

Calibrating Ground Sprayers Using Shortcut Methods

by Cecil Tharp, Pesticide Education Specialist, MSU Department of Animal and Range Sciences

Applicators often find calibrating ground sprayers challenging. Short cut methods to calibration were developed to remedy this situation. This publication was created as an aid to understanding the variety of short cut methods that are available for ground spraying equipment



MontGuide

MT200915AG Revised 12/16

PESTICIDE APPLICATION EQUIPMENT SHOULD

be calibrated every field season. Short cut calibration methods were developed to minimize the math required for calibration. These simple to use methods are specific to the spray equipment they may be used on. This guide has gathered many short cut methods into one short publication to minimize confusion. Simply select the ground application equipment to be calibrated and follow the instructions.

Prior to the calibration of any pesticide application equipment, applicators should follow a pre-calibration checklist. This includes knowing the field speed, selecting spray pressure, and selecting appropriate nozzles for the application. Field speed is often preset between safety and maximizing ground covered, while spray pressures are often recommended on the pesticide product labels. For more information on determining field speed or selecting spray pressure refer to MSU Extension MontGuide *Calibrating Pesticide Application Equipment* (MT200914AG). A stopwatch, measuring tape, flags, measuring container, pencil and paper are required for calibration.



Pre-Calibration Using the 5940 Method

Though the 5940 method contains some math, it aids applicators in refining their field speed and selecting appropriate nozzles prior to actual field calibration. The 5940 method takes advantage of many factors which often are already known by the applicator. This method should serve as a guide only, with a follow-up field calibration to assess any equipment inconsistencies.

1. Selecting appropriate nozzles (GPA, speed and nozzle spacing known). One of the most critical steps to the calibration process is the selection of appropriate nozzles. If the field speed, GPA, and nozzle spacing are known, nozzle flow rate (gallons per minute) can be determined with the 5940 equation. An applicator may purchase the appropriate nozzles once nozzle flow rate is known.

$$\frac{\text{GPA} \times \text{MPH} \times \text{W}}{5940} = \text{GALLONS PER MINUTE} \text{ (flow rate of nozzles)}$$

Example: The product label recommends an output of 20 GPA, the width of the nozzles on the spray boom is 18 inches and your field speed is 4 MPH:

$$(20 \times 4 \times 18) \div 5,940 = 1,440 \div 5,940 \\ = \mathbf{0.24 \text{ Gallons per minute Flow rate}}$$

5940 Abbreviations

MPH = constant

GPA = Gallons per acre*

MPH = Field speed in miles per hour

GPM = Gallons per minute (nozzle flow rate)

W = Width between nozzles in inches, or width of a broadjet swath in inches.

**Keep in mind that recommended GPA is often given on the product label while nozzle spacing is often preset. Simply measure in inches your nozzle spacing or spray swath width. Nozzle flow rate can be obtained by simply collecting liquid from one nozzle for one minute (all nozzles should be assessed for uniformity on spray booms).*

2. Assessing ideal field speed to obtain a given GPA (GPA, nozzle flow rate and nozzle spacing known). It may be necessary to know the ideal field speed when the output of the sprayer (GPA), nozzle flow rate, and nozzle spacing is known. Field speed may be adjusted to fine-tune the output of the sprayer. Remember, ideal GPA is given on the product label and a sprayer may often have nozzles installed at a given spacing.

$$\frac{\text{GPM} \times 5940}{\text{GPA} \times \text{W}} = \text{FIELD SPEED} \quad (\text{miles per hour})$$

Example: The product label recommends an output of 10 GPA, the width of the nozzles on the spray boom is 24 inches and the nozzle flow rate is 0.2 gallons per minute:

$$(0.2 \times 5,940) \div (10 \times 24) = 1,188 \div 240 = 4.95 \text{ miles per hour Field Speed}$$

3. Assessing the spray output of your boom when speed, nozzle spacing, nozzle flow rate and width between nozzles are known. It may be beneficial to know the sprayer output prior to changing the spray equipment set up. It may not be necessary to adjust anything from the current configuration.

$$\frac{\text{GPM} \times 5940}{\text{MPH} \times \text{W}} = \text{GPA} \quad (\text{gallons per acre})$$

Example: A boom has a nozzle spacing of 18 inches, nozzle flow rate of .2 gallons per minute, and a field spray speed of 4 MPH:

$$(0.2 \times 5940) \div (4 \times 18) = 1,188 \div 72 = 16.5 \text{ GPA}$$

Always double check the actual sprayer output (GPA) in the field after using the 5940 equations. The 5940 equations do not guarantee a given GPA in the field due to inconsistencies such as non-uniformity of nozzles or equipment failure. This is simply a tool to get closer to the ideal spray output.

