Agricultural Pocket Pesticide Calibration Guide

University of Maine Cooperative Extension
& The Northeastern IPM Center
in cooperation with
The Northeastern Pesticide Coordinators

Name ______________________________

Address ______________________________

Phone ______________________________

FAX ______________________________

Email ______________________________

Telephone Numbers

Poison Control Center ____________________

Doctor ______________________________

Police ______________________________

Fire ______________________________

Misc. ______________________________

____

____

____

____

____

Agricultural Pocket Pesticide Calibration Guide

Editors: James Dill and Glen Koehler, UMaine Cooperative Extension Pest Management Office.

Desktop Publishing: Don Barry, UMaine Cooperative Extension Pest Management Office.

Acknowledgements: Candace Bartholomew, UConn; Jeffery Dorman, formerly UMCE; Gary Fish, Maine BPC; Zane Helsel, Rutgers Univ.; Clay Kirby, UMCE; David Wagner, Penn State Univ.; a special thanks to Mike Helms, Cornell Univ., for his diligent review.

Printed: Nov, 2005. 16M

Table of Contents

This publication is supported, in part, with funding from the

Northeastern IPM Center

The Northeastern Integrated Pest Management Center fosters the development and adoption of IPM, a science-based approach to managing pests in ways that generate economic, environmental, and human health benefits. We work in partnership with stakeholders from agricultural, urban, and rural settings to identify and address regional priorities for research, education, and outreach.

Introduction

Factors such as temperature, humidity, rain, soil type, material, type of application equipment, and application rate influence the effectiveness of a pesticide application.

This Agricultural Pocket Pesticide Calibration Guide is designed to serve as a portable reference for formulas and conversion factors useful to pesticide applicators. We hope that this guide will help you to accurately calibrate your equipment, and to properly mix and apply pesticides.

Section one has procedures for calibrating various types of commonly used pesticide application equipment. Section two has useful calculations and unit conversions.

Why Calibrate?

Properly maintained and calibrated equipment is a requirement for proper and effective use of pesticides. Many different factors, such as the effectiveness, cost, and safety concerns, determine pesticide choice.

Effectiveness: In terms of effectiveness, pesticide rates are determined experimentally, and approved by the EPA. Applying too little or too much pesticide can contribute to pesticide resistance, and may not be sufficient to control the target pest(s). Applying too much pesticide may increase the probability of toxicity to crops, non-target, or beneficial insects, animals, and people nearby. The pesticide label is the law. It is illegal to apply a material inconsistent with its labeling.

Cost: Using improper application rates will cost you money. Using too little pesticide can cause increased pest damage through poor pest control. Using too much pesticide costs more in material. Too much pesticide can also be toxic to crops or animals. By using pesticides improperly, you can be held accountable for off-target problems such as environmental contamination, illegal residues, pesticide drift, and regulatory violations.

Safety: As a person who applies pesticides, you are responsible for proper pesticide use. Using a pesticide inappropriately increases the risk of immediate and long-term harm to crops, animals, the environment, other people, and to you.

You, as the applicator, want the pesticide application to be effective. By properly calibrating equipment and following label instructions, you increase the chance for achieving the desired pest control, getting the most benefit for the time and money you spend while minimizing the chance of unwanted consequences.

Be sure to wear proper personal protective equipment (PPE) when calibrating your equipment.

Calibration Procedures

Table 1. Abbreviations Commonly Used in Calibration

fl. oz.	= fluid ounce	mph	= miles/hour
ft.	= feet	oz.	= ounce (dry weight)
sq. ft.	= square feet area	pt.	= pint
gal.	= gallon	qt.	= quart
GPA	= gallons/acre	sec.	= second
GPM	= gallons/minute	T. or tbs.	= tablespoon
in.	= inches	t. or tsp.	= teaspoon
lb.	= pound	psi	= pounds/square inch

For a more complete list see page 29

All measuring and mixing utensils used with pesticides or other chemicals should be clearly labeled with warnings that they are only to be used for measuring and mixing pesticides. Measuring equipment should be locked in the pesticide storage area. All equipment calibration should be done on the same surface to which the pesticide will be applied and at the same speed, pressure, etc.

1. Calibrating Hand and Backpack Sprayers

The simplest method to use to calibrate small equipment is to measure a 1,000 sq. ft. area (20 ft. x 50 ft. or 10 ft. x 100 ft.) to use for your test plot.

Calibration steps:

1. Measure out a 1,000 sq. ft. area.
2. Using only water in the sprayer, spray the test plot at the same speed, pressure and boom height at which you will treat the larger area. Record the number of seconds that it takes to spray the test plot. Repeat the process 2–3 times and find the average time.
3. Measure the amount of water (fl. oz.) used to spray the test plot. This can be accomplished by collecting the spray output from your sprayer set at the same pressure and collected for the same number of seconds you found in step 2.

4. Using the output per 1,000 sq. ft. from step 3, you can determine the amount of pesticide and water you'll need to treat the intended area.

Example 1:

Apply a liquid insecticide for grub control on a lawn that is 50 ft. x 90 ft. The lawn area to be sprayed is 50 ft. x 90 ft. = 4,500 sq. ft. The label rate is 4 fl. oz. of insecticide per 1,000 sq. ft. Time it took to cover 1,000 sq. ft. calibration plot = 60 sec. Therefore, sprayer output is 48 fl. oz. per 1,000 sq. ft.

Determine the total amount of spray mixture needed by setting up a ratio and cross multiplying.

$$\frac{48 \text{ fl. oz.}}{1{,}000 \text{ sq. ft.}} = \frac{\text{total amount of spray needed in fl. oz.}}{4{,}500 \text{ sq. ft.}}$$

$$1{,}000 \times \text{total amount of spray needed in fl. oz.} = 48 \times 4{,}500$$

$$\text{total amount of spray needed in fl. oz.} = \frac{48 \times 4{,}500}{1{,}000} = \frac{216{,}000}{1{,}000}$$

total amount of spray needed in fl. oz. = 216 fl. oz. of total spray

Determine the amount of insecticide needed by setting up a ratio and cross multiplying.

$$\frac{4 \text{ fl. oz.}}{1{,}000 \text{ sq. ft.}} = \frac{\text{total amount of insecticide needed in fl. oz.}}{4{,}500 \text{ sq. ft.}}$$

$$1{,}000 \times \text{total amt of insecticide needed in fl. oz.} = 4 \times 4{,}500$$

$$\text{total amount of insecticide needed in fl. oz.} = \frac{4 \times 4{,}500}{1{,}000} = \frac{18{,}000}{1{,}000}$$

total amt of insecticide needed in fl. oz. = 18 fl. oz. of total spray

To treat the 4,500 sq. ft. lawn, you will need 18 fl. oz. of insecticide added to 198 fl. oz. of water (216 fl. oz. of total spray). Reminder: there are 128 fl. oz. in a gallon.

