

Backpack Sprayer Calibration Made Easy

This fact sheet covers calibrating a backpack sprayer to determine how much herbicide to add for band applications and spot treatments. “Calibration” simply means determining the output of a sprayer so a known amount of spray solution is applied to a given area. Applicators must know this if they wish to apply an herbicide at a specific dosage, which is described as the amount of product per given area (e.g., ounces or quarts per acre). Failure to calibrate spray equipment can result in misapplication of herbicides, repeat applications, damaged nontarget plants, excess costs, and environmental concerns.

The amount of spray applied to an area will depend on walking speed, spray pressure, spray swath width, and the spray tip selected. If any one of these variables changes, the amount of spray applied per unit area changes and the sprayer must be calibrated from the beginning. Each applicator may have a different walking speed, regulate pressure differently, and have a different idea of what adequate coverage looks like. Therefore, it is important to have each applicator calibrate.

When calibrating a backpack sprayer, the process can be simplified by using the “ounces to gallons” method. With this method, the amount of spray, measured in ounces, converts directly to gallons per acre. It is based on making the calibration application to an area of 1/128 acre, or 340 square feet (43,560 square feet per acre ÷ 128 = 340 square feet).

We do this because 1 gallon equals 128 ounces. By treating 1/128 acre, 340 square feet, we can convert a measurement of ounces of water sprayed directly to gallons sprayed per acre. Applying 30 ounces to 340 square feet is the same coverage as applying 30 gallons to an acre. Once we have determined our coverage in gallons per acre, we can determine how much herbicide to mix per gallon of spray solution. This method will be used to calibrate two types of applications:

- Band or fixed-width application
- Spot treatment, where target plants are scattered and variable

Band Application

A band application is a fixed-width, fixed-speed application in which the applicator treats larger, continuous areas of vegetation. In forestry applications, band treatments are commonly used for spraying interfering plants such as hay-scented and



Understories of hay-scented fern, an interfering plant, can be treated systematically with a backpack sprayer. This type of treatment is referred to as a “band” or “fixed-width” application.
Photo: Mike Eckley



Backpack sprayers are commonly used for treating invasive plants like this autumn olive. This type of treatment is referred to as a “spot” treatment.
Photo: David Jackson

New York fern. Infestations of some invasive plants, including Japanese stiltgrass and mile-a-minute vine, are also commonly treated with band applications. In addition, band applications may also be used to treat weeds along fence lines and trees planted in rows. It is important to understand that a band application is a specific, specialized treatment with a fixed speed.

Steps to calibrate this application:

1. Lay out a calibration area equal to 340 square feet.
2. Spray and record the time it takes to treat the calibration area (340 square feet).
3. Measure the volume sprayed, in ounces, in the amount of time it took to treat the calibration area.
4. Determine the herbicide amount to mix per gallon.



Step 1: Lay out the Calibration Area

To set up the 340-square-foot calibration area, first measure the width of your spray pattern. This is your “band” width. To determine the length of the calibration area, divide 340 by the band width (in feet). If the width of your spray pattern is 4 feet, then the length of the calibration row is 85 feet ($340 \div 4 = 85$).

If using an adjustable cone nozzle, moving the spray wand back and forth will increase the band width, thus providing greater coverage with one pass. Be sure to first set the tip to the desired spray pattern.

For this example, our band width is 9 feet. Therefore, our length will be $340 \div 9 = 37.8$, or 38 feet.

Step 2: Spray and Time the Application of the Calibration Area

The next step is to spray the calibration area using your backpack sprayer filled with just water. It is important to get uniform coverage while walking at a comfortable, repeatable speed.

Band Applications



Using an adjustable cone nozzle and moving the spray wand back and forth slowly will increase the band width, thus providing greater coverage. Here our band width is 9 feet. *Photo: Kimberly Bohn*



Time how long it takes to treat the calibration area, 340 square feet. Operate the backpack as you would when spraying in the field, getting uniform coverage while walking at a comfortable speed. (Note: This level of wetting is heavier than operational to enhance the pattern for the purposes of this image.) *Photo: Kimberly Bohn*

When measuring the time required to treat the calibration area, operate the backpack as you would when spraying in the field. Adjust the spray nozzle to the desired setting, hold the wand at a consistent height above the vegetation, and pump the sprayer to the normal operating pressure. Record the time it takes to cover the distance. Do this several times to get a reliable average. If more than one applicator is doing treatments, then times must be recorded for each applicator.

In our example above, we treated the 9-foot width by 38-foot length in 40 seconds.

