MISSISSIPPI STATE UNIVERSITY EXTENSION

Forest Herbicides: Calibrating Backpack Sprayers

Figure 1. Equipment to be used in applications must be the same as that used in calibration. Identical backpack sprayer models using the same tank pressure may have completely different spray output if different spray nozzles are used. Each of these spray tips and strainers result in different spray output when all other factors are constant.

Two of the most common herbicide questions are, "What herbicide do I use to kill it?" and "How much herbicide do I put in my spray tank?" The first question is usually not that difficult to answer using information that is readily available for herbicidal control of most plant species. However, the second question can lead to frustration between those asking the question and those attempting to provide the answer. The amount of herbicide to include in a spray mixture is not hard to determine but does depend on factors that vary among individual applicators as well as their equipment. For example, applicators may have different walking speeds and equipment as well as different ideas of what constitutes "good coverage."

The proper amount of herbicide to put in a tank depends on variables including speed of application, spray swath width (both aboveground and at contact with vegetation), amount of spray volume needed to achieve proper coverage of vegetation (thicker vegetation requires more spray for good coverage), tank pressure, the type and number of

spray tips used, as well as several other variables (Figure 1). This calculation is not magic but does require calibration (determining sprayer output so that a known amount of spray solution is applied). Remember, if any variable changes, the amount of spray per unit of area changes, and the sprayer should be recalibrated.

This publication discusses proper backpack sprayer calibration methods to determine how much herbicide to add into a tank for banded and spot applications. Applicators must achieve proper calibration in order to apply the correct amount of herbicide per unit of area (e.g., pounds, ounces, pints, quarts per acre). Failure to calibrate sprayers often results in misapplication, having to reapply later, non-target plant damage, and increased costs. In addition, "off-label" herbicide rates are possible and carry legal risk in some cases.

Backpack sprayer calibration can be simplified by using the "ounces to gallons" method. This method converts the amount of applied spray (measured in ounces) to gallons per acre. It uses a calibration application area of 1/128 of an acre, or 340 square feet. For demonstration, 1 gallon equals 128 ounces, and an acre covers 43,560 square feet:

$$43{,}560\ ft^2 \div 128\ oz/gal = 340\ ft^2$$

Treating 1/128 of an acre allows for easy conversion of ounces of water sprayed to gallons sprayed per acre (GPA). Applying 20 ounces on 340 square feet provides the same spray volume as applying 20 gallons per acre. Once spray volume in GPA is determined, you can calculate the amount of herbicide to mix per gallon of spray solution.

Figure 2. Backpack sprayers are often used to apply banded treatments to control herbaceous vegetation in hardwood planting efforts.

Banded Applications

Banded applications are fixed-width, fixed-speed applications where vegetation is treated over a continuous distance. In forestry, banded treatments are commonly used for applying herbaceous weed control (HWC) over rows of tree seedlings, to vegetation along fence lines, and in scenarios where control is needed for problematic plant species such as Japanese stiltgrass, Johnsongrass, or various vines (Figure 2). It is incredibly important that applicators understand that banded applications are specific to individuals, their equipment, and a fixed constant speed.

Steps to calibrating for banded applications:

1. Measure out a calibration area equal to 340 square feet.
2. Spray and record the length of time it takes to treat the calibration area.
3. Measure the ounces needed to treat the calibration area.
4. Calculate the amount of herbicide needed per gallon.

Step 1. Measure out a calibration area equal to 340 square feet.

The first part of setting up a calibration area is determining spray pattern width. This width will be the width of the "band" in herbicide applications. To determine the correct length of the calibration area, divide 340 by the band width (in feet). For example, if the spray pattern is 4 feet wide, then length of the calibration area will be 85 feet (340 ft^2 ÷ 4 ft = 85 ft). Remember, different nozzles or nozzle tips provide different spray patterns and volumes, so they should not be changed unless the applicator is ready to recalibrate the sprayer.

Example

Band width

4 ft

Calibration area

340 ft^2

Length of calibration area

340 ft^2 ÷ 4 ft = 85 ft

A cautionary note: Moving the spray wand back and forth will increase band width and provide greater coverage. While this is tempting for applicators, without extreme caution, outer regions of the spray band receive lower herbicide concentrations, while the inner regions receive overlap. For calibration purposes, applicators should take care to avoid undue overlap while maintaining continuous coverage within the calibration area.

Step 2: Spray and record the length of time it takes to treat the calibration area.

The next step in the calibration process is to spray the calibration area using a backpack sprayer filled with water only. For the most consistent results, apply while walking at a comfortable, repeatable speed that you can maintain for extended periods. Operate the backpack in the same manner as expected in field operation. Adjust nozzles to the same setting or use identical tips. Hold the wand at a consistent and comfortable height (based on expected vegetation height), and maintain pressure at normal operating level. While spraying in this fashion, cover the distance of the application area several times. Record each time to obtain a reliable average.

