Calibrating a Knapsack Sprayer for Reforestation and Christmas Tree Weed Control

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Knapsack sprayers are used for many types of spraying jobs, including insect and disease control, as well as weed control. This publication deals with weed control for two specific forestry situations, reforestation and Christmas tree production. It may be possible to adapt the calibration method for other weed control purposes.

Careful calibration of the sprayer allows the operator to use a low volume of spray—fewer gallons of water to carry and pump. Many operators get by with 20 gallons of spray per acre, or even less. The alternative is a much heavier application, using a further diluted solution of as much as 100 gallons per acre. A 20-gallon-per-acre rate is adequate for most forestry situations, and as little as 10 gallons will be enough for some situations. Aerial applications, for example, are commonly applied at a 10-gallon rate, and careful ground application should work better. The amount of water applied has no effect on the weed control so long as enough is used to allow uniform coverage.

In calibrating the sprayer, work with assumption of total coverage over 1 acre. In scattered reforestation plantings, you may treat several acres with 1 acre of spray, due to intermittent or spot treatment.

The basis for uniform application of weed control sprays is constant pressure, constant speed, and the proper nozzle or nozzles. Knapsack sprayers can meet these requirements for most chemicals used for weed control in forestry. The key to uniform application with a knapsack sprayer is to walk at uniform speed, keep...
Single nozzles are useful in Christmas tree plantings and for taller trees that cannot be straddled by the two-nozzle boom at the recommended height.

Two-nozzle booms are ideal for spraying over small trees, up to about 2 feet, so boom can be held at recommended height above ground level.

the nozzle at the proper height, and have uniform pressure.

Several knapsack sprayers on the market are adequate. Some come equipped with a pressure gauge or a pressure relief valve. A pressure gauge can be added to any other sprayer. A two nozzle boom is optional equipment with at least one knapsack sprayer. On others you can make a boom using standard pipe and fittings or copper tubing. A good knapsack sprayer costs between $100 and $150 depending on optional equipment.

Knapsack sprayers can be used for small operations, but also can be used for certain jobs on larger operations. For instance, a 5 foot by 5 foot weed-controlled area around a seedling is adequate for reforestation, and requires only 25 percent of the chemical needed for complete coverage on a area 10 feet wide. Often, tractor type ground spray equipment can’t be used because of rough conditions, and when aerial spraying isn’t feasible a knapsack sprayer can be a logical alternative.

Nozzles

A fan-type nozzle is necessary for uniform application. Many nozzle arrangements can be adapted to Forestry weed control, but most often used are a single nozzle, or two nozzles on a boom. (See illustrations.) A single nozzle is best for spraying in plantings where tree branches would interfere with a boom. A single Tee Jet TK2 nozzle will cover a 5-foot width when held 18 to 20 inches above the ground. This single-nozzle system gives a low volume of spray.

The Tee Jet 8003 flat-spray nozzle will cover 2½ feet, or 5 feet total width when the nozzle is operated about 27 inches from the ground. This height is necessary to get this width. The band nozzle 8003E can be used as a single nozzle. The 2½- or 5-foot width is ideal for 5 foot by 5 foot Christmas tree plantings, the spacing commonly used. The two-nozzle boom is ideal for weed control on small trees—either for Christmas trees or reforestation. When the boom is centered over the tree, a nozzle is on each side of the tree, as illustrated.

Screens

To prevent nozzle clogging, use screens ahead of the nozzle. Generally, a 50-mesh screen is adequate, but for some nozzles with very small sized orifices a 100-mesh screen may be necessary. Wettable powder chemical formulations such as atrazine will tend to plug a 100-mesh screen. Screens are available with a check valve that prevents drip after the nozzle stops spraying. Careful cleaning after use is important for continued function of the check valve. The 50-mesh screen with the check valve is recommended for the knapsack sprayer used as described in this publication.

Pressure and Walking Speed

A pressure gauge or pressure regulator is necessary for this system as it will enable you to maintain constant pressure. About 20 to 30 pounds per square inch (psi) pressure is right for weed sprays. Walking speed is equally important, and is not easy to regulate, precisely, particularly when walking up and down hills or in rough terrain. Base calibration on a walking speed that is comfortable for you rather than try to walk at an unnatural pace to adjust yourself to a formula. With a little practice, a comfortable and quite uniform walking speed can be controlled to help insure a uniform application rate. You can have someone check your speed with a watch.
with a second hand to determine the feet traveled per minute.

Spray Tank Agitation

Some chemicals used in forestry weed control are suspended in water and not actually in solution. Examples are atrazine and pronamide (Kerb). Some, such as glyphosate (Roundup) and hexazinone (Velpar) actually go into solution. Most knapsack sprayers rely on movement from walking to keep suspended chemicals from settling out. You must shake up the sprayer before starting to spray and periodically while spraying to make sure the chemical stays in suspension.