2. Calibrating Boom Sprayers

Types of Nozzles

Flat Fan Nozzles: There are a number of different forms.

Standard flat-fan nozzles are primarily used for banding pesticide over the row. General pressure range is 30–60 psi.

Even flat-fan nozzles can be used for banding pesticide over the row. General pressure range is 20–40 psi.

Extended range flat-fan nozzles provide the uniform distribution of standard flat-fan nozzles, however they operate at lower pressures providing some drift control. General pressure range is 15–25 psi.

Certain flat-fan nozzles have specialized advantages:

Off-center flat-fan nozzles are boom end nozzles with a wide swath.

Twin-orifice flat-fan nozzles produce two spray patterns—one 30° forward and one 30° backward. They have a small droplet size for improved coverage and penetration.

Venturi type nozzles mix the spray solution with air, and significantly reduce drift.

Flood Nozzles: Flood nozzles are generally used to apply fertilizer or herbicide/ fertilizer combinations. The spray pattern is greatly affected by pressure. When used at lower pressures, they provide larger droplets, reducing drift, however, they can produce droplets smaller than a flat-fan operated at the same flow rate. It is recommended that flooding nozzles have a 100% overlap for good coverage. The general range of pressures is 10–25 psi.

Hollow-cone Nozzles: Hollow-cone nozzles are used for applying insecticides or fungicides to field crops where penetration and complete coverage is desired. The general pressure range is 40–100 psi. Fine hollow-cone nozzles can be used where finely atomized spray is needed for complete coverage

Raindrop Hollow-cone Nozzles: These nozzles produce a large droplet and are used where overlap is desired. The general pressure range is 20–50 psi.

Full-cone Nozzles: Full-cone nozzles are good where drift is a concern. They produce larger droplets than flood nozzles. The general pressure range is 15–40 psi.

Turbulence Chamber and Venturi Type Nozzles: These nozzles use air injection and/or pre-orifice chambers that produce large droplets that are less prone to drift.

Nozzle Selection:

Nozzle selection is an important step in boom sprayer calibration. The type of nozzle selected needs to be based on the pesticide applied, the spray pattern needed, the pressure range used, application volume needed, and most importantly, the droplet size desired to minimize risk. Before applying a pesticide, you need to determine the type of nozzle needed. Use the following steps to select the proper nozzle for the job.

1. *Read the pesticide label!* The label will often list the type of nozzle to use or what droplet size will provide the most effective application.
2. Determine how fast your sprayer will travel. (Refer to Section 7 to determine travel speed regardless whether your vehicle has a speedometer or not).
3. Calculate the nozzle discharge rate in GPM.
4. Consult a nozzle catalog to find the specific nozzle type needed and the droplet size range you desire.
5. Once nozzles are installed, calibrate the sprayer.

Calculate Nozzle Discharge:

The Gallons Per Minute (GPM) needed from each nozzle are found using the following formula for broadcasting:

$$GPM = \frac{\textit{(Gallons per Acre} \times \textit{mph} \times \textit{Nozzle Spacing (in.))}}{\textit{5,940 (a constant that converts to GPM)}}$$

Example 2:

What nozzle flow rate should be used for an application of 21 gallons per acre with a sprayer traveling 4 mph and the nozzles spaced 20 inches apart on the boom?

$$\text{GPM} = \frac{21 \text{ gal.} \times 4 \text{ mph} \times 20 \text{ in.}}{5{,}940} = 0.282$$

Refer to your nozzle manufacturer's catalog and select a nozzle tip that applies the required flow (GPM) in your desired pressure range.

Table 2. Suggested Nozzle Heights for 20" spacing and 30% Overlap

Spray pattern angle	Nozzle height above crop
65°	21" to 23"
70°	20" to 22"
80°	17" to 19"
90°	15" to 17"
110°	10" to 12"

Steps to calibrate:

1. Check nozzles to make sure that they are the same size.
2. Fill the sprayer tank with clean water only.
3. Run the sprayer inspecting it for leaks and making sure all vital parts function properly. Also check the spray pattern to make sure it is uniform between all nozzles. Replace those the are not.

Table 3. Travel Distance for 1/128 Acre

Nozzle spacing/ Band width (in.)	Travel distance (ft.)	Nozzle spacing/ Band width (in.)	Travel distance (ft.)
18	227	30	136
20	204	32	127
22	186	34	120
24	170	36	113
26	157	38	107
28	146	40	102

4. Measure the spacing between nozzles in inches, and then find the appropriate travel distance in Table 3. Mark a test run in the field that is this distance.
5. Drive the measured distance at your normal application speed, recording the travel time in seconds. Be sure you are at your normal operating speed before entering the test course. Repeat this procedure at least once more and average the times. Also note the gear you are using and the RPMs of the engine.
6. With the sprayer parked, operate at the same pressure you will use in the field. Catch the spray from a nozzle in a measuring jar for the amount of time it took you to drive the test course. Record the amount of water collected. Repeat this process for the remaining nozzles on the sprayer.
7. Calculate the average nozzle output by adding the outputs from all of the nozzles together and then divide by the number of nozzles tested. If the output from an individual nozzle is more than 5 percent higher or lower than the average nozzle output, check for clogs, clean the tip, or replace the nozzle.
8. Repeat steps 5, 6 and 7 until the discharge rate for all nozzles is within 5 percent of the average.
9. The average output in fluid ounces is equal to the application rate in gallons per acre.
   Example: 1 ounce output = 1 gallon per acre

10. If you need to change the output rate, you can do any of the following:
   a.) Change the sprayer pressure to make small adjustments. Lowering the pressure will reduce the spray delivered and increasing the pressure will increase the spray delivered. However, it takes a large increase or decrease in pressure to change nozzle output. For example, a 4X increase in pressure will only double the output. Do not operate outside the pressure range recommended for the nozzles that you use. If large adjustments are needed use one of the following methods.
   b.) Large adjustments can be made by changing the travel speed. Changing speed inversely affects the application rate. For example, decreasing speed by ½ will double the application rate and doubling the speed will decrease the application rate by ½.
   c.) If either of these changes do not produce the desired application rate, then you need to select a different set of nozzles that will meet your needs.
11. Compare the application rate from the procedure to the label stated value. If the actual rate is more than 5 percent higher or lower than the recommended amount, you must make adjustments.
12. Recalibrate the sprayer (repeat steps 5 through 12) after any adjustment.

3. Calibrating Band Sprayers

1. Determine the volume of spray solution to apply. Use the formula below to convert a recommended broadcast application rate per acre into an amount of spray per field acre when using a banded application.

$$\textit{Band Rate} = \textit{Broadcast Rate} \times \frac{\textit{Band Width(in.)}}{\textit{Row Spacing(in.)}}$$

2. Calibrate the sprayer using the procedure outlined for broadcast sprayers only using the band width to determine the appropriate travel distance. If you are using a band sprayer that has multiple nozzles, you will need to collect spray output from all the nozzles for the band.
3. Compare the actual application rate to the desired rate for a band application. Make adjustments and recalibrate the sprayer if the actual rate is more than 5 percent above or below the desired rate.