Example (cont.)
Band width =
4 ft
Length of calibration area =
85 ft
Average time to spray 85 feet =
40 sec

Step 3: Measure the ounces needed to treat the calibration area.

Once you know the amount of time needed to treat the calibration area, you can calculate the amount of spray applied during that time. Hold a measuring vessel under the spray nozzle and collect spray solution for the amount of time that it takes to spray the calibration area. This quantity (in ounces) will equal the GPA of the application. If it takes 15 seconds to spray the calibration area, you should collect spray from the backpack sprayer for 15 seconds before measuring.

Be sure to maintain pump pressure consistent with what you used while spraying the test application. If pressure differs between steps, flow rate will vary, and calibration accuracy will suffer. Repeat this step several times to calculate a reliable average output rate.

An alternative to averaging outputs is to collect spray for multiple time periods. For example, using the measurements above, if collection time is 15 seconds, spray solution could be collected for 60 seconds. Then divide 60 seconds by 4 to calculate average ounces collected in a 15-second period.

Example (cont.)
Average time to spray calibration area =
40 sec
11 ounces were collected in 40 seconds
Spray rate =
11 GPA

Step 4: Calculate the amount of herbicide needed per gallon.

After determining the applicator's spray rate, the next task is to calculate the amount of herbicide to add per gallon. This is often easier for larger spray tanks than backpack sprayers. Backpack sprayers are more volume-limited, so herbicide must be added in smaller quantities. If a treatment prescription specifies applying 10 ounces of a given herbicide per acre and the applicator sprays at 15 GPA, then you will add 10 ounces of herbicide for every 15 gallons of total spray solution.

The first step in this process is to determine how much herbicide to add per gallon of solution. Simply divide ounces of herbicide recommended (found on the product's label) by the GPA rate.

The following example uses the standard 2 ounces per acre of sulfometuron methyl (e.g., Oust XP) commonly used for HWC in hardwood plantings. To calculate ounces of herbicide to add per gallon of spray, divide the recommended per acre rate of herbicide (ounces) by the calculated GPA.

Example (cont.)
2 ounces per acre of sulfometuron methyl
Spray rate
11 GPA
Amount of herbicide to add per gallon of spray solution
2 oz/ac ÷ 11GPA =
0.18 ounce sulfometuron methyl per gallon
For a 3-gallon capacity backpack sprayer, multiply the number above by 3
0.18 oz × 3 gal =
0.54 oz sulfometuron methyl

At this point, you are ready to measure the amount of herbicide needed, add it to the spray tank, and begin an application. Often, a very low weight or volume of herbicide is needed; a graduated cylinder or scale gives accurate herbicide measurements.

Figure 3. Spot applications control unwanted species like eastern baccharis while leaving nearby desirable vegetation unharmed.

In the example above, to measure 0.54 ounce of Oust XP, you would need a small kitchen-type scale capable of weighing 0.01-ounce units. Remember, the same speed of application, tank pressure, band width, and spraying equipment used in calibration must be maintained to ensure correct herbicide application rates.

Spot Application

Probably the most common use of a backpack sprayer is in "spot" applications to control unwanted vegetation that is not continuous across the entire site. Spot spraying is used to treat individual plants or patches of undesirable plants. One of the most common uses of this application type is by commercial spray crews on rights-of-way. While labor costs are usually higher than with broadcast applications, spot applications do lower the total amount of herbicide applied. This reduces the herbicide footprint and works well when total vegetation control is not required. Spot applications can be used to control almost any undesirable species (Figure 3). However, applicators should calibrate for these treatments so that applications are effective without over- or underapplying herbicides.

As with any form of sprayed treatment, to achieve proper calibration for spot applications, you must know how much area you are treating in a given amount of time. With spot treatments, the treated acreage is the total area of plants targeted in an area. This is important because some vegetation coverage can be highly variable from site to site. Remember, recommended herbicide rates are provided in ounces, or quarts applied per treated acre. In the case of spot applications, you aren't treating all vegetation on a site. Instead, you will sum the smaller areas as you spray targeted vegetation across the site. This summed area (treated acre) is used in calibration calculations.

With a couple of important differences, calibration for spot application is similar to that of banded applications:

1. Measure calibration area equal to 340 square feet that has vegetation like final treatment area.
2. Spray vegetation in the calibration area.
3. Determine the ounces applied in the calibration area.
4. Calculate the amount of herbicide needed per gallon.

Step 1: Measure calibration area equal to 340 square feet with vegetation like final treatment area.

Measure a 340 square-foot calibration area with vegetation similar to what will be targeted in the actual spot treatments. For example, if the goal is treating invasive shrubs like eastern baccharis, find an area with shrubs of similar height, branching pattern, and leaf texture. In fact, the actual application site is the best place to calibrate the equipment.

This is an important consideration. Calibration on an area with dissimilar vegetation will likely result in too much or too little herbicide used in actual applications. For example, if on-site vegetation is 7 feet tall (as high as most individuals can comfortably spray), the length of the calibration area will be 48.6 feet (340 ft^2 ÷ 7 ft = 48.6 ft).