Steps in Calibrations

Check nozzle capacity

a. Get the capacity in gallons per minute at the desired pressure from a chart.

b. Test the delivery from the nozzle. Spray for 1 minute and collect the spray.

\[
\text{Gal per min} = \frac{\text{Oz collected/min}}{128 \text{ oz/gal}}
\]

Compute the area covered, in square feet per minute.

a. Select a comfortable walking speed and figure how many feet per minute you walk. A convenient fast walk for some people is 2\(\frac{1}{2}\) miles per hour, but this may vary for you. One mile per hour equals 88 feet per minute. Easiest way to compute is to simply measure the distance you walk in 1 minute.

b. Figure out the width you wish to cover with the nozzle or nozzles you have selected.

\[
\text{Sq ft/min} = \text{Speed in ft/min} \times \text{swath width in ft}
\]

Compute the gallons per acre

The above information is used to compute the gallons of spray that will be applied per acre.

\[
\text{Gal/acre} = \frac{\text{Gal/min} \times 43,560 \text{ sq ft/acre}}{\text{Sq ft/min}}
\]

Chemical per gallon of water

Chemical recommendations are made in the amount of chemical to apply per acre sprayed. The following equation will enable you to figure the amount of chemical to use in a gallon of water.

\[
\text{Chemical per gal water} = \frac{\text{Recommended chem/acre}}{\text{Gal/acre applied}}
\]

The chemical per gallon can be multiplied times the capacity of the sprayer in gallons to get the chemical per knapsack sprayer tank.

Example

This is an actual example of the computations used to calibrate a sprayer using the Tee Jet 8003 Flat Tip nozzle.

Checking nozzle capacity

a. Twenty-five psi is a convenient pressure and the 8003 nozzle will deliver 0.24 gallons per minute at this pressure. The gallons per minute can be computed if a nozzle capacity chart isn't available. Collect the spray for one minute at 25 psi.

\[
\text{Gal/min} = \frac{31 \text{ oz/min}}{128 \text{ oz/gal}} = 0.24 \text{ gal/min}
\]

Area covered per minute

a. Walking speed of 220 ft. per minute was selected for this example as a walking speed. (This is 2.5 mph.) In this example, a spray width of 2.5 feet was selected. The example works for the two-nozzle boom because while the extra nozzle doubles the width it also doubles the volume of spray.

\[
\text{Sq ft/min} = 220 \text{ ft/min} \times 2.5 \text{ ft.} = 550
\]

Gallons of spray applied per acre

\[
\text{Gal/acre} = \frac{0.24 \text{ gal/min} \times 43,560 \text{ sq ft/acre}}{550 \text{ sq ft/min}} = 19
\]

Chemical needed per gallon of water

Chemical recommendations are made in the amount of chemical to apply per acre sprayed. It is easier to measure chemicals in liquid form so use liquid formulations when practical. Wettable powder should be weighed because of different weights of materials. For instance, atrazine 80 WP weighs 0.21 ounces per tablespoon (3.36 oz/cup) and Velpar (hexazinone); 60 Dry Flowable weighs 0.31 ounces per tablespoon (5.03 oz/cup).

The liquid (L) formulation of atrazine will be used in this example. This contains 4 pounds of active ingredient per gallon and is equivalent to 5 pounds of 80 percent wettable powder (80 WP).

\[
\text{Chem/gal} = \frac{16 \text{ cups atrazine 4 L (1 gal/acre)}}{19 \text{ gal/acre}} = 0.84 \text{ cups atrazine 4L/gal of water}
\]

The Tee Jet TK 2 nozzle can be calibrated using the same example. This TK 2 nozzle is adapted to a wide spray pattern for the 5-foot customary width of a Christmas tree planting. At the same 25 psi pressure and 2\(\frac{1}{2}\) mph speed this nozzle delivered 13 gallons per acre, but with less uniformity than the two-nozzle boom.
Testing Equipment and Recording Information

Test your equipment with water before starting to spray. The spray pattern of the nozzle or nozzles can be checked by spraying water on a dry surface, such as a road or garage floor. Check the per-acre delivery by spraying 1 measured gallon of water and computing area covered by multiplying distance traveled times width.

\[
\text{Gal/Acre} = \frac{\text{Sq ft covered with 1 gal. of water}}{43,560 \text{ sq ft/acre}}
\]

When everything checks out, add chemical and start spraying. Measure the area covered with the combination of chemicals and water. The chemicals may change the delivery enough so a minor adjustment may be necessary.

After the final check, record the information. You don’t need to recalibrate every time you use your sprayer, but occasional checks are advised after the original calibration.

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<tr>
<th>Conversion Tables for Liquid and Dry Measure</th>
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<tr>
<td>Milliliter or c.c.</td>
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<td>Teaspoon</td>
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<tr>
<td>Tablespoon</td>
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<td>Ounce (fluid)</td>
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<td>Cup</td>
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<td>Liter</td>
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|                  | Oz | Gram |
| Dry measure      |    |      |
| Gram             | .035| 1    |
| Ounce            | 1  | 28   |
| Pound            | 16 | 454  |
| Kilogram         | 35 | 1000 |