Step 3: Measure the Ounces Needed to Treat the Calibration Area

Once you know how long it takes to treat the calibration area, the next step is to determine how much liquid is applied in that time. Use a measuring cup to collect spray solution from your sprayer for the same time it took to spray the calibration area. This amount, in ounces, will equal the gallons per acre of your application. If it takes 15 seconds to cover the calibration area, then collect spray water from your backpack in a measuring cup for 15 seconds, and measure the volume in ounces.

When collecting, it is important to pump the sprayer the same way as when making the test application; otherwise, the flow rate will differ and calibration will be less accurate. To get a reliable average volume, repeat this process two or three times to get the average nozzle output.

An alternative is to collect the solution for a “multiple” time period. If the sample collection time is 15 seconds, collect the solution for 30 seconds, and divide the ounces collected by 2 to get the ounces collected per 15 seconds (or collect for 45 seconds and divide by 3, etc.).

In our example, it took us 40 seconds to spray the calibration area. We collected 11 ounces using a measuring cup to collect water from the nozzle for the same time period. Therefore, we are spraying 11 gallons per acre.

Step 4: Determine the Herbicide Mixture

Now that you have determined your gallons per acre, the next step is to calculate how much herbicide to add per gallon. If the treatment called for applying 10 ounces of herbicide per acre, and based on your calibration exercise you sprayed 15 gallons per acre, then you would simply mix 10 ounces of herbicide in 15 gallons of total spray solution.

Since we are using a backpack sprayer, we want to mix smaller amounts. The first step is to determine how much herbicide to add to each gallon of solution. This is a division process that gives the answer in ounces per gallon. Simply divide the ounces of herbicide recommended per acre by the gallons of mix applied per acre.

$$\frac{\text{Ounces of herbicide recommended per acre}}{\text{Gallons of mix applied per acre}} = \frac{\text{ounces}}{\text{gallons}}$$

From our example we will use the typical fern and stiltgrass recommendation of spraying 2 ounces of a sulfometuron methyl herbicide (e.g., Oust XP) per acre. To calculate ounces of herbicide per gallon of spray solution, divide the rate of herbicide applied per acre in ounces by the total gallons applied per acre

as determined from the calibration exercise. (*Important note: For granular herbicides, such as Oust XP, measurements are provided by weight rather than volume.*)

Calculate ounces of herbicide per gallon of spray solution:

$$\begin{aligned} & 2 \text{ ounces per acre} \div 11 \text{ gallons per acre} \\ & = 0.18 \text{ ounce of sulfometuron methyl herbicide per gallon} \end{aligned}$$

To mix 3 gallons in a backpack sprayer, simply multiply the above number by 3:

$$\begin{aligned} & 0.18 \text{ ounce} \times 3 \text{ gallons} \\ & = 0.54 \text{ ounce of sulfometuron methyl herbicide} \end{aligned}$$

Now you are ready to measure out the amount of herbicide needed, mix it in your sprayer, and begin treating. Be sure to use the same walking speed, spray pressure, spray swath width, and spray tip used when calibrating. This will ensure that the herbicide is being applied at the proper rate.

Spot Application

The most common use of a backpack sprayer will likely be to “spot” treat undesirable weeds that are scattered about a site. Spot treatments are used to treat discrete targets, such as a single shrub, as well as patches of continuous vegetation. Spot herbicide treatments are commonly used to control invasive shrubs such as multiflora rose, shrub honeysuckle, autumn olive, Japanese barberry, and privet. Calibrating for these types of treatments allows the applicator to estimate spray coverage so the mix will be effective without over- or underapplying.

It is important to put this type of treatment in terms of “treated” acres. A treated acre refers to the sum total area of plants targeted across a site. Sites can be quite variable—some have dense coverage of target plants, while others will have light coverage. Recommended herbicide rates will be provided in ounces or quarts applied per treated acre.

The steps to calibrate this application are similar to those outlined above, with a couple of important differences:

1. Lay out a calibration area equal to 340 square feet that has vegetation similar to your target weeds.
2. Treat all vegetation in the calibration area the same way target weeds are sprayed.
3. Use the “subtraction” method to calculate ounces applied and gallons per treated acre.
4. Calculate the herbicide amount to mix per gallon.

Step 1: Lay out the Calibration Area

Measure a test area of 340 square feet that is a “wall” of vegetation representative of what will be targeted with the actual spot application. If treating invasive shrubs, then a hedgerow of shrubs with similar height, branching pattern, and leaf texture is ideal. In other words, don’t use a lawn or parking lot to calibrate for a multiflora rose treatment.

For this example, we will spray a hedgerow or wall of vegetation to a height of 7 feet (a height we can comfortably spray). Therefore, our length will be $340 \div 7 = 48.5$ feet.