Example 3:

If the broadcast rate given on the pesticide label is 18 gallons per treated acre and you are spraying 12-inch bands on rows spaced 36-inches apart, how much pesticide mixture will you need per acre of field?

$$\text{Band Rate} = 18 \text{ GPA} \times \frac{12 \text{ in.}}{36 \text{ in.}}$$

$$= 18 \text{ GPA} \times (.333)$$

$$= 6 \text{ GPA}$$

In this example, the bands only cover 12 in. or one third of the row. Therefore, it makes sense that the application rate is one third of the total broadcast rate.

4. Calibrating Granular Applicators

Due to the variability in types of granular applicators, it is difficult to choose one overall method of calibration. Therefore, we will provide some general guidelines, allowing you to use the method applicable to your situation.

When calibrating granular applicators, you must use the actual pesticide product. That way your calibration will be accurate. Since you will use the actual pesticide, be sure to use the label-listed personal protective equipment.

Granular Applicator Calibration:

1. **First, refer to the pesticide label and the operator's manual.** Each piece of equipment and pesticide has its own recommendations.
2. **The calibration method must provide a means for collecting and weighing the granules.** You must either know the weight of the material before putting it into the hopper or you must have a means of weighing the material as it comes out of the applicator. A bag or collection tube is often used.
3. **You must know the application rate and the size of the test area.** The rate is on the pesticide label. You should choose your test area based on the application rate and the calibration method.

Broadcast Granular Applicator Calibration:

1. Read the pesticide label to determine the application rate.
2. Determine the size of your test plot. If the rate is per acre, choose a plot based on a fraction of an acre, such as $^1/_2$, $^1/_4$, or $^1/_8$. If the rate is per 1,000 ft. of row, then choose a plot based on a fraction of that.
3. Using the application rate and test plot size, determine the amount of pesticide that should be applied to the test plot.
4. Using the equipment operator's manual for reference, adjust the applicator's settings to apply this rate.
5. Fill the hopper, marking the hopper level as a reference point.

6. Apply the pesticide to the test plot traveling at the same speed you will use for the pesticide application.
7. Determine the amount of material applied by recording the amount of pesticide required to bring the hopper back to the reference point. This should be in pounds.
8. Make adjustments if necessary. If the rate is more or less than 5% of the application rate, make adjustments and do another trial run. Repeat the calibration procedure until the rate applied is within 5% of the application rate.

Example 4:
The label states that the application rate for your crop is 20 pounds per acre, and your spreader has a swath width of 40 feet. You decide to use 1/4 of an acre as your sample plot size. How much material should you catch in you collection bag during your test run?

$$\textit{Travel Distance (ft.)} = \frac{\textit{Test Plot Size (sq. ft.)}}{\textit{Swath Width (ft.)}}$$

$$\textit{Pounds of Pesticide} = \frac{\textit{Rate (lb./acre)} \times \textit{Swath Width (ft.)} \times \textit{Travel Distance (ft.)}}{\textit{43,560 (sq. ft./acre)}}$$

In this example, your swath width is 40 feet, and 1/4 acre is 10,890 sq. ft. or (43,560 sq. ft. ÷ 4). This means that your travel distance is 272 feet. Once we know the swath width and travel distance, we can determine the amount of pesticide to apply. In this case, the amount is 5 pounds.

Band Granular Applicator Calibration:

1. Read the pesticide label to determine the application rate.
2. Determine the size of your test plot. If the rate is per acre, choose a plot based on a fraction of an acre, such as $\frac{1}{2}$, $\frac{1}{4}$, or $\frac{1}{8}$. If the rate is per 1,000 feet of row, then choose a plot based on a fraction of that.
3. Using the application rate and test plot size, determine the amount of pesticide that should be applied to the test plot. (Use Table 4)

$$\textit{Travel Distance (ft.)} = \frac{\textit{Test Plot Size (sq. ft.)}}{\textit{Band Width (ft.)} \times \textit{Number of Bands} \times \textit{Spreader Width (ft.)}}$$

For application rates in lb./acre:

$$\textit{Pounds Collected} = \frac{\textit{Application Rate} \times \textit{Travel Distance (ft.)} \times \textit{Row Width (ft.)} \times \textit{Band Width (ft.)}}{\textit{43,560 sq. ft.}}$$

For application rates in oz./1,000 ft. of row:

$$\textit{Ounces Collected} = \frac{\textit{Application Rate (oz./1,000 row ft.)} \times \textit{Travel Distance (ft.)} \times \textit{Band Width (ft.)}}{\textit{1,000 ft.}}$$

4. Using the equipment operator’s manual for reference, adjust the applicator settings to apply this rate.
5. Disconnect the drop tubes and attach a bag or container to collect the granules.
6. Drive over the test plot traveling at the same speed you will use for the pesticide application.
7. Weigh the granules collected on a scale calibrated to weigh in ounces.
8. Make adjustments to the equipment if necessary. If the rate is more or less than 5% of the application rate, make adjustments and do another trial run. Repeat this step until the rate applied is within 5% of the application rate.

Table 4: Band Application of Granular Pesticides

Row spacing (in.)	Row length per acre (ft.)	Weight (ounces per 1,000 feet of row)			
		Pounds/ acre			
		1	5	7	10
20	26,136	.61	3.1	4.3	6.1
24	21,780	.73	3.7	5.1	7.3
28	18,669	.86	4.3	6.0	8.6
30	17,424	.92	4.6	6.4	9.2
32	16,335	.98	4.9	6.9	9.8
34	15,334	1.04	5.2	7.3	10.4
36	14,520	1.10	5.5	7.7	11.0
38	13,756	1.16	5.8	8.1	11.6
40	13,068	1.22	6.1	8.6	12.2

Example 5:
The label states that the application rate for your crop is 10 oz. per 1,000 feet of row. You are using a band granular applicator and are applying 10 in. bands. The row spacing is 36 in.

$$\textit{Ounces Collected} = \frac{\textit{Application Rate (oz./1,000 row ft.)} \times \textit{Travel Distance (ft.)} \times \textit{Band Width (ft.)}}{\textit{1,000ft}}$$

In this example, we need to choose a travel length. In this case, we will use 500 feet. With a 10 oz. per 1,000 ft. of row application rate, a 500 ft. travel length, and a 0.833 ft. band width (converting inches to feet using the chart in Section 10, 10 in. × 0.0833 = .833 ft.), we can figure out the ounces collected. The amount of pesticide collected at the end of our trial run should be 4.2 oz.

