calibration course
   - did not overlap your passes
   - the pressure was lower than what you used to originally calibrate
   - you made a math error in your calibration steps

   If you ran out long before the end, then you either
   - went slower than what was tested on the calibration course
   - overlapped the passes too much
   - the pressure was higher than what you used to originally calibrate
   - you made a math error in your calibration steps

How much herbicide should I add to the backpack spray tank?

How much herbicide do we add to the tank?

General formula

Tank size (gallons)	A	rate
	Calibrated spray volume (gallons)	acre

Example. I would like to spot treat creeping bentgrass in my Kentucky bluegrass turf with Tenacity herbicide. How many ounces of Tenacity do we add to the tank? We have a 4 gallon spray tank that is calibrated to spray 60 gallons per acre. We need to treat 5,000 ft^2 of turf with 5 fluid ounces of Tenacity per acre.

4 gallons	acre	5 fl oz
	60 gallons	acre

This should be computed as 4 gallons × 1 A × 5 fl oz ÷ 60 gallons ÷ 1 acre = ________
Answer = 0.33 fluid ounces of Tenacity

Here are some conversions that might help make this small number more meaningful.
1 fluid ounce = 2 tablespoons = 6 teaspoons = 29.58 milliliters

Thus, our answer of 0.33 fluid ounces is equal to 2.0 teaspoons.

From the Tenacity label we read:

Spot Application of Tenacity (apply at 1 gallon per 1000 sq. ft.)

Spray Mix	Rate of Tenacity (teaspoons)	NIS adjuvant (teaspoons)
2 gal	1	3

Do not apply more than 16 oz. of Tenacity per acre per year or per crop (equivalent to a maximum of 0.50 lb. of mesotrione per acre per year), whichever is shorter.

Thus, our answer of 2 teaspoons per 4 gallon sprayer is equal to their recommendation for spot treatment (they recommend 1 teaspoon per 2 gallons of spray mix). Although our spray volume of 60 gallons per acre (1.4 gallons/1000 ft^2) is higher than their recommendation at 1.0 gallons/1000 ft^2 (43.56 gallons per acre), our application will still be successful. The Tenacity label allows for higher spray volumes. It does not set a spray volume maximum but does recommend the product be applied in at least 30 gallons per acre of spray volume. Don't forget to add the nonionic surfactant recommended by the label.

Since each applicator has a unique calibration (gallons per acre) the Tenacity label provides a general rate recommendation for spot treatments that will work (be pretty close) for most applicators across a range of backpack/hand pump sprayers.

Rotary Spreader Calibration

A properly calibrated spreader is essential equipment for all professional turfgrass managers.

Overapplying fertilizers wastes money and can injure turf and nearby ornamental plants. Underapplying fertilizers can lead to customer complaints when turf quality declines. You can avert these sorts of problems by calibrating your spreaders to deliver products uniformly at the proper rates.

At a minimum, you should calibrate a spreader each time you use a new product, even if that product has the same nutrient content, size guide number (SGN), or amount of active ingredient as a previous product. The main reason to recalibrate is the important influence that granule size and particle density has on flow through the spreader opening. It's also important to note that, just like a sprayer, changing your travel speed (gear) requires you to recalibrate the fertilizer spreader.

To make uniform applications with rotary spreaders, you must check for proper distribution and then determine your effective spread width.

The distribution pattern is important because a rotary spreader must be adjusted for each product to make sure it throws equal amounts of the product to the left and to the right.

The effective spread width is important because with a rotary spreader you must overlap the product to achieve a uniform application. This overlap is critical for uniform fertilizer distribution, because the highest rate of product is placed directly in front of the spreader while a lesser amount is placed to the right and left.

Before calibrating your spreader, use this checklist to make sure it is in good working condition. Before calibrating, make sure that the:

- Tires are properly inflated
- Axles are greased
- Spreader hopper and impeller are clean
- Screen and agitation bar in the hopper are clean
- Adjustment knob holds its position when tightened
- Gears are greased (if recommended) and teeth on the gears are present
- Desired pattern adjustment is set

There are three components for calibrating rotary fertilizer spreaders:

1. Check the distribution pattern of fertilizer across the spreader swath
2. Determine the effective spread width
3. Calculate the application rate

COMPONENT ONE: CHECK THE DISTRIBUTION PATTERN

In a rotary spreader, it's important that the spinner plate (impeller) throws equal amounts of fertilizer to the right and left. If one side gets more product than the other, then overlapping will magnify this error and result in uneven application and banding/striping.

Some applicators try to observe how much fertilizer the spreader throws to the sides, but it is not possible to accurately calibrate the spreader pattern this way. A more thorough check of the pattern after a visual estimate often reveals that you need to make additional adjustments. It is worth your time to spend a few extra minutes to properly adjust the pattern if your goal is to achieve uniform application.

The first thing to do is make a spreader calibration kit (see next page).

Making Spreader Calibration Kits

Calibration kits are easy to make/assemble. Many different designs and specifications can be used to create a working calibration kit.