Step 2: Treat All Vegetation

In this procedure, your gallons per treated acre will be estimated by spraying all vegetation in the calibration area in the

Spot Applications



Flag a calibration area (340 square feet) that is a “wall” of vegetation representative of what will be targeted with the actual application. A hedgerow of shrubs with similar height, branching pattern, and leaf texture is ideal for invasive shrub treatments. *Photo: Kimberly Bohn*



The use of dyes or spray pattern indicators is helpful for observing the desired level of coverage on foliage. *Photo: Kimberly Bohn*

same manner isolated targets would be treated in the field. Begin by practicing your application outside the calibration area. Adjust the nozzle to the proper setting and calibrate your eye to be sure a consistent level of coverage is achieved. The use of dyes or spray pattern indicators is helpful for observing the desired level of coverage on foliage.

Once your eye is calibrated and you are achieving the proper level of coverage, treat all vegetation in the calibration area. Treat it to the same level of coverage that you would treat similar target weeds in the field. Be consistent in your coverage over the entire area.

For this procedure, you cannot simply time how long it takes to apply. Before spraying you must mark the starting water level in your backpack so you can determine, by subtraction, the total volume applied.

Step 3: Use the Subtraction Method

From a graduated container with a known amount a solution,

refill the sprayer to the original water level marked on the sprayer, and determine by subtraction the volume sprayed.

In our example, we started with 40 ounces of water in the graduated container and had 5 ounces left after the sprayer was refilled to the starting level. Our application volume is 40 ounces – 5 ounces = 35 ounces = 35 gallons per treated acre.

This provides a reasonable estimate of coverage and allows mixing to be more precise, rather than simply guessing a percent solution.

Step 4: Determine the Herbicide Mixture

Now that you have determined your gallons per treated acre, the next step is to calculate how much herbicide to add per gallon. This will be calculated similarly to that outlined for band treatments. Again, if the treatment called for applying 10 ounces of herbicide per acre, and based on your calibration exercise you sprayed 15 gallons per acre, you would simply mix 10 ounces of herbicide in 15 gallons of total spray solution.

However, since we are using a backpack sprayer, we want to mix smaller amounts. The same formula used for band applications applies here. To determine the amount of herbicide to mix in each gallon, simply divide as shown below to get your answer in ounces of herbicide per gallon of spray solution.

$$\frac{\text{Ounces of herbicide recommended per acre}}{\text{Gallons of mix applied per acre}} = \frac{\text{ounces}}{\text{gallons}}$$

For our example, we will use a typical invasive shrub treatment, which calls for an application of 3 quarts of a glyphosate herbicide (e.g., Accord XRT II) and 1 quart of a 4-pounds-per-gallon triclopyr amine herbicide (e.g., Vastlan) per acre. To calculate ounces of herbicide per gallon of spray solution, convert quarts to ounces and then divide the rate of herbicide applied per acre in ounces by the total gallons applied per acre from the calibration exercise. (Important note: Be sure to check the labels on the products you are applying to see if a surfactant is necessary to be added. Accord XRT II is a surfactant-loaded herbicide.)

First, convert quarts to ounces:

128 ounces per gallon

4 quarts per gallon

$128 \div 4 = 32$ ounces per quart

32 ounces per quart \times 3 quarts = 96 ounces of glyphosate

32 ounces per quart \times 1 quart = 32 ounces of triclopyr amine

Next, calculate the ounces of herbicide per gallon of spray solution:

For the glyphosate herbicide:

96 ounces \div 35 gallons = 2.7 ounces, or 3 ounces per gallon



When using the subtraction method, mark the starting water level in your sprayer, treat the calibration area, and determine by subtraction the volume sprayed as you refill the sprayer to the starting point. Photo: Kimberly Bohn

For the triclopyr amine herbicide:

32 ounces \div 35 gallons = 0.91 ounce, or 1 ounce per gallon

To mix 4 gallons in a backpack sprayer, simply multiply the above numbers by 4:

3 ounces \times 4 gallons = 12 ounces of glyphosate herbicide

1 ounce \times 4 gallons = 4 ounces of triclopyr amine herbicide

If you have more than one person treating, each applicator will need to calibrate. Each applicator's idea of adequate coverage is different, thus requiring each applicator to calibrate and mix individually. When applicators are working together, it makes sense to have the group choose one target volume per acre and alter their spray practices so everyone is applying the same level of coverage and using the same mix solution.

Summary

Variation in treatments will always exist, but taking the time to calibrate the application will ensure you are using the dose of herbicide you need. Although calibration represents an "extra" step and time you feel you don't have, it is not. Applications cannot be made correctly without calibrating first. Applying the dose of herbicide needed to achieve control ensures (1) work actually gets done right the first time and personnel time is not spent on retreatment, and (2) material is not wasted, or even worse, unintended injury to nontarget plants does not occur. Additionally, applicators who master calibration gain a valuable skill and take control of the process rather than simply mimicking instruction that may be incorrect.

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