5. Calibrating Airblast Sprayers

Note: The following examples can be used for orchards or crops requiring a tree row volume calculation where height is a factor. For those crops that are low to the ground, please refer to your operator's manual.

Before you calibrate an airblast sprayer, you must know the volume of foliage to be covered by spray. Use the Tree Row Volume (TRV) formula to calculate how much water must be applied per acre for a "dilute" application. This is called the Dilute Gallons per Acre (DG/A). A dilute application is when the leaves are saturated with water and any additional spray would just run off. Even though orchardists rarely apply pesticide in a dilute spray application, it is necessary to know the amount of water needed for a dilute application because this is the basis for calculating how much pesticide to use. The dilute gallons per acre varies with tree height, tree width, and the length of travel row per acre.

Calculating TRV dilute gallons per acre:

$$TRV = (H \times W \times RLA)$$

H = Average Tree Height
W = Average Tree Width (this is twice the distance the average tree extends from the trunk into the travel row).
RLA = Row Length per Acre
= 43,560 sq. ft. ÷ feet between rows (center to center).

$$\text{Dilute Gallons per Acre (DG/A)} = (TRV \times 0.7) \div 1{,}000$$

The dilute gallons per acre formula uses an average value of 0.7 gal. needed to cover each 1,000 cu. ft. of tree canopy area. This average value is adequate for practical use. The true value varies from about 0.4 gal./1,000 cu. ft. early in the spring to as much as 1.0 gal./1,000 cu. ft. on poorly pruned trees in late summer.

Example 5:

How many gallons of water per acre are needed to make a dilute application to trees that are 13 feet tall, 12 feet wide and planted in rows that are 20 feet apart?

TRV = 13 ft. × 12 ft. × (43,560 sq. ft. ÷ 20 ft.)
= 156 sq. ft. × 2,178 ft.
= 339,768 cubic feet of tree canopy per acre

DG/A = (339,768 × 0.7) ÷ 1,000
= 237,838 ÷ 1,000
= 238 gallons per acre

Caution: For very small trees, the TRV dilute gallons per acre can be below 100 gallons. However, these very small trees are very inefficient at capturing spray deposit. Therefore, *always assume at least 100 gallons per acre is needed for a dilute application*, even if tree size indicates a lower amount.

Concentrate Gallons per Acre

A dilute application is also called a 1X spray. The actual amount of water used to apply pesticide is usually much less than the dilute rate. The actual amount is the *Concentrate Gallons per Acre* (CG/A). An application that uses $^{1}/_{3}$ the dilute amount of water is called a "3X" spray. Commonly used spray concentrations are 2X, 3X, 4X, 6X, and 8X.

Concentrations above 8X increase the difficulty in getting adequate spray coverage and increase the potential for phytotoxicity (damage to plants).

Example 6:

For the previous example with 238 gallons per acre for a dilute application, what are the *Concentrate Gallons per Acre* for different commonly used concentration factors?

CG/A = DG/A ÷ Concentration (or "X" factor)

For 2X, CG/A = 238 ÷ 2 = 119 gallons per acre
For 3X, CG/A = 238 ÷ 3 = 79 gallons per acre
For 4X, CG/A = 238 ÷ 4 = 60 gallons per acre
For 6X, CG/A = 238 ÷ 6 = 40 gallons per acre
For 8X, CG/A = 238 ÷ 8 = 30 gallons per acre

Determining pesticide dosage

The dosage amount listed on labels for pesticides used on fruit trees is stated in two ways. The first way is the amount per 100 gallons dilute spray. To determine how much pesticide to put in the tank using pesticide dosage per 100 gallons dilute, use this formula:

$$\text{Amount of Pesticide} = \frac{\text{Amount of Spray Mix} \times \text{Pesticide per 100 gal.} \times \text{Concentration Factor "X"}}{\text{100 gallons}}$$

Example 7:

If the pesticide label calls for 4 oz. per 100 gallons dilute, and you are making 200 gallons of 3X spray mix, how much pesticide should you put into the sprayer?

Amount of pesticide = (200 gal. × 4 oz. × 3) ÷ 100 gal.
= 2400 oz. ÷ 100
= 24 oz. = 1.5 lb.

The second way that application rates are stated is the amount to use per acre of trees. As shown earlier in the TRV formula, trees are a volume target for spray. Acreage is a measure of area, not volume. The number of acres does not indicate what the tree size is and the amount of foliage per acre that needs to be covered with spray.

There are conventions used to translate acres into a volume measure. For example, for apple trees, treating an acre of standard root stock apple trees is assumed to require 400 gallons of solution per acre for a dilute application. Since very few orchards with trees this size remain, the "standard" rate must be adjusted to current production practices for dwarf and semi-dwarf rootstocks.

To convert a label amount per acre of "standard" apple trees to the amount needed for your orchard, use the following formula:

$$\textbf{Amount of Pesticide per Acre} = \frac{\text{Amount per acre for "standard" trees} \times \text{DG/A in your orchard}}{\text{400 Gallons per Acre}}$$

Example 8:

If the label calls for 3 lbs. per acre when treating standard trees, how much pesticide should you use per acre for trees where the dilute gallons per acre is 180?

Amount of pesticide to use per acre = (3 lb. × 180) ÷ 400
= (540 ÷ 400)
= 1.35 pounds per acre

Note: Some pesticide labels recommend a minimum rate per acre regardless of adjustment for TRV.

Always follow the label!

Nozzle Setup:

Airblast nozzles should only be used within their specified pressure range. Airblast sprayer pressure is usually between 100 and 200 pounds per square inch (psi). Using pressures above 200 psi creates superfine spray droplets, which significantly increases the risk of spray drift. In addition, hot weather can cause superfine droplets to evaporate before hitting their target. Using pressures below 100 psi may create droplet sizes too large to reach their intended target increasing the risk of poor coverage. However, this pressure guideline will not apply to your sprayer if it is one of the alternate designs, such as an air shear sprayer that uses low pressure nozzles.

For trees over 10 feet tall, a general guideline is to select nozzles that direct $^2/_3$ of the sprayer output to the upper half of the tree.

Airblast Sprayer Calibration:

1. Mark out a test course of 88 feet.
2. Fill the sprayer with clean water only.
3. With a moving start, pull the airblast sprayer at the speed you would use to apply pesticide through the length of the test course.
4. Record the time it takes to travel the 88 feet.
5. Repeat steps 3 & 4 on the return trip.
6. Average the two travel times together.
7. Calculate Travel Speed (TS):

   TS = 60 ÷ average time in seconds to travel 88 feet
8. Calculate the Swath Width (SW):

   For spraying every row,

   SW = the distance between rows.

   For alternate row application,

   SW = twice the distance between rows.
9. Calculate the desired Gallons Per Minute (GPM) from all the nozzles combined:

$$GPM = \frac{(CG/A) \times SW(ft.) \times TS(mph)}{495}$$

Example 9:

For the same orchard as described in Example 5 and a sprayer that takes 20 seconds to travel 88 feet, what is the desired gallons per minute for a 3X application applied every row?