1. Collection boxes/pans can be purchased or made. Cardboard boxes work well but you can also use plastic or aluminum pans. Shallow boxes 2″ in height or less with upright lips work best. If boxes are too tall (> 2″), they might not catch all the fertilizer and they will be too high to allow for clearance from the equipment.

Collection boxes should be 1 ft (12 inches) wide as this makes it easy to determine your spread width. The length of the boxes is variable with boxes as short as 12 inches or as long as 36 inches. The longer the box, the fewer the number of passes need to be made in order to collect enough material to fill your tubes.

The size we use for our calibration demonstrations is 12 inches wide by 36 inches long and 2 inches deep. We made ours by cutting out pieces of cardboard from a large shipping box and then assembling the pieces using packing tape. To do this we used 12 by 36 inch pieces for the bottom, and 2 inch strips measuring 12 and 36 inch for the sides. Similar sized boxes can be purchased online. For example, item #016700 at http://www.papermart.com/ is a 12″ wide by 36″ long and 4″ deep cardboard box. A quantity of 25 of this box can be purchased for about $28. This 4″ tall box is too tall, but after cutting off the lid and lowering the sides with a blade it should work well.

Figure 1. These custom 1 ft by 3 ft long collection boxes were made from cardboard scraps and packing tape.

2. Baffles help keep fertilizer from bouncing out of the collection boxes during calibration. Baffles or partitions can be made using cardstock paper. Cut cardstock paper into strips the same height as the height of your boxes. At 2 inch intervals along the length of the strip, cut half-way through strips to create slits. After doing this on several strips, fit the strips together using the slits to make baffles.

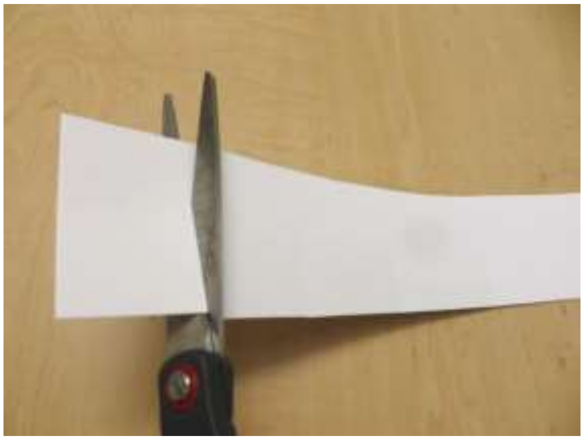


Figure 2. Cut cardstock paper into strips the same height as the height of your boxes. At 2 inch intervals along the length of the strip, cut half-way through strips to create slits.

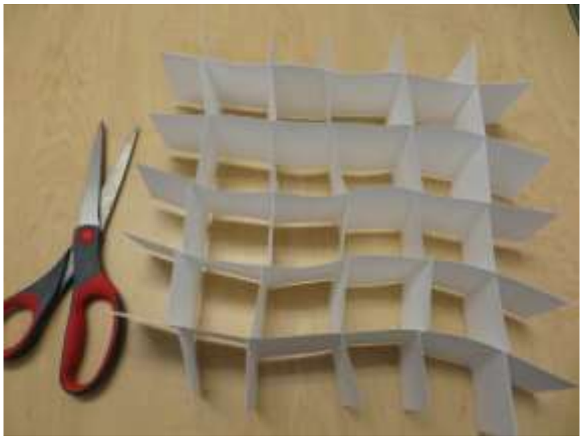


Figure 3. After making several pre-cut strips, fit the strips together using the slits to make baffles.

3. Various types of clear tubes to collect fertilizer from each collection box can be used. Test tubes, graduated cylinders, or rain gauges work well and are available through various vendors. Plastic tubes are preferred. We suggest getting at least 50 so that you can compare 2 to 3 different calibration runs. Tubes should be 1-4 fluid ounces (30 to 120 mL (cm^3)) in capacity. Below are a few examples of types of tubes that you can use.

Figure 4. These plastic 50 mL centrifuge tubes are one option as a type of tube that can be used for spreader calibration.

Figure 5. These Baby Soda Bottles (also known as Giant Test Tubes) can be ordered online. They hold 35 mL and work well for spreader calibration.

Figure 6. This plastic graduated cylinder is another option as a type of tube that can be used for spreader calibration. Since these tubes already have a base, no rack is needed.

Figure 7. A rain gauge also works well for spreader calibration.

4. Tube racks can be purchased to hold these tubes or one could be easily constructed. Racks that can hold enough tubes (11 to 15) to display the results from all the collection boxes are preferred.

Figure 8. This test tube rack works well for displaying these tubes. A funnel is a helpful tool for pouring the fertilizer from the collection boxes into the tubes.

Follow these six steps to check your spreader's distribution pattern.

Step 1

Place shallow boxes or pans side-by-side in a line that is perpendicular to the path the spreader will be traveling. Ideally, these boxes should contain dividers (baffles) to keep the fertilizer in the box and prevent it from bouncing out.

