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## Backpack and Hand-Held Sprayer Calibration

Backpack and hand-held sprayers consist of a tank to hold the spray mix, a pump to provide pressure, and a spray wand with one or more nozzles to deliver the spray solution in the desired spray pattern. Most backpack sprayers hold 4-6 gallons of spray mix, and hand-held sprayers usually hold 1-3 gallons. The small size, transportability, and ease of use make the sprayer a versatile tool. Backpack and hand-held sprayers are good for small acreages, spot spraying, and hard to reach locations.

Proper application of pesticides is only possible with an accurately calibrated sprayer. Calibration is the process of measuring and adjusting output of application equipment in order to apply the correct amount of active ingredient per unit area. Failure to care for and correctly calibrate spray equipment can result in misapplication of pesticides, repeat applications, damaged plants, excess cost, and environmental contamination.



Photo courtesy of Michael Goatley, Jr., Ph.D.

### Pre-Calibration Checklist

Proper maintenance and preparation of spray equipment will minimize application mistakes and prolong the life of your sprayer. Follow the guidelines below before making a pesticide application.

- Fill the sprayer tank  $\frac{1}{2}$  full of clean water. Use only clean water. Do not add pesticides until the sprayer has been checked for leaks, is in good operating condition, and has been calibrated.
- Inspect the sprayer to be sure all components are in good working order and are undamaged. Pay special attention to the pump, spray wand, strainers, and hoses.
- Check that there are no obstructions or leaks in the sprayer. Fix any leaks before calibration or making a pesticide application. If the sprayer has a pressure gauge, check it for accuracy. If the sprayer has a pressure regulator, follow manufacturer recommendations for periodic cleaning and inspection.
- Be sure your spray tips are the correct type and size for the spray application you want to make. The spray tip is perhaps the most important, yet most neglected, component of the sprayer. It is critical to use the appropriate nozzle tip for the intended pest target and turfgrass conditions. The spray tip determines the spray pattern and droplet size. For single nozzle band applications, it is recommended to use even-flat-fan or flood-jet types. For spot applications, hollow or solid-cone nozzles, even-flat-fan, or flood-jet types will work well.
- Remove, clean, and replace (if necessary) the screen behind the spray tip. Clean the spray tip and screen in soapy water with a soft brush. Remove any deposits from the nozzle opening with a toothpick or compressed air. Never use a knife or metallic object to clean tips as it will ruin them. Never try to unclog a tip by blowing through it with your mouth.

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- With the spray tip removed, and in a place away from wells and water supplies, pressurize the sprayer and flush the system with plenty of water to remove any particles or debris.
- Reassemble the nozzle and pressurize the sprayer to check the tip for a uniform spray pattern. This can be done by spraying water on a paved or bare surface and watching for streaks as the spray dries. Wet streaks that occur directly under the nozzle may result from damaged or worn spray tips, low operating pressure, or holding the wand too close to the ground. Clogged tips may produce streaks anywhere in the spray pattern of the affected nozzle. If a spray tip has an improper spray pattern, replace it with a new tip that is the same style and output volume.
- Consistency with this calibration technique is dependent on how evenly the operator can spray an 18.5 feet by 18.5 feet area. This can be performed on a concrete or asphalt driveway/parking lot to observe how evenly the surface dries. The angle of a nozzle's spray pattern and the height at which it is held from the ground determine the width of the spray pattern. Try different spray heights and observe the drying rate. A uniform drying rate indicates uniform coverage. Nozzle height can be adjusted to control excess streaking. Once your application techniques are consistent, then you can begin calibrating your backpack or hand-held sprayer.
- Constant pressure must be maintained for consistent application rates. High pressure equals more product being applied per unit area as well as higher drift potential, while lower pressure equals less product per unit area. Few hand-held and backpack sprayers contain pressure regulators. Pressure fluctuations can be prevented by



Photo courtesy of Michael Goatley, Jr., Ph.D.

installation of a pressure gauge or spray management valve (SMV) or constant flow valve (CFV) on the spray handle or boom. Spray rates and patterns will be more consistent, drift potential can be reduced, and calibration is easier. If a pressure regulator is not an option, fairly even pressure can be maintained if the hand pump is operated by a constant number of pumps per minute. It is not necessary to know the exact pressure output to calibrate a sprayer, but the pressure must be kept constant throughout calibration and application. Keep in mind that each operator will have a different walking speed and will regulate pressure differently. Therefore, it is important to calibrate a sprayer for each operator.

### Calibration Process

The amount of spray applied to an area will depend on walking speed, pressure, spray swath width, and the spray tip selected. If you change any one of these, the amount of spray applied changes and the sprayer must be calibrated from the beginning.

There are several different ways to accurately calibrate a sprayer. The process being outlined in this bulletin is based on the 128th Acre Calibration Method. The spray collected from a single nozzle measured in fluid ounces directly converts to gallons per acre regardless of the number of nozzles. Because there are 128 fluid ounces in a gallon, the fluid ounces collected from 1/128th of an acre will equal gallons of solution per acre.