Short Cut Method for Calibrating Output

Boom Sprayers

Testing Uniformity of Nozzles Accurate calibration of boom sprayers is a combination of assessing uniform nozzle flow, determining sprayer output rate, and tank mixing. Checking all nozzles on spray booms for uniformity is always the first step.

Nozzles may be worn or damaged, preventing uniform spray coverage. All nozzles across a boom must be applying the same amount of liquid within a certain error range (usually 10 percent on either side of the average for all nozzles). Clean and/or replace any nozzles that fall outside of the error range. When assessing nozzle uniformity, follow these steps:

1. Measure the volume of water from each nozzle for one minute at a constant pressure and/or RPM.
2. Determine average nozzle output.
3. Determine the acceptable error range (usually within 10 percent).
4. Replace or clean nozzles outside of range and retest.

Example: You have a five nozzle boom and have collected water from each nozzle for one minute. You note the following outputs:

$$\begin{aligned} \text{Nozzle} &= 1 & 2 & 3 & 4 & 5 \\ \text{Ounces} &= 30 & 29 & 30 & 24 & 30 \\ \text{Total} &= 143 \text{ ounces} \\ 143 \div 5 &= \mathbf{28.6 \text{ oz. Average Nozzle Output}} \end{aligned}$$

Find your 10 percent range: $28.6 \times 0.10 = 2.86$ oz to add and subtract from the average. Your range is 25.74 to 31.46 ounces. *Replace or clean nozzle 4 and retest.*

Assessing GPA of your Boom Sprayer To determine the output of your boom sprayer use the 128th acre method. The 128th acre shortcut method involves determining the length of time necessary to drive a preset distance and then measuring the amount of liquid applied during that time. With this short cut, one ounce of discharge per nozzle equals a one gallon per acre output. Preset course lengths must be obtained by comparing nozzle spacing with Table 1.

1. Define course length (*Example:* 20 inch nozzle spacing = 204 feet course length).
2. Time how long it takes to travel the course at a constant spray speed. Conduct the test two to three times and calculate the average time required (*Example:* Traveled 204 feet in 30 seconds).
3. Collect liquid at a constant pressure and/or RPM from one nozzle for that amount of time (*Example:* Collected 30 ounces from 1 nozzle in 30 seconds).
4. Determine GPA by converting ounces of liquid collected into Gallons Per Acre (*Example:* 30 ounces collected = 30 GPA).

TABLE 1. Defined course lengths.

Nozzle Spacing or Band Width (inches)	Course Length (feet)
18	227
20	204
30	136
36	113
40	102

If you have another nozzle width use this formula to determine course length: $340 \div \text{nozzle spacing in feet}$.

Handheld Sprayers

The 128th acre shortcut method can also be used for calibrating the output of handheld sprayers. With this method one ounce of discharge equals a one gallon per acre output.

Measure an 18½ x 18½ foot area which represents a 128th acre. Then time how long it takes to spray this area with water at a constant speed and pressure (*Example: 20 seconds to hand spray 128th acre*). Repeat two to three times and calculate the average time required. Spray water into a measuring container for that amount of time. The number of ounces collected can be converted directly to gallons per acre (*Example: Collected 40 ounces from nozzle in 20 seconds which equals an output of 40 GPA*).