Time(sec) to travel 88 feet	= 20 sec.	
Travel Speed (TS)	= 60 ÷ 20	= 3 mph
Swath Width (SW)	= 20 ft. for an every row application	
CG/A (from Example 1)	= 238 ÷ 3	= 79 gal. per acre

$$\text{Gallons Per Minute} = \frac{(79 \text{ CG/A} \times 20 \text{ ft.} \times 3 \text{ mph})}{495}$$

$$= 9.58 \text{ GPM}$$

Checking Sprayer Output:

Sprayer output can be measured using a nozzle flow meter or by the sprayer refill method. A combined approach using a flow meter to detect worn or plugged nozzles, and the sprayer refill method to measure overall sprayer output is recommended. Another method of checking nozzle output is by attaching hoses to the nozzles and collecting the output in a bucket or calibration jar. This allows you to determine individual nozzle output and deviation.

Nozzle Flow Meter:

Using a flow meter allows you to find individual nozzles that deviate more than 5% above or below the desired output. (If a nozzle deviates more than 5% below the average, it may need cleaning. If it deviates more then 5% above the average, it may have a worn orifice and needs replacement. Recalibrate the sprayer after cleaning or replacing nozzles). Adding together the flow meter measurements for all of the nozzles on the sprayer gives you the total sprayer output.

Sprayer Refill Method:

1. Fill the sprayer with water.
2. Spray water at normal sprayer pressure for 3 minutes.
3. Turn off the sprayer.

4. Determine the gallons per minute (GPM) discharged by the sprayer:

GPM = gal. needed to refill the sprayer ÷ 3 min.

Making adjustments

After the actual output is calculated, compare it to the desired gallons per minute output (calculated in Example 3). Adjust and recalibrate until the volume is within 5% of the recommended volume. For small adjustments, you can adjust the pressure within the recommended range suitable for the nozzles being used. You also can adjust travel speed. If other settings remain the same, increasing travel speed decreases the amount of spray per acre. The application rate is inversely affected by travel speed. For example, doubling the travel speed will halve the amount of spray mixture applied. However, travel speed should remain in the range of 1.5–3 mph for best coverage. For large adjustments, you may need to add or subtract nozzles, or change to nozzles with a different output rate.

After adjustments are made, repeat the calibration steps until the desired gallons per minute output rate is reached. Refer to your operator's manual for methods of adjustment.

Adjusting for different sized trees in the same orchard

One way to do this is to use "flip nozzles" that give you two nozzle configurations on the same sprayer. More commonly, growers calibrate the sprayer for the largest trees they will spray, and then shut off nozzles not needed to get good coverage of small trees. This approach may be practical, but it usually results in overspraying smaller trees. A more exact nozzle configuration for small trees can easily pay for itself in spray material savings, less risk of drift, less risk of phytotoxicity, and other problems associated with inaccurate dosage.

Airblast Sprayer Calibration for Row Crops:

Before spraying row crops with an airblast sprayer, refer to the operator's manual to determine the proper nozzle selection and arrangement. This should include turning off the upper spray nozzles.

Next, you need to determine the Gallons Per Minute (GPM) to be applied. Before you can determine the GPM, you need to determine the desired Gallons Per Acre (GPA), travel speed, and swath width.

1. GPA: Be sure to use enough water to get adequate coverage for the crop treated and pesticide used. Some product labels list minimum amounts of water to use. If the label does not provide enough guidance, check with your Cooperative Extension representative or other trusted source for help.
2. Swath Width (SW) for row crops: Here the swath width is how far the spray pattern reaches on both sides of the sprayer. It is measured from the centerline of the sprayer. For example, if the spray pattern covers 25 feet on each side from the center the sprayer, then your swath width is 50 feet.
3. Travel Speed (TS): To determine the travel speed, follow the instructions below.
    a. Mark out a test course of 88 feet.
    b. Fill the sprayer with clean water only.
    c. With a moving start, pull the airblast sprayer at the speed you would use to apply pesticide through the length of the test course.
    d. Record the time it takes to travel the 88 feet.
    e. Repeat steps 3 & 4 on the return trip.
    f. Average the two travel times together.
    g. Calculate Travel Speed (TS):

$$TS = 60 \div \text{average time in seconds to travel 88 feet}$$

Now you can calculate the desired GPM.

$$\textit{Desired GPM} = \frac{GPA \times SW(ft.) \times TS(mph)}{495}$$

Once you know the desired gallons per minute, calibrate the sprayer for the appropriate GPM using the sprayer refill method.

Sprayer Refill Method:

1. Fill the sprayer with clean water only.
2. Spray water out of the sprayer for 3 minutes at normal sprayer pressure.
3. Turn off the sprayer.
4. Determine the gallons per minute discharged by the sprayer:

$$\textit{Gallons Per Minute} = \frac{\textit{Gallons needed to refill the sprayer}}{\textit{3 min.}}$$

If the sprayer output differs by more than 5%, recalibrate the sprayer and use the sprayer refill method to re-check the output. Use the following equation to determine the percent error.

$$\textit{Sprayer Output Error (\%)} = 100 \times \left(1 - \left(\frac{\textit{Actual GPM}}{\textit{Expected GPM}}\right)\right)$$

Once you know the total gallons per acre you are applying to the crop, you can calculate the amount of pesticide to add to the tank using the following formula.

$$\textit{Amount of Pesticide per Tank (lb. or gal.)} =$$

$$\textit{Pesticide Dose per Acre (lb. or gal.)} \times \frac{\textit{Tank Size (gal.)}}{\textit{GPA to be Applied}}$$

Example 10:

You are treating a strawberry field with a fungicide. The desired GPA is 30 gallons, the swath width is 50 feet, and the average time it took to travel the 88 foot test course was 20 seconds.

A. Determine gallons per minute:

Travel speed (TS) = 60 ÷ 20 sec. (travel time for 88 ft.)
= 3 mph

Calculate the desired GPM:

Desired GPM = (30 GPA × 50 ft. × 3 mph) ÷ 495
= 9.09 GPM

B. Calibrate the sprayer:

Using the sprayer refill method, it takes a total of 31 gallons to refill the sprayer at the end of three minutes.

GPM = 31 gallons ÷ 3 minutes
= 10.33 GPM

C. Determine if the GPM is within 5% of the expected GPM:

Output Error = 100 × (1- (10.33 gal ÷ 9.09 gal))
= 13.6%

In this case, there is too much error. In order to decrease the output, you can make adjustments such as selecting different nozzles, increasing the travel speed, or reducing the sprayer pressure. Once you have made the adjustments, test again using the sprayer refill method.