# Backpack and Hand-Held Sprayer Calibration

## Remember:

1 acre = 43,560 square feet  
1/128th of an acre = 340.31 square feet  
1/128th of an acre = 18.5 feet by 18.5 feet  
1 gallon = 128 fluid ounces

A worksheet has been provided at the end of the document to help you move through each step and calculation to successfully calibrate your sprayer.

Collect materials needed to calibrate the sprayer:

- Sprayer
- Correct spray tips (if using more than one, the tips are identical)
- Measuring tape
- Water
- Flags or turf paint
- Measuring container (measurement in fluid ounces)
- Stopwatch

## Step 1: Determine application pressure and timing.

Mark off an area 18.5 feet by 18.5 feet. Turf paint or flags can be used to establish boundaries.

Fill the sprayer tank  $\frac{1}{2}$  full of clean water. Use only clean water during calibration. Never add pesticides to a sprayer until it is properly calibrated and ready for use. Pump to the normal operating pressure to simulate the average spray situation.

Walk at a comfortable, steady speed while spraying to achieve uniform coverage. Maintain consistent pressure while spraying. Measure the time in seconds it takes to uniformly spray the 18.5 feet by 18.5 feet area. Record the time.

### Example:

It took 46 seconds to spray the 18.5 feet by 18.5 feet area.



Photo courtesy of Michael Goatley, Jr., Ph.D.

## Step 2: Measure nozzle output.

Nozzle flow rate is the amount of liquid sprayed from the nozzle in a given amount of time. Operate the sprayer with water in the tank at the desired pressure. Using a stopwatch and measuring cup marked in fluid ounces, collect water from the nozzle for the time (in seconds) it took to spray the predetermined area. Record the amount collected. Repeat this process 2-3 times to get the average nozzle output.

# Backpack and Hand-Held Sprayer Calibration

Note: Application rates can be highly variable with backpack or hand-held sprayers. Simple adjustments can be made to ensure a consistent application rate. To increase application rates, the operator can increase pressure and to decrease application rates, the operator can decrease pressure.

## Example:

The first amount collected after 46 seconds is 44 fluid ounces.  
The second amount collected after 46 seconds is 45 fluid ounces.

The third amount collected after 46 seconds is 44 fluid ounces.  
The average output of the nozzle is 44 fluid ounces.



Photo courtesy of Michael Goatley, Jr., Ph.D.

**The sprayer is now correctly calibrated. The average amount of water collected in fluid ounces equals the gallons applied per acre (GPA).**

## Example:

44 fluid ounces is the average nozzle output. Therefore, the sprayer is calibrated to deliver 44 gallons per acre.

## Remember:

The concept of the 128th method is based on the time it takes to spray 128th of an acre with a single nozzle. That time requirement is then used to collect fluid ounces from a single nozzle. Since there are 128 fluid ounces in a gallon, the simple conversion or result is in gallons per acre (GPA).

## Multiple Nozzles

If there is more than one nozzle being used, check the uniformity of all nozzles on the boom. Collect the water sprayed from each nozzle individually for the time (in seconds) it took to spray the predetermined area. After catching the spray from each nozzle individually, add the amounts collected and divide by the number of nozzles to get the average output per nozzle. If the flow rate of any spray tip is 7% greater or less than the average nozzle output, clean or replace the nozzle tip. If any of the nozzles need to be cleaned or replaced, recheck the output from all nozzles and recalculate the average.



Photo courtesy of Michael Goatley, Jr., Ph.D.

## Backpack and Hand-Held Sprayer Calibration

### Example:

Nozzle Test

Output collected from each nozzle after 46 seconds:

Nozzle 1 – 44 fluid ounces

Nozzle 2 – 45 fluid ounces

Nozzle 3 – 44 fluid ounces

Total output from all nozzles: 133 fluid ounces

Determine average output for each nozzle:

$$\frac{133 \text{ fluid ounces}}{3 \text{ nozzles}} = 44.3 \text{ or } 44 \text{ fluid ounces average nozzle output}$$

### Remember:

$$\frac{\text{Sum of total fluid ounces}}{\text{Number of nozzles}} = \text{average nozzle output in fluid ounces}$$

Check that all nozzles are within 7 percent of the average nozzle output.

$$0.07 \times 44 \text{ fluid ounces} = 3.08$$

The acceptable range for nozzle output is between 40.9 to 47.1 fluid ounces. All of the nozzles in the example fall within the acceptable range. If they do not, clean or replace the spray tips and repeat this step.

**The sprayer is now correctly calibrated. The average amount of water collected in fluid ounces equals the gallons applied per acre (GPA).**

### Example:

44 fluid ounces was the average nozzle output. Therefore, the sprayer is calibrated to deliver 44 gallons per acre.