To check a spreader's distribution pattern, place shallow boxes with baffles side-by-side in a line perpendicular to the direction the spreader will travel.

The size guide number (SGN) indicates the size of the fertilizer granules. Fertilizer bags or product information sheets often include SGNs.

For fertilizers with small granules (SGN≤150), use 11 boxes. For fertilizers with large granules (SGN>150), use 15 boxes. SGNs are typically provided on fertilizer bags and labels. Place the collection boxes side-by-side so that you can collect granules along the entire width of the spread.

It's important to use an odd number of boxes for this test. That way, there is one box in the middle and an equal number of boxes on both sides. For example, if you use 15 boxes, there is a box in the middle, and then seven on the left and seven on the right.

You can space the boxes up to 12 inches apart depending on the impeller speed and granule size. Large granules spread farther, so space the boxes farther apart. Small granules do not spread as far, so place the boxes right next to each other.

Make sure to place one box directly beneath the spot where the middle of the spreader will pass. Leave enough space between this center box and the boxes on the left and right sides for the wheels to pass. Make sure that the boxes on the outside edges are far enough out that they will collect little fertilizer — about 10 percent or less of that in the middle box.

The center box is marked with an arrow. Notice the extra space on either side of the center box to allow room for the wheels. In this example, the spreader is being calibrated for a product with a large granule, so the boxes are placed about 12 inches apart to catch the granules along the entire width of the spread.

In this example, the spreader is being calibrated for a product with a small granule , so there is no space between the boxes. Closer box spacing with small granules helps you determine the effective spread width more accurately.

Step 2

Choose a starting point for your rate that will be similar to your final rate setting. Most fertilizer bags do not include settings for ride-on spreaders since this equipment type is still fairly new. However, some manufacturers are starting to include this information on their products. In any case, it is hard to approximate what this setting will be without previous field experience with the product.

The owner's manual for a spreader typically offers little guidance about what the proper spreader setting should be. However, you may get some valuable information if you call the spreader manufacturer's customer support line or your local fertilizer distributor. Trial and error and advice from your peers at turf conferences and workshops will yield valuable information about how they determine their initial rate settings.

Keep in mind that any information you obtain (regardless of the source) will not be exact because your equipment's age, how it's operated, the product's granule size, and the product's flow can alter how much product the spreader actually applies. This information serves only as a guide to get you started with your own calibration.

Step 3

Set the pattern adjustment. Set the adjustment based on input from the manufacturer, previous experience, or advice from others. This is only a starting point. You will make further adjustments until the fertilizer distribution is uniform.

Step 4

Fill the hopper at least halfway with fertilizer to run the test. Pass over the boxes several times (moving in the same direction with each pass) until there is plenty of fertilizer in the front of the boxes. Remember, it is essential to go over the boxes from the same direction each time. Your goal is to go over the boxes enough times to collect enough material to fill collection tubes. Specifically, you want to collect enough material in the center box to fill a collection tube at least halfway. This might take two to eight passes over the collection boxes, depending on the size of your boxes.

When you pass over the boxes, operate the spreader at the speed you intend to use over turf. Ride-on spreaders have an advantage over walk-behind spreaders in that the impeller speed is more independent of its operating speed.

When you calibrate, be sure to record the applicators walking speed (phone apps will help determine your speed, time how long it takes to walk 100 ft as a reference, or calculate your walking speed in MPH using the equation below), gear, and RPM. For some units, you may be able to record the impeller speed. It is important to set and record the engine speed and any other impeller speed control during the calibration process so you can maintain it consistently later when you make applications.

General formula for speed in miles/hour (MPH)

$$= \frac{\text{Distance in feet} \times 60 \text{ (conversion factor)}}{\text{Time in seconds} \times 88 \text{ (conversion factor)}}$$

Example 1. Calculate the MPH for an applicator who pushes a spreader 100 feet in 22 seconds.

$$= \frac{100 \text{ ft} \times 60}{22 \text{ sec} \times 88} = 3.1 \text{ miles per hour (MPH)}$$

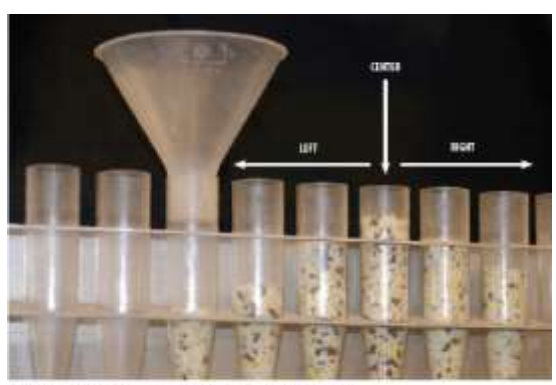
When calibrating the spreader pattern, make sure to use the same fertilizer or pesticide you plan to apply.

Some ride-on spreaders may have a hydraulic impeller motor that can adjust the spread width. When you calibrate one of these units, note the setting you are using. If you adjust this setting you will need to recalibrate.