Let us assume that on the second 3-minute test it takes you 28.2 gallons to refill the sprayer. You find that your flow rate is now:

GPM = 28.2 gallons ÷ 3 minutes
= 9.4 GPM

Checking to see that the rate is within 5% of the expected GPM:

Output Error = 100 × (1- (9.4 gal ÷ 9.09 gal))
= 3.4%

This error is within the 5% tolerance.

Aquatic Materials

Note: Always check with your environmental regulatory authority before applying pesticides to any channel (river or stream) or body of water (lake or pond). There are special regulations about using pesticides in these situations.

Units and Conversion Equivalents:

1 acre = 43,560 square feet

1 acre-foot (A-ft) = 43,560 cubic feet
= 325,872 gallons
= 2,720,000 pounds of water

1 gallon = 128 fluid ounces (fl. oz.)
= 8.34 lb. of water

1 cubic foot per second (cfs)
= 450 gallon per minute (GPM)

1 cubic foot (cu. ft.) of water
= 7.48 gallons = 62.4 pounds

1 part per million by volume (ppmv)
= 1 gal. per million gallons of water

1 part per million by weight (ppmw)
= 8.34 lb. of chemical per million gallons of water

Pounds active ingredient (a.i.)
= a.i. required ÷ lb. a.i. per 1 gallon of concentrate

Pounds of dry formulation required
= (lb. a.i. required × 100) ÷ Percent a.i. in formulation by weight

Cubic feet per second (cfs)
= cross section area in sq. ft. × average velocity in feet per second (fps)

The cross section area of a rectangular channel in sq. ft.
= the average width in feet × the average depth in feet

Formulas for Application to Channels (Limited Flow Waterways, Moving Water):

$$ppmv = \frac{Material(gal.) \times 1{,}000{,}000}{cfs \times 450 \times time\ applied(min.)}$$

$$Material(gal./cfs) = \frac{ppmv \times 450 \times cfs \times time\ applied(min.)}{1{,}000{,}000}$$

$$Material\ required(gal.) = \frac{ppmv \times 450 \times time\ applied(min.)}{1{,}000{,}000}$$

$$ppmw = \frac{Material(lbs.) \times 1{,}000{,}000}{cfs \times 3{,}744 \times time\ applied(min.)}$$

$$ppmw = \frac{Material(gal.) \times a.i.(lb./gal.) \times 1{,}000{,}000}{cfs \times 3{,}744 \times time\ applied(min.)}$$

$$Material(lbs./cfs) = \frac{ppmw \times 3{,}744 \times time\ applied(min.)}{1{,}000{,}000}$$

$$Material(gal./cfs) = \frac{ppmw \times 3{,}744 \times time\ appled(min.)}{a.i.(lb./gal.) \times 1{,}000{,}000}$$

Formulas for Application to Ponds and Lakes

Volume of pond (cu. ft.) = Surface area (sq. ft.) × Average depth (ft.)

Volume of pond (A-ft.) = Surface area (acres) × Average depth (ft.)

Volume of pond (A-ft.) = volume of pond (cu. ft.) ÷ 43,560 sq. ft.

ppmv = gallons of 100% a.i. ÷ (volume in A-ft. × 0.33)

Total gallons of chemical required = A-ft. × ppmv × 0.33

ppmw = lb. a.i. of material applied ÷ (volume in A-ft. × 2.72)

Active ingredient required (lb.) = A-ft. × 2.72 × ppmw desired

$$Material\ required\ (gal.) = \frac{Acre\ feet \times 2.72 \times ppmw\ desired}{a.i.\ (lb.) \div gallons\ of\ concentrate}$$

Table 5: Dilution (Quantity of liquid material to be added to water for certain dilutions)

Dilution Desired	Gallons of water						
	100	50	25	10	5	2.5	1
1:100	1.00 gal.	2.00 qt.	1.00 qt.	12.8 fl. oz.	6.40 fl. oz.	3.20 fl. oz.	8.00 tsp.
1:200	2.00 qt.	1.00 qt.	1.00 pt.	6.40 fl. oz.	3.20 fl. oz.	1.60 fl. oz.	4.00 tsp.
1:400	1.00 qt.	1.00 pt.	0.50 pt.	3.20 fl. oz.	1.60 fl. oz.	0.80 fl. oz.	2.00 tsp.
1:600	1.50 pt.	0.75 cup	0.75 cup	2.40 fl. oz.	1.20 fl. oz.	0.60 fl. oz.	1.50 tsp.
1:800	1.00 pt.	0.50 pt.	0.50 cup	1.60 fl. oz.	0.80 fl. oz.	0.40 fl. oz.	1.00 tsp.
1:1000	0.88 pt.	7.00 fl. oz.	3.50 fl. oz.	1.40 fl. oz.	0.70 fl. oz.	1.75 tsp.	0.88 tsp.
1:1200	0.75 pt.	5.00 fl. oz.	3.00 fl. oz.	1.20 fl. oz.	0.60 fl. oz.	1.50 tsp.	0.75 tsp.
1:1600	0.50 pt.	0.25 fl. oz.	2.00 fl. oz.	0.80 fl. oz.	0.40 fl. oz.	1.00 tsp.	0.50 tsp.

7. Calculating Travel Speed

1. Set two markers in the field 88 feet apart. (88 feet is $^1/_{60}$ of a mile.)
2. Select gear and throttle setting on your tractor.
3. From a running start, measure the number of seconds needed to drive 88 feet.
4. Calculate travel speed:

$$\textit{Travel Speed (mph)} = \frac{60}{\textit{time to travel 88 feet (sec.)}}$$

Example 11:
If it takes 15 seconds to travel 88 feet, then the field speed is 60 ÷15 = 4 mph.

8. Common Abbreviations

Measurements

bu. = bushel
cc = cubic centimeter
cm = centimeter
cu. ft. = cubic feet
cu. in. = cubic inch
fl. oz. = fluid ounce
ft. = feet
sq. ft. = square feet
gal. = gallon
GPA = gallons per acre
g = grams
in. = inches
kg = kilogram
l = liter
lb. = pound or pounds
m = meter
ml = milliliter
mm = millimeter
mph = miles per hour
oz. = ounce or ounces (dry weight)
ppm = part per million
psi = pounds per square inch
pt. = pint
qt. = quart
T. = tablespoon
t. or tsp. = teaspoon
yd. = yard

Pesticide formulations

D = Dust
DF = Dry Flowable
DG = Dry Granule
EC = Emulsifiable Concentrate
F = Flowable
G = Granular
L = Liquid
S or SP = Soluble Powder
SC = Soluble Concentrate
WG or WDG = Water Dispersible Granule
W or WP = Wettable Powder
WS = Water Soluble Powder

