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Sprayer Calibration with Handheld Sprayer Systems for Orchard Crops

Andrea Kawabata[1], Jensen Uyeda[1], Matthew Miyahira[1], Rosemary Gutierrez-Coarite[1], Shannon Sand[2], and Stuart T. Nakamoto[3]
[1]Tropical Plant and Soil Sciences, [2]Natural Resources and Environmental Management, [3]Human Nutrition, Food and Animal Sciences

Introduction

Calibrating spray equipment is an important step in applying pesticides such as fungicides, insecticides, or miticides to a targeted crop and pest (disease, insect, etc.). Proper calibration of a sprayer helps to ensure accurate pesticide application at the rate per acre specified on the product label. The "Sprayer Calibration for Orchard Crops and Pesticide Calculations" Excel Workbook is a tool to help you estimate how much water your sprayer is applying to your trees. It will also help you calculate the correct amount of pesticide to mix into a tankful of spray.

This document accompanies the workbook, and provides a step-by-step guide and explanation of how to calculate the rate at which the equipment sprays the water-pesticide mix, in gallons-per-acre rate (GPA). Using the GPA, Appendix 1 describes the steps to calculate the amount of pesticide needed per gallon of water and for the sprayer's tank, and suggestions for mixing and applying pesticides. Appendix 2 is a form (field sheet) to record the information for sprayer calibration and should be saved as part of the farm records. Appendix 3 is an example using the field sheet, and also shows the computations for anyone wishing to do hand calculations. Appendix 4 is an example for pesticide calculations, including calculations by hand.

This guide can be used for calibrating a motorized backpack mist blower; battery-powered backpack sprayer; and small, motorized tank sprayer with hose and wand attachment (Fig. 1). Maintaining consistent pressure using hand pump sprayers makes calibration difficult; however, these procedures will also provide estimates for non-mechanized sprayers.

Why Calibrate a Sprayer?

Ideally, a pesticide is applied at the concentration that kills the targeted pest(s) in the field, then quickly disappears from the environment. Spray coverage must be accurate to be effective. The amount of chemical applied needs to be correct and in the recommended dosage.

Spraying too much pesticide wastes money by using more product than is needed. Applying too much pesticide and otherwise not following the label is also illegal. Violations can result in fines and jail time by both federal and state authorities, and crop or harvests can be confiscated and destroyed. The reputation of you and your farm could be damaged so future business is lost. Over-applying pesticides will unnecessarily expose you, your family, and your community to potentially toxic chemicals, and have environmental impacts, such as run-off that eventually reaches the ocean, or contamination of groundwater. Crop injury and phytotoxicity (Fig. 2) can also occur.

Spraying too little pesticide wastes money by spending time and product without getting the expected results. The grower will either need to re-treat

Footnote: For the use of herbicides in orchards, consider following the 1/128th sprayer calibration method explained by publications noted in the "References" section.

or suffer from lower yields and quality from a damaged crop. An even bigger problem is that over time, misapplication can hasten the unwanted process of a pest developing resistance to the pesticide. Resistance will result in sprays not working even at the correct amount, so in addition to the cost of the wasted spraying, the pest still damages the crop so revenues are lower. Further, once pesticide resistance develops, fewer pesticides to control the problem are available and often are more costly. Spraying accurate amounts can help to slow the process by which pests develop resistance to pesticides.

Always read the pesticide product label before use. Wear proper personal protective equipment and follow all label instructions. The label is the law and it is a violation of federal law to use a pesticide product in a manner inconsistent with its labeling.

Sprayers should be (re)calibrated when there are any changes in the applicator, equipment, field, crop, and pest.

Examples of When to Calibrate Your Sprayer

- New or different spray applicator (person)
- Newly serviced spray equipment
- New or different sprayer equipment
- Different sprayer nozzle(s)
- Different motor speed (rpm) or sprayer pressure
- Change in tree height or size
- Change in tree density or spacing
- Different target pest, incidence and physical location on the tree
- Change in field terrain (e.g., slope, roughness of terrain, etc. that would affect spraying)
- Different spray technique (for better coverage, etc.)

Before Calibrating Your Handheld Sprayer

Be sure to clean and service your sprayer, hose, nozzle, motor, etc. before starting the steps for calibration. Nozzles can become worn or plugged and can cause over-application or under-application by restricting the flow of spray solution. Test and set your sprayer nozzle, pressure, and aperture settings as appropriate for good coverage of the targeted crop and pest.

Calibrating Your Handheld Sprayer for Orchard Crops

Follow the steps below and record your information into the Field Sheet (Appendix 2), to later be used to make hand calculations (Appendix 3) or for use with the "Sprayer Calibration for Orchard Crops and Pesticide Calculations" Excel Workbook. When using the Excel spreadsheets, many of the steps are automatically calculated.

Step 1: Determine the total crop acreage to be sprayed. Enter this value in the Field Sheet.

Note: It is useful to start with a map of the farm. Use a contractor's measuring wheel (Fig. 3), your TMK info, Google Earth, Web Soil Survey, a similar program or app, or a hand drawing to plot out and calculate your crop acreage.

Step 2: Determine the total number of trees per acre to be sprayed. Enter this number in the Field Sheet. Note: If you know your tree spacing and approximate road (%) area, you can estimate your number of trees per acre with the Excel worksheet labeled "Conversions".

Step 3: Select and count trees to be sprayed typical of the total orchard. Mark or flag the trees so you know where to start and stop spraying to determine water usage. Repeat a total of three times for Reps 1, 2, and 3.

Note: A larger number of trees in the sample can help to provide more accurate estimates; however, estimates should also be compared against actual results. Selecting good, representative trees to spray for calibration will help ensure that the correct amount of product is applied to the actual target area.

Example: If a coffee farm is pruned in the Beaumont-Fukunaga (BF) method, your spray sample should include trees in the stumped row (unless not spraying these trees), 1st year of growth, 2nd year of growth, and if present, the 3rd year of growth – in the same proportions as in the field.

Step 4: Set the sprayer or tank on a level surface and fill the hopper or tank to 2/3 or ¾ full, with a known amount of water (e.g., 320 fl oz = 3 gals, or 256 fl oz = 2 gals) in fluid ounces. Enter this number in the Field Sheet under "Rep 1".

Note: Use a graduated cylinder or measuring cup or container for volume accuracy. Always calibrate with a known orifice opening and motor speed. Consider marking your throttle lever setting if it helps maintain motor speed and adding a note to your Field Sheet.

Step 5: Spray water on the marked or flagged trees in a comfortable, consistent motion to get the best spray coverage of the targeted pest. Your spraying motion and coverage should mimic an actual pesticide spray application. Enter this number in the Field Sheet under "Rep 1". This should be a whole number indicating that half or partial trees were not sprayed.

Note: If you run out of water before you are able to completely spray all marked trees for Rep 1, redo steps 3–4. It is important to remember with backpack mist sprayer systems that the higher you raise the spray tube and nozzle, the slower the solution will discharge (Fig. 4). Therefore, you may need to calibrate the sprayer for high and low tree heights.

Variability in solution output due to the raising and lowering of the sprayer orifice on mist blowers can be mitigated by the use of pressure pump kits (Fig. 5). Pres-sure pump kits can help maintain a consistent output rate when the