Step 5

Measure what you collected in the boxes. Before you begin, leave each box in place — this is important because you will need to measure the distance between these boxes later. Arrange a series of collection tubes in a rack. You should have a tube for each box. Arrange the tubes in the rack. It is a good idea to number the tubes and boxes such as L1 and L2, etc., center, and R1 and R2, etc., to help keep them in order. Face the tubes in the same direction as if you were passing over the collection boxes.

Pour the contents of each collection box into its own corresponding tube (starting from one end). For this to work, all of the tubes must be identical. Tall and narrow containers are better because they will allow you to easily see the fertilizer distribution from one end of the spreader to the other. When you are done pouring all the boxes into the tubes, you will visually see the spreader's distribution pattern.

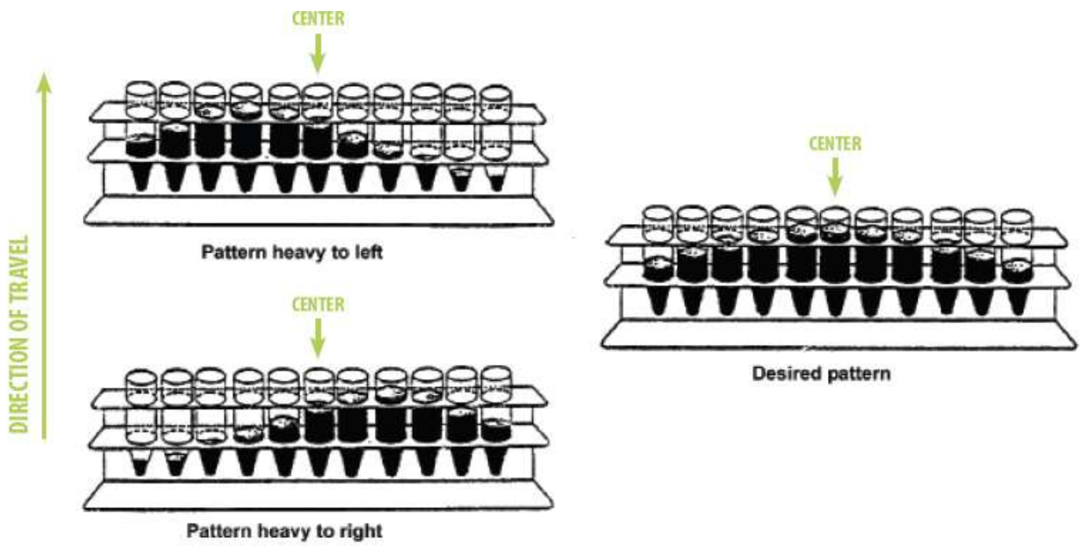


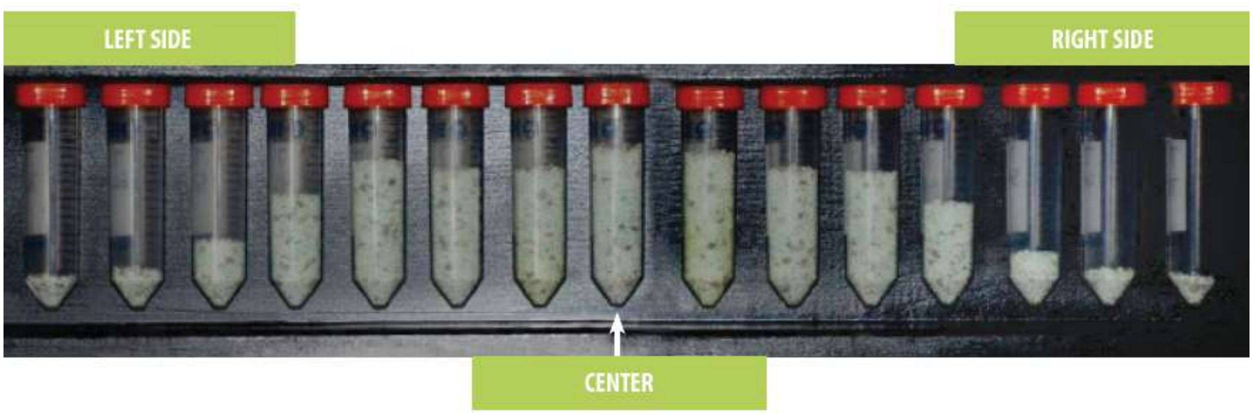
After your calibration run, pour the contents of each box into its own small container. Keep the boxes (and tubes) in order from left to right.

When you finish pouring the contents of one box into a tube, put it back on the ground where it was during the calibration run. As mentioned above, you will need to measure the distance between these boxes later.

As the illustration shows, collecting fertilizer like this allows you to see if you are getting even distribution across the spread width or if one side is getting more than the other. The illustration also shows good and bad spreader patterns.

It's worth noting that it might take several attempts to get an ideal or desired pattern and that the pattern you achieve might not look as perfect as an ideal one.