# Backpack and Hand-Held Sprayer Calibration

## Tips for Product Application







Correct and accurate application of any pesticide product to a turfgrass area is essential to prevent damage to the turfgrass and prevent pollution of water sources. Use the following tips for accurate and safe applications with your sprayer:

- Read all product labels to ensure safe handling, proper application, and correct use rates. In addition, be sure to comply with all state and federal environmental regulations.
- Make sure the sprayer is in good operating condition. Review the Pre-Calibration Checklist before each pesticide application.
- Calibrate the sprayer every fourth application (if using the same applicator) or every application (if a new applicator) to ensure the sprayer and nozzles are still delivering the correct volume of product.
- Always stay a safe distance from water sources to prevent any possible pollution.
- Don't apply pesticides on windy days (less than 7 mph or less than 5 mph near sensitive crops).
- Maintain a consistent walking speed and pressure during calibration and match it during application to deliver an accurate amount of product.
- Use different sprayers for insecticide and herbicide applications.
- Be sure to clean the sprayer thoroughly after applying pesticide products to prevent build up and corrosion on sprayer parts.

# Backpack and Hand-Held Sprayer Calibration Worksheet

Color-coded squares are meant to help in entering repeated numbers.

## Key for color codes:

-  : amount of time in seconds it takes to spray the 18.5 feet by 18.5 feet area
-  : sum of fluid ounces collected from the nozzle
-  : average nozzle output measured in fluid ounces
-  : number used to determine acceptable range for nozzle output
-  : minimum number of fluid ounces that is acceptable from each nozzle
-  : maximum number of fluid ounces that is acceptable from each nozzle

## Remember:

1 acre = 43,560 square feet  
1/128th of an acre = 340.31 square feet  
1/128th of an acre = 18.5 feet by 18.5 feet  
1 gallon = 128 fluid ounces

## Step 1: Determine application pressure and timing.

Mark off an area 18.5 feet by 18.5 feet. Turf paint or flags can be used to establish boundaries. Measure the time in seconds it takes to uniformly spray the 18.5 feet by 18.5 feet area. Remember to walk at a comfortable, steady speed and maintain consistent pressure while spraying.

Total:  seconds to spray the 18.5 feet by 18.5 feet area.

## Step 2: Measure nozzle output.

Operate the sprayer with water in the tank at the desired pressure. Using a stopwatch and measuring cup marked in fluid ounces, collect water from the nozzle for the time (in seconds) it took to spray the predetermined area.

Collect water output for  seconds.

Amount collected:

- 1) \_\_\_\_\_ fluid ounces
- 2) \_\_\_\_\_ fluid ounces
- 3) \_\_\_\_\_ fluid ounces

# Backpack and Hand-Held Sprayer Calibration Worksheet

Total output from the nozzle (sum of the 3 collections):        fluid ounces

Determine average output:

$$\frac{\text{red fluid ounces}}{3} = \text{grey fluid ounces for average nozzle output}$$

Average nozzle output:        fluid ounces is equal to        GPA

The sprayer is calibrated to deliver        gallons per acre.

## Multiple Nozzles

If there are multiple nozzles, check that all nozzles are within 7 percent of the average nozzle output by determining the range.

$$0.07 \times \text{grey fluid ounces} = \text{yellow (range)}$$

**Minimum acceptable fluid ounces that can be collected from each nozzle:**

$$\text{grey fluid ounces} - \text{yellow} = \text{blue fluid ounces}$$

**Maximum acceptable fluid ounces that can be collected from each nozzle:**

$$\text{grey fluid ounces} + \text{yellow} = \text{purple fluid ounces}$$

The acceptable range for individual nozzle output is between        fluid ounces to        fluid ounces.

If a nozzle does not fall within the acceptable range, clean or replace the nozzle and repeat this step. Once nozzle output falls within the acceptable range, the sprayer is calibrated.

Remember, the concept of the 128th method is based on the time it takes to spray 128th of an acre with a single nozzle. That time requirement is then used to collect fluid ounces from a single nozzle. Since there are 128 fluid ounces in a gallon, the simple conversion or result is in gallons per acre (GPA).

Average nozzle output:        fluid ounces is equal to        GPA

The sprayer is calibrated to deliver        gallons per acre.

### References:

STMA Information Outreach Committee

University of Missouri – Calibrating Pump-up Can or Solo-type Backpack Sprayers

Oregon State – Calibrating and Using Backpack Sprayers - [http://extension.oregonstate.edu/linn/sites/default/files/pnw\\_320\\_calibrating\\_and\\_using\\_backpack\\_sprayers.pdf](http://extension.oregonstate.edu/linn/sites/default/files/pnw_320_calibrating_and_using_backpack_sprayers.pdf)

Virginia Tech – Calibrating Hand-held and Backpack Sprayers for Applying Pesticides - <http://pubs.ext.vt.edu/456/456-502/456-502.html>

North Carolina State University – Calibrating a Backpack Sprayer - [https://www.bae.ncsu.edu/topic/agmachine/turf/pubs/ag-576-callibrating\\_backpack\\_sprayer.pdf](https://www.bae.ncsu.edu/topic/agmachine/turf/pubs/ag-576-callibrating_backpack_sprayer.pdf)