9. Unit Conversions

Cubic Measure

cu. ft. = 1,728 cu. in.
cu. ft. = 0.037 cu. yard
cu. ft. = 7.48 gal.
cu. ft. = 59.84 pt. liquid
cu. ft. = 29.92 qt. liquid
cu. ft. = 25.71 qt. dry
cu. ft. = 0.804 bushels
cu. ft. = 28.32 liters

bushel = 2,150.4 cu. in.
bushel = 1.24 cu. ft.
bushel = approx 1/20 cu. yard
bushel = 35.24 liters

liter = 1,000 cc
liter = 0.035 cu. ft.
liter = 61.02 cu. in.

milliliter = 1 cc

cu. yd. = 27 cu. ft.
cu. yd. = 46,656 cu. in.
cu. yd. = 202 gal.
cu. yd. = 1,616 pt. liquid
cu. yd. = 808 qt liquid
cu. yd. = 21.71 bushels

gallon = 269 cu. in.
gallon = 3785 cc
gallon = 0.134 cu. ft.
gallon = 231 cu. in.

peck = 537.6 cu. in.

ounce (liquid) = 1.805 cu. in.

pint = 28.87 cu. in.

lb. water = 27.68 cu. in.
lb. water = 0.016 cu. ft.

quart = 67.2 cu. in. (dry)
quart = 57.7 cu. in. (liquid)

Capacity Measure (Liquid)

fl. oz. = 2 T.
fl. oz. = 6 tsp.
fl oz = 29.57 ml
fl. oz. = 1.805 cu. in.

teaspoon = 5 ml
teaspoon = 0.17 fl. oz.
teaspoon = 60 drops

pint = 2 cups
pint = 16 fl. oz.
pint = 473 ml
pint = 28.87 cu. in.
pint = 0.125 gal.
pint = 0.473 liters
pint = 32 T.

cu ft = 29.22 qt. liquid

gallon = 128 fl. oz.
gallon = 3,785 ml
gallon = 0.83 British gal

cup = 8 fl. oz.
cup = 0.5 pt.
cup = 236.5 ml
cup = 0.25 qt
cup = 16 T.
cup = 48 tsp.

tablespoon = 3 t.
tablespoon = 15 ml
tablespoon = 0.5 fl. oz.

quart = 32 fl. oz.
quart = 2 pt.
quart 57.75 cu. in.
quart = 946 ml
quart = 0.25 gal.
quart = 0.94 liters

liter = 2.1 pt.
liter = 1.06 qt.
liter = 1000 cc

10. Conversion Factors

acres	×	0.4047	=	hectares
acres	×	43,560	=	square feet
acres	×	4,840	=	square yards
bushels	×	2,150.4	=	cubic inches
bushels	×	4.0	=	pecks
bushels	×	64	=	pints
bushels	×	32	=	quarts
centimeters	×	0.39	=	inches
centimeters	×	0.01	=	meters
centimeters	×	10.0	=	millimeters
cubic feet	×	1,728	=	cubic Inches
cubic feet	×	0.037	=	cubic feet
cubic feet	×	7.48	=	gallons
cubic feet	×	59.8	=	pints (liquid)
cubic feet	×	29.9	=	quarts (liquid)
cubic inches	×	16.3	=	cubic centimeters
cubic meters	×	1,000,000	=	cubic centimeters
cubic meters	×	35.31	=	cubic feet
cubic meters	×	61,023	=	cubic inches
cubic meters	×	1.30	=	cubic yards
cubic meters	×	264.2	=	gallons
cubic meters	×	2,113	=	pints (liquid)
cubic meters	×	1,057	=	quarts (liquid)
cubic yards	×	27	=	cubic Feet
cubic yards	×	46,656	=	cubic Inches
cubic yards	×	0.76	=	cubic Meters
cubic yards	×	202	=	gallons
cubic yards	×	1,616	=	pints (liquid)
cubic yards	×	807.9	=	quarts (liquid)
feet	×	30.48	=	centimeters
feet	×	12	=	inches
feet	×	0.305	=	meters
feet	×	0.33	=	yards
feet per minute	×	0.0167	=	feet per second
feet per minute	×	0.0114	=	miles per hour

gallons	×	3,785	=	cubic centimeters
gallons	×	0.1337	=	cubic feet
gallons	×	231	=	cubic inches
gallons	×	128	=	ounces (liquid)
gallons	×	8	=	pints (liquid)
gallons	×	4	=	quarts (liquid)
gallons of water	×	8.3453	=	pounds of water
grains	×	0.0648	=	grams
grams	×	15.43	=	grains
grams	×	0.001	=	kilograms
grams	×	1,000	=	milligrams
grams	×	0.0353	=	ounces
grams per liter	×	1,000	=	parts per million
hectares	×	2.471	=	acres
inches	×	2.54	=	centimeters
inches	×	0.0833	=	feet
inches	×	0.0278	=	yards
kilograms	×	1,000	=	grams
kilograms	×	2.205	=	pounds
kilometers	×	3,281	=	feet
kilometers	×	1,000	=	meters
kilometers	×	0.62	=	miles
kilometers	×	1,094	=	yards
liters	×	1,000	=	cubic centimeters
liters	×	0.0353	=	cubic feet
liters	×	61.02	=	cubic inches
liters	×	0.001	=	cubic meters
liters	×	0.264	=	gallons
liters	×	2.113	=	pints (liquid)
liters	×	1.057	=	quarts (liquid)
meters	×	100	=	centimeters
meters	×	3.28	=	feet
meters	×	39.37	=	inches
meters	×	0.0010	=	kilometers
meters	×	1,000	=	millimeters
meters	×	1.094	=	yards

miles	×	5,280	=	feet
miles	×	320	=	rods
miles	×	1,760	=	yards
miles per hour	×	88	=	feet per minute
miles per hour	×	1.467	=	feet per second
miles per minute	×	88	=	feet per second
miles per minute	×	60	=	miles per hour
ounces (dry)	×	437.5	=	grains
ounces (dry)	×	28.35	=	grams
ounces (dry)	×	0.0625	=	pounds
ounces (liquid)	×	1.81	=	cubic inches
ounces (liquid)	×	0.0078	=	gallons
ounces (liquid)	×	29.57	=	milliliters
ounces (liquid)	×	0.0625	=	pints
ounces (liquid)	×	0.0313	=	quarts
parts per million	×	0.0584	=	grains per US gallon
parts per million	×	0.001	=	grams per liter
parts per million	×	8.345	=	lbs. per million gal.
pecks	×	0.25	=	bushels
pecks	×	537.6	=	cubic inches
pecks	×	16	=	pints (dry)
pecks	×	8	=	quarts (dry)
pints (dry)	×	0.0156	=	bushels
pints (dry)	×	33.603	=	cubic inches
pints (dry)	×	0.0625	=	pecks
pints (dry)	×	0.5	=	quarts (dry)
pints (liquid)	×	28.87	=	cubic inches
pints (liquid)	×	0.125	=	gallons
pints (liquid)	×	0.4732	=	liters
pints (liquid)	×	16	=	qunces (liquid)
pints (liquid)	×	0.5	=	quarts (liquid)
pounds	×	7,000	=	grains
pounds	×	453.5924	=	grams
pounds	×	16	=	ounces
pounds	×	0.0005	=	tons