This is a good spreader distribution pattern. Although not perfect, this might be as close as you can get to an ideal pattern. Make sure that the fertilizer distribution is evenly balanced on the left and right sides of the center. The arrow marks the center collection tube and direction of travel.

Step 6

If necessary, adjust the spreader pattern adjustment setting (not the gate opening), and then repeat Steps 4 and 5 (Pages 37-39). You can adjust the pattern in a number of ways depending on the make and model of the spreader. You can:

1. Change the opening size of the third hole adjustment (Lesco, others)
Some spreaders use the third hole to adjust the spreader pattern. Whether the third hole is open, closed, or somewhere in between affects how the product is distributed onto the moving impeller. A third hole-type spreader should come with a calibration gauge. This gauge has stepped increments of 1/32 inch to allow the applicator to accurately measure the size of the opening. Use the gauge (not the numbers on the operating lever) to accurately document the opening size. After you obtain the desired spread pattern, document the step number and the product information for future reference.

2. Adjust the sliding gate (Spyker, others)
Some spreaders use sliding gates to adjust their spread patterns. Be cautious because small adjustments in the gate can result in major product distribution changes.

3. Rotate the conical distribution device (Andersons, Scotts, others)
This spreader uses a rotating conical distribution device to adjust where the fertilizer hits the impeller, which adjusts the spread pattern.

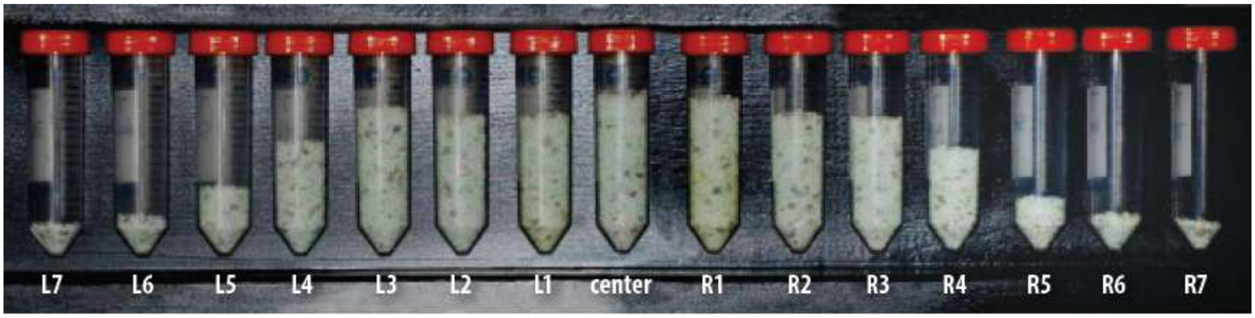
COMPONENT TWO:

DETERMINE THE EFFECTIVE SPREAD WIDTH

After you collect the product from your spreader, the tubes clearly show where the fertilizer is being applied. Once you adjust the spreader to achieve the desired pattern (equal amounts of fertilizer to the right and left sides of the spreader), find the tubes on the right and left that contain about half the product as the center tube.

Go to the collection box on the left that corresponds to the tube that collected half the product. Measure the distance between this left box and the corresponding box on the right (through the center). This measurement is the *effective spread width.*

The effective spread width is the distance between spreader passes necessary for uniform distribution. In the example shown in the photos, the spreader's effective spread width was 11 feet.



The effective spread width for this spreader is the distance from the box that corresponds to the L4 tube to the box that corresponds to the R4 tube.

Start from the box on the left that collected half as much material as the center box. Measure the distance between that box on the left, through the center, to the corresponding box on the right (R4 to L4). This measurement is the *effective spread width.*

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To spread product uniformly, the operator of that spreader needs to make applications 11 feet apart. That is, the center of the wheel tracks should be 11 feet apart on each pass to make a uniform application. Experienced applicators will be able to approximate this distance through practice. New applicators can practice by using flags to mark the desired width.

Of course, the effective spread width will change from product to product. Some applicators overlap fertilizer applications by throwing fertilizer back to the center of the previous wheel tracks. Although this strategy works for most applications, it can slightly overestimate or underestimate the effective spread width. When you overestimate the effective spread width, some areas between the wheel tracks could receive too light of an application, which will cause a banding or striping effect. It is best to determine the effective spread width (using the method described here) than it is to rely solely on the wheel-to-wheel application strategy.

COMPONENT THREE:

CALCULATE THE APPLICATION RATE

Before you can calculate the fertilizer application rate, you must first know the effective spread width (Component Two). The seven steps for calculating the fertilizer application rate appear below.

Step 1

Determine how much fertilizer you want to apply per 1,000 square feet. Fertility rates for turf are based on the pounds of nitrogen (N) applied per 1,000 square feet. First determine how much actual N you need to apply per 1,000 square feet. This is your rate. Here is how to do the math.