Broadjet Sprayers

The 128th acre method is often difficult to use on broadjet application equipment due to the limited course length. Another short cut method has been developed which makes it easier to calibrate output for broadjet sprayers. Follow these steps when calibrating your broadjet sprayers:

1. Determine spray width (feet) of broadjet sprayer (*Example: 30 feet*). This may be assessed by measuring the distance between spray passes.
2. Determine test strip distance by dividing 340.3 by the spray swath width and multiplying by 10 (*Example: 340.3 ÷ 30 x 10 = 113.4 feet*). This is the test strip distance.
3. Time how long it takes to travel the course at desired spray speed and RPM (*Example: Traveled 113.4 feet in 25 seconds*).
4. Collect liquid from all nozzles or outlets for that amount of time at desired spray pressure and/or RPM (*Example: Collected 130 ounces in 25 seconds*).
5. Divide ounces by 10 to obtain gallons per acre. (*Example: 130 ounces ÷ 10 = 13 Gallons Per Acre*).

Proper Tank Mixing

Proper tank mixing requires knowing sprayer output, area being sprayed, and product rate which is expressed on the label.

Determine Anticipated Spray Area Using Spray Tank Capacity

To determine how much product or solution to add to the spray tank, the area you can cover with your spray tank must be known. If the tank is too small to hold enough solution to cover an intended application, two or more separate applications will be necessary. To determine the area the sprayer can cover follow this formula:

$$\frac{\text{Gallons in Tank}}{\text{Gallons per acre (GPA)}} = \text{Sprayable Acres}$$

Example: If the sprayer is calibrated at 30 GPA and holds 500 gallons, 16.6 acres can be sprayed ($500 \div 30 = 16.6$ acres).

Determine the Amount of Spray Solution

To determine the amount of spray solution needed in a spray tank, simply follow this formula:

$$\text{GPA} \times \text{Sprayed Acres} = \text{Spray Mix Needed}$$

Example: If your sprayer was calibrated at 30 GPA and you needed to spray 15 acres you would need 450 gallons of spray mixture ($30 \times 15 = 450$ gallons).

Determine Amount of Product to Add to the Tank When Acres to Spray is Known

The amount of pesticide product to deliver over a given area is stated on the product label. The following formula will convert the labeled product rate to the amount of pesticide product to add to the tank:

Example: If you are spraying 15 acres and your product rate is 4 oz/acre you would need to add 60 ounces to your spray tank ($15 \times 4 = 60$ ounces).

$$\text{Acres to Spray} \times \text{Product Rate} = \text{Product to Add}$$

Determine Amount of Product to Add to Tank when Acres to Spray is Unknown.

At times it is difficult to determine the acres you are to spray prior to the spray application. When acres to spray is unknown you may use the following steps to determine the amount of pesticide product to add to the spray tank.

Divide the recommended product rate (must be in an amount per acre) by the output (GPA) of your sprayer. This will give an applicator the amount of pesticide product to add per gallon of solution.

$$\frac{\text{Product Label Recommendation (per acres) Gallons per acre (GPA)}}{\text{Amount of Pesticide Product to add per Gallon of Solution}} =$$

Acknowledgements

I would like to thank Jerome Schleier III (MSU Graduate Research Assistant), Jeannie Olmstead (MSU Toole County Extension Agent) and Tom Fischer (Southern Agricultural Research Center Agricultural Research Specialist) for their input in creating this MontGuide.

For Further Information

Additional resources are available online at www.pesticides.montana.edu by selecting 'Reference Materials'. At that Web site you may download a more detailed calibration MontGuide titled *Calibrating Pesticide Application Equipment (MT200914AG)*. You may also download an interactive program which aids applicators in using short cut methods titled *The MSU Calibration Assistant*. For more information contact your local Montana State University Extension Office or the MSU Pesticide Education Program:

Pesticide Education Program

103 Animal Bioscience Building

Montana State University

Bozeman, MT 59717

Web: www.pesticides.montana.edu

e-mail: pesticides@montana.edu

phone: (406)994-5067

TABLE 2. Useful conversion factors.

Multiply	By	To Get
Acres	43,560	Square Feet
Cups	8	Ounces
Gallons	128	Ounces
Grams	.001	Kilograms
Grams	.035	Ounces
Hectares	2.47	Acres
Kilograms	2.205	Pounds
Liters	.264	Gallons
Meters	3.28	Feet
Miles per Hour	88	Feet per Minute
Ounces	2	Tablespoons
Pints	.125	Gallons
Pints	16	Liquid (oz)
Pounds	16	Ounces
Pounds	453.6	Grams
Quarts	32	Ounces
Tablespoon	0.5	Ounces



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