pounds of water	×	0.016	=	cubic feet
pounds of water	×	27.68	=	cubic inches
pounds of water	×	0.1198	=	gallons
quarts (dry)	×	0.0313	=	bushels
quarts (dry)	×	67.2	=	cubic inches
quarts (dry)	×	0.125	=	pecks
quarts (dry)	×	2	=	pints (dry)
quarts (liquid)	×	57.75	=	cubic inches
quarts (liquid)	×	0.25	=	gallons
quarts (liquid)	×	0.946	=	liters
quarts (liquid)	×	32	=	quarts (liquid)
quarts (liquid)	×	2	=	pints (liquid)
rods	×	16.5	=	feet
square feet	×	144	=	square inches
square feet	×	0.11	=	square yards
square inches	×	0.0069	=	square feet
square miles	×	640	=	acres
square miles	×	28,878,400	=	square feet
square miles	×	3,097,600	=	square yards
square miles	×	259	=	hectares
square yards	×	0.0002	=	acres
square yards	×	9.0	=	square feet
square yards	×	1,296	=	square Inches
temperature °C	×	1.8 + 32	=	temperature °F
temperature °F – 32	×	0.56	=	temperature °C
ton	×	907.1849	=	kilograms
ton	×	32,000	=	ounces
ton	×	2000	=	Pounds
yards	×	3	=	feet
yards	×	36	=	inches
yards	×	0.9144	=	meters
yards	×	0.0006	=	miles

11. Temperature Conversion

°Centigrade	°Fahrenheit
–100	–148
–40	–40
–18	0
0	32
37	98.6
37.8	100
100	212

12. Test Plot Conversion Tables

1 kilogram = 1000 grams = 2.2 pounds
1 gram = 1000 milligrams = .035 ounce
1 liter = 1000 milliliters or cubic centimeters
1 milliliter or cubic centimeter = .034 fluid ounces
1 milliliter cubic centimeter of water weighs 1 gram
1 liter of water weighs 1 kilogram
1 pound = 453.6 grams
1 ounce = 28.35 grams
1 pint of water weighs approximately 1 pound
1 gallon of water weighs approximately 8.34 pounds
1 gallon = 4 quarts = 3.785 liters = 128 fluid ounces
1 quart = 2 pints = .946 liters
1 pint = .473 liters
1 fluid ounce = 29.6 milliliters or cubic centimeters

13. Cleaning Equipment

Frequency:

1. Flush with water after each day's use.
2. Clean thoroughly whenever changing chemicals or storing the equipment.

Cleaning Steps

1. Be sure to choose and wear the proper protective equipment.
2. Hose down inside of the tank and partially fill it with water. Operate sprayer to flush water through the nozzles.
3. Repeat step 1.
4. Remove nozzle tips and screens. Clean in strong detergent using a toothbrush or other soft brush. Avoid hard objects that might scratch and damage the orifice (wire, knives, etc.).
5. Partially fill the tank with water and add cleaning agent.
6. Operate sprayer to flush the system with the cleaning agent.
7. If you have a sprayer pad with a catch basin, be sure to wash the outside of the sprayer occasionally.

Note: Certain pesticides require special cleaning agents to remove residues from the sprayer tank. Carefully read the label and use the appropriate materials to clean the tank.

Cleaning Granular Applicators:

1. Remove all pesticide from the applicator. To do a thorough job, certain parts may require disassembly.
2. Thoroughly clean the inside of the hopper.
3. Clean rusted or corroded parts with sandpaper, emery cloth, or wire brush. Paint with rust preventative primer and machinery paint.
4. Apply a coat of oil to inner and outer surface. Oil or grease bearings, if appropriate.
5. Clean and oil the flow control valve and adjustment.
6. Clean and oil any steel tubes that were used.
7. Wipe off oil that may come in contact with granules.

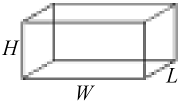
State regulations vary regarding proper disposal of sprayer rinsate. Check with your environmental regulatory authority to determine what kind of drainage and/or catch basin is required in your state and if it is practical to reuse the rinsate for future spraying.

Appendix 1. Volume Calculations

You can use these formulas to calculate volume based on the shape and measurements of a building or greenhouse. $\pi = 3.14$

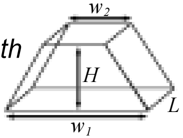
Rectangular or cubic:

Volume = Height × Width × Length



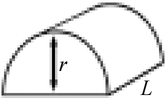
Regular trapezoidal:

Volume = $\frac{1}{2}(w_1 + w_2)$ × *Height* × *Length*



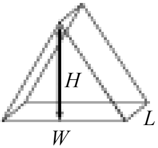
Half Cylinder (Quonset Hut):

$$Volume = \frac{3.14 \times r^2}{2} \times Length$$



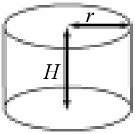
Triangular:

Volume = $\frac{1}{2}$ *(Width × Height) × Length*



Cylinder (Silo):

$$Volume = 3.14 \times r^2 \times Height$$



Appendix 2.   Row Length Per Acre

Distance Between Rows	Row Length per Acre
Inches	Feet
12	43,560
18	29,040
24	21,780
30	17,424
36	14,520
42	12,446
48	10,890
54	9,680
Feet	Feet
5	8,712
6	7,260
7	6,223
8	5,445
9	4,840
10	4,356
11	3,960
12	3,630
13	3,351
14	3,111
15	2,904
16	2,723
17	2,562
18	2,420
19	2,293
20	2,178
21	2,074
22	1,980
23	1,894
24	1,815
25	1,742

Resources

Barry, D. and Fish, G., *University of Maine Pesticide Education Manual*. University of Maine Cooperative Extension, 2003.

Boys, F. and Murphey, F., *Pocket Pesticide Calibration Guide*. Northeastern Pesticide Coordinators.

Dill, J.F. and Yonker, J.W., *Calibration of Pesticide Application Equipment: A Training Manual for Pesticide Instruction*. Purdue University, 1980.

Farrell, M.A., *1/128 Method of Calibration*. Fact Sheet MP-93.4, University of Wyoming Cooperative Extension.

Koehler, G.W. (editor), *New England Apple Pest Management Guide*. Universities of CT, MA, ME, NH, RI, VT, 2000.

Ozkan, H. E., *Boom Sprayer Calibration*. Fact Sheet AEX-520-92, Ohio State University Cooperative Extension.

Wamsley, M. and Vermeire, D., *Aquatic Pest Control: A Guide for the Commercial Applicator*. U.S. EPA, 1976.