Calculating Granular Fertilizer Needs for Calibration

To determine how much fertilizer you need to apply you need to know two important things:
1. The rate you want to apply
2. The percentage of the nutrient in the fertilizer product you will use

Example: Let's say your target application rate is 1.0 pound of actual N per 1,000 square feet, and you are using a 20-0-0 fertilizer product.

Here's how you determine how much actual fertilizer product you will need for a calibration run equivalent to 1,000 ft^2.

1. Convert the percentage of nitrogen to a decimal. The 20-0-0 fertilizer product contains 20 % N, so the decimal value is 0.20.
2. Divide the target application rate (1.0 pound N per 1,000 square feet) by the decimal value from step 1.
   $1.0 \div 0.20 = 5.0$
   This is how many pounds of actual fertilizer product you will need per 1,000 square feet of turf to deliver the target application rate (1.0 pound of actual N per 1,000 square feet).

Step 2

Set the length of the calibration course. In this example, you want the calibration course to measure 1,000 square feet (make the run over turf so you do not have to sweep up the fertilizer).

The width of the calibration course is the effective spread width that you calculated in Component Two (Page 42). Determine the length by dividing 1,000 square feet by the effective spread width.

For example, let's say your spreader has an effective spread width of 11 feet:

$1{,}000\ ft^2 \div 11\ ft = 91\ ft$

This means your calibration course is 11 feet wide by 91 feet long. Place flags at the start and finish of the calibration course. Table 2 provides calibration course lengths based on various effective spread widths.

Table 2. Using the Effective Spread Width to Calculate the Length of a 1,000 Square Foot Calibration Course

Effective Spread Width	Length of Calibration Course
5	200
5.5	182
6	167
6.5	154
7	143
7.5	133
8	125
8.5	118
9	111
10	100
11	91
12	83
13	77
14	71
15	67
16	63

Step 3

Set the gate opening. Set the opening based on the fertilizer bag, manufacturer recommendations, input from peers, or input from fertilizer distributors. Consider this setting as a starting point for your rate calibration.

Step 4

Pour an entire fertilizer bag into the hopper. You will know exactly how many pounds of product this is by looking at the net weight written on the bag. Alternatively, weigh out a smaller amount to reduce the amount of fertilizer you need to add to the hopper. You could use a weight such as 25 pounds.

Step 5

Apply the product over the calibration course. Use a shop vacuum or similar device to collect all the remaining fertilizer from the hopper. Pour the contents from the shop vacuum into a bucket and weigh it. Subtract the empty weight of the bucket, and that's how much fertilizer was left in the hopper after your calibration run. Subtract this weight from the total weight you put in the hopper in Step 4. This will tell you how many pounds of fertilizer you applied over the calibration course.

For example, let's say you added 25 pounds of fertilizer to the hopper in Step 4. After the calibration run, you collected 20 pounds from the hopper. This means you applied 5 pounds of fertilizer to 1,000 square feet.

Always repeat this process a second time to verify your results.

A shop vacuum will help you remove the fertilizer that was left in the hopper. Subtract what's left from the amount you started with to calculate how much fertilizer you applied to the calibration course.

Use a digital scale to weigh the product left in the hopper after the calibration run.

Step 6

Adjust the spreader if necessary. You should make adjustments if the amount that you applied over the calibration course differs more than 10 percent from the amount of fertilizer you want to apply. Make the necessary gate opening adjustments and repeat Steps 4 to 5 until you achieve the desired application rate.

Warning: do not go over the same calibration course more than once. Each time you calibrate, move your course over a distance that is at least equal to the effective spread width so that you don't over apply fertilizer to your turf calibration area.

Step 7

Record the speed and/or gear, engine RPM, impeller speed setting (if applicable), and gate opening. It is also important to write the brand of fertilizer and other information that will identify that product — including its SGN. Keep this information for future reference.

It is important to remember that the formulation of a specific brand may change over time, which can throw off your calibration. Two other ways to collect this information are to save the actual bag and/or to place a little fertilizer in a container for reference. If you use another fertilizer product, you will have to repeat the calibration process. A wide variety of turf fertilizers are available to turf professionals. Turf fertilizers vary in size and shape, which affects their distribution with a spreader.

Calibration Worksheet for Rotary Fertilizer Spreaders (Make copies for future use)

Spreader Information
Make: ________________________ Model: _____________________ Year: ___________
Gear: ____________ and engine RPM: _______________ Speed: ______________
Pattern adjustment setting:______________ Spreader opening setting:________________
Fertilizer manufacturer: _________________________________
Fertilizer name/descriptor (if any): __________________________
Fertilizer analysis (N-P2O5-K2O): _________________________
Fertilizer size guide number (SGN): _________________________

Component One

Check the distribution pattern settings on your spreader. See Pages 31-41.