Step 2: Spray vegetation in the calibration area.

Calculate gallons per treated acre by spraying all vegetation in the calibration area using the same technique and equipment that will be used in actual applications. Use a comfortable application speed, and maintain consistent coverage of the targeted vegetation (dye may be helpful). Once coverage is consistent, treat all vegetation in the calibration area to the same level of coverage that will be used in actual applications.

Unlike calibration in banded applications, spot treatment does not rely simply on the amount of time required to spray an area. Instead, applicators must determine the total amount of spray volume applied across the calibration area. Be sure you know the starting level of water in the backpack sprayer so you can determine the final volume after the calibration area is treated. Simply draw a line with a marker at the starting level on the tank (Figure 4).

Step 3: Determine the ounces applied in the calibration area.

After spraying the calibration area, determine how many ounces of water were used. Most backpack sprayers have premeasured volume markers (e.g., gallon, half gallon, quart, ounce) on the body of the sprayer tank. However, these markers are not always accurate, nor do they offer the level of precision needed for exact calibration. To ensure proper calibration, use a measuring cup, graduated cylinder, or some other measuring vessel. Fill the vessel to a known volume, and use it to refill the backpack sprayer to the original water level. Afterward, calculate the amount used by subtracting the measuring cup's remaining volume from the amount it held initially. This is the amount of water sprayed in the calibration area.

Example

Initial measuring cup volume
40 oz
Final measuring cup volume after refilling backpack sprayer
5 oz
Spray rate per treated acre
(40 oz - 5 oz) = 35 oz =
35 gal / treated ac

Differences in vegetation as well as visually estimating spray coverage limit the accuracy of spot treatment calibration. However, this process provides a reasonable estimate of an applicator's spray volume and allows for more precise mixing than guessing an applicable percent solution of herbicide.

Step 4: Calculate the amount of herbicide needed per gallon.

After calculating gallons per treated acre, the next step is to determine the quantity of herbicide to add per gallon of spray mix. The same formula used for banded applications is used to determine this amount. To calculate the amount of herbicide to mix in each gallon of spray mixture, divide the recommended per acre rate of herbicide (ounces) by the calculated GPA.

Figure 4. Knowing the starting level in a backpack is very important for proper calibration in spot applications. Use a marker or grease pencil to mark the starting level.

The following example uses an invasive shrub treatment of 3 quarts of a glyphosate product (e.g., Accord XRT II) and 1 quart of a triclopyr herbicide (Garlon 3A) per acre. To calculate ounces of herbicide to add per gallon of spray solution, convert quarts to ounces, and then divide the recommended rate of herbicide (ounces) by the calculated GPA.

It is important to remember that calibration is specific to both individual applicator and their spray equipment. Applicators often have a different estimation of what constitutes adequate spray coverage, requiring individual calibration and mixing of herbicides. If several applicators are spraying together, consider altering individual spraying techniques so that all apply the same spray rate. However, this takes practice. Take care not to misapply herbicides.

Summary

Variation between applicator spraying technique and equipment will always exist. Even an individual applicator's spray coverage and rate will vary depending on several factors. For this reason, it is important to take the time to calibrate before applying herbicides. Calibration is an extra step, but it prevents herbicide misapplication. Applying the correct amount of herbicide saves time and money and minimizes the risk of unintended damage to nontarget plants.

Example

Convert quarts to ounces

1 gal = 128 oz
1 gal = 4 qt =
128 oz / gal ÷ 4 qt / gal =
32 oz / qt

Determine the number of ounces of each herbicide needed per sprayed acre

32 oz / qt × 3 qt =
96 oz of glyphosate =
32 oz / qt × 1 qt =
32 oz of triclopyr

Calculate the ounces of herbicide needed per gallon of spray solution

35 GPA spray rate
Suggested rate: 96 ounces of glyphosate and 32 ounces of triclopyr per sprayed acre

Glyphosate:
96 oz of glyphosate ÷ 35 GPA =
2.7 oz / gal of solution

Triclopyr:
32 ounces of triclopyr ÷ 35 GPA =
0.91 oz / gal of solution

For a 3-gallon capacity backpack sprayer, multiply the number above by 3

2.7 oz × 3 gal = 8.1 or 8 oz of glyphosate =
0.91 oz × 3 gal = 2.73 or 3 oz of triclopyr

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Publication 3821 (POD-12-25)

Adapted for use in Mississippi by **Brady Self**, PhD, Extension Professor, Forestry, from *Backpack Sprayer Calibration for Woodland Application*, Penn State Extension Forest Science Fact Sheet EE0184.

Produced by Agricultural Communications.

Extension Service of Mississippi State University, cooperating with U.S. Department of Agriculture. Published in furtherance of Acts of Congress, May 8 and June 30, 1914. ANGUS L. CATCHOT JR., Director

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