Component Two

Determine the effective spread width. Effective Spread Width ___________________ ft

Component Three: Calculation the Application Rate

Step 1. Determine how much fertilizer you want to apply per 1,000 square feet.

a. Convert the percentage of nitrogen to a decimal. For example: A 20-0-0 fertilizer contains 20 % N, so the decimal value is 0.20.

b. Divide the target application rate in pounds of nitrogen per 1,000 square feet by the decimal value from step a. For example, 1.0 ÷ 0.20 = 5.0. This is how many pounds of actual fertilizer product you will need per 1,000 square feet of turf.

Step 2. Set the length of the calibration course.

1,000 ft^2 ÷ ____________ (effective spread width in feet from Component 2) = ______ length of calibration course (ft)

Step 3. Set the gate opening.

Step 4. Pour fertilizer into the hopper. Record the weight here: ______ lbs

Step 5. Apply the product over the calibration course. Collect the remaining fertilizer out of the hopper and weigh it. Subtract this amount from the weight in Step 4.

______ (from Step 4) - ______ weight collected in shop vacuum = ______ lbs/1,000 ft^2

Step 6. Adjust the spreader if necessary. Repeat steps 3-5 until you achieve the desired application rate.

Step 7. Record the speed and/or gear, engine RPM, impeller speed setting (if applicable), and gate opening (top of this worksheet). Calibrate each spreader to each product.

CHECK THE ACCURACY OF YOUR SPREADER CALIBRATION

After you calibrate the spreader, double-check its accuracy. Here is the general formula to determine how much actual N you applied:

lbs fertilizer applied × analysis (% N as a decimal) × 1,000 square feet ÷ total area treated in square feet

Let's say your goal was to apply 0.5 pound of N per 1,000 square feet to a lawn that is 7,000 square feet. The product you calibrated for was a 12-0-5 fertilizer and came in a 50-pound bag. You filled the hopper with all 50 pounds of the product and spread the fertilizer until the hopper ran dry just as you finished treating the lawn.

How close to the 0.5 pound of N per 1000 square feet did you apply?

50 lbs fertilizer applied × 0.12 × 1,000 ft^2 ÷ 7,000 ft^2 = 0.86 lb N/1,000 ft^2

In this example, the actual amount of fertilizer applied was 0.86 pound per 1,000 square feet. This is an over-application because the goal was 0.5 pound of N per 1,000 square feet.

It doesn't seem like much, but the turf received 72 percent more than the target rate of fertilizer. In other words, your fertilizer bag is covering much less than it should have and nearly doubled your fertilizer cost.

DROP SPREADER CALIBRATION

Calibration of a drop spreader is simpler than for a rotary spreader. Drop spreaders have a fixed uniform distribution across the pattern, a fixed spread width. Therefore, only the rate of application requires calibration.

Step 1 Calculate the required weight of fertilizer, seed, or pesticide per 1,000ft^2 needed to apply the desired amount of product. Example: If you want to apply 1.0 lbs. actual nitrogen per 1,000ft^2 using urea (46-0-0) you should apply 2.17 lbs. of urea per 1,000 ft^2. NOTE: It is common to apply one-half the product in one direction and then to apply the second half in a perpendicular or angular direction to the first pass. If applying in two-directions, then calculate half of the required application rate.

General formula - fertilizer

Rate	1 lb fertilizer	Area to be treated
1,000 ft^2	Analysis	

General formula - seed

Seeding rate	1 lb seed	Area
1000 ft^2	PLS	

General formula – pesticide product

Rate	Area to be treated
1,000 ft^2	

or

Rate	Area to be treated
acres	

General formula – pesticide dry active ingredient

Rate	1 lb	Area to be treated
1,000 ft^2	percent a.i.	

or

Rate	1 lb	Area to be treated
acre	percent a.i.	

Step 2 Fill the drop spreader with the chosen product used in step 1.

Brand of Spreader: _________ Brand of Product: _________

Step 3 Lay out a calibration course. Record the total length of the course, the spreader width, and then calculate the area covered in the calibration course. Make sure to calibrate over terrain similar to the intended application site. For example, don't calibrate over a smooth concrete floor if you are planning on spreading over a dry, bumpy bare soil area. Since drop spreaders work using gravity, a bumpy surface will cause more product leave the spreader than a smooth surface.

A. Total length traveled: _________ (ft)
- NOTE: Use a course at least 40 feet in length. If you travel down and back during the calibration, make sure to multiply the number of passes (i.e. down and back = 2 passes) by the length of the calibration course to correctly calculate the total area covered.

B. Spreader width: _________ (ft)

C. Area of calibration course: __________ (ft^2)
- Calculate as A × B = C.

Step 4 Calculate the amount of product that will be collected from the calibration course when calibrated correctly. Which step you use below depends on what units your digital scale measures.

lbs product (from Step 1)	Area of calibration course (from Step 3) (ft^2)	454 g
1,000 ft^2		lbs

This should be computed as _______ × _______ ft^2 × 454 g ÷ 1,000 ft^2 ÷ _______ lbs = _________ grams.

or

lbs product (from Step 1)	Area of calibration course (from Step 3) (ft^2)	16 oz
1,000 ft^2		lbs

This should be computed as _______ × _______ ft^2 × 16 oz ÷ 1,000 ft^2 ÷ _______ lbs = _________ oz.

Step 5 Estimate the required setting to deliver the appropriate amount of product and adjust the spreader to that setting.

Step 6 Build a catch tray to hand underneath your drop spreader. A short section of guttering with endcaps, a PVC tube with end caps sliced horizontally, or custom made sheet metal catch trays can all be used. With each, a section of short chain with hooks will need to be used to hold the tray in place (below the hopper but not touching the ground) during calibration.

Step 7 Apply product to the calibration course with the catch pan in place.

Step 8 Weigh the product (in ounces or grams) released into the catch pan during the calibration run and note the setting in the chart below.

Step 9 Repeat steps 7-8 until the spreader delivers the correct amount of product calculated in step 4. Accuracy within 10% is often acceptable. Once you think you have it calibrated successfully, repeat the process again to ensure that you get two successful (within 10%) calibrations in a row before proceeding.

Spreader Setting	Weight of Fertilizer Applied (oz)	Weight of Fertilizer Applied (g)

Step 10 Record the proper setting for this product at this rate using this particular drop spreader.

Spreader setting: _______ Brand of Spreader: _______

Product rate: ________________ Product SGN (fertilizers): ________________

Product analysis/formulation (fertilizers and pesticides): ________________

Problems

2 pints	=	1 quart	1 pound	=	454 g
4 quarts	=	1 gallon	1 yard	=	3 ft
1 gallon	=	128 fluid ounces	1 mile	=	5,280 ft
1 gallon	=	3,785 ml	1 acre	=	43,560 ft^2
1 gallon	=	8 pints	1 gallon	=	3.785 liters
1 pound	=	16 ounces			
1 hectare (ha)	=	10,000 m^2			

1. A sprayer has a 12 ft boom with 10 nozzles. The distance between nozzles is 16 inches. Each nozzle releases 1,500 ml of spray in 45 seconds. A 255 ft test strip is established and the sprayer is timed to travel the distance in 45 seconds. How many gallons per acre are being applied?

2. How many gallons per 1,000 ft^2 would be applied using the following boom sprayer?

- 4 nozzles
- 5 foot wide boom
- 20 inches between nozzles
- A 204 course is traveled in 32 seconds
- Each nozzle releases 444 mL in 32 seconds which is equal to 15 fl oz

3. Using the handout on calibrating a backpack sprayer, determine the area covered by a backpack sprayer and an applicator with the following information.

Spray width of nozzle = 18 inches (1.5 feet)
175 seconds to spray 1/128 of an acre (18.5 ft by 18.5 ft square)
Collected 50 fluid ounces in 175 seconds
Sprayer has a total capacity of 3 gallons

Based on this information, how many square feet covered will be covered by a full tank of spray solution?

___________ square feet

4. You wish to calibrate your drop spreader to seed some creeping bentgrass. You measure out a test area 50 ft long and you are using a drop spreader with a width of 36 inches. You wish to seed at a rate of 1.0 lbs/1000ft^2. You travel down 50 ft and back 50 ft once. How many grams of seed must you collect (down and back) in order for your spreader to be calibrated accurately?

5. You wish to calibrate the sprayer portion of your boomless ride-on spreader/sprayer. You travel an average of 19.7 seconds per 100 feet in low gear and collect 29 fl oz of water in 19.7 seconds using the high volume output nozzle. Assuming that your effective spray width is 8 feet, how many gallons per acre would you be applying with this sprayer?

Answers
1. 50.7 gallons/acre
2. 0.34 gal/1000 ft^2 (15 gallons/acre)
3. 2,614 ft^2
4. 136.2 grams

CONCLUSION

Turf management is a science that requires you to understand agronomic principles, pest biology, fertilizers and pesticides, and application equipment. Ultimately, you need to apply any products uniformly and at the correct rate.

Calibrating your equipment is part of your overall responsibilities as turf manager. Calibration ensures that you apply products correctly the first time, which can save you time and money, and lead to turf you can be proud of.

Turf provides a safe place for recreation and provides a pleasant setting for people to enjoy the outdoors. With proper calibration, you can maintain a high-quality athletic field, residential yard, commercial property, or cemetery that all can enjoy.

Find Out More

The Purdue Turf Science Program and Purdue Pesticide Programs offer a number of publications on related topics to help you manage your operations better.

All publications are available from The Purdue Extension Education Store:

www.the-education-store.com

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Find Purdue Extension publications, research reports, and educational opportunities on the Purdue Turfgrass Science website: www.agry.purdue.edu/turf.

Related Publications

The Impact of Water Quality on Pesticide Performance (PPP-86). Learn how water quality can affect your applications and bottom line.

Measuring Pesticides: Overlooked Steps To Getting the Correct Rate (PPP-96). Find solutions to common measuring problems.

Turfgrass Weed Control for Professionals (AY-336). Develop effective weed control programs for golf courses, athletic fields, sod farms, residential and commercial lawns, and other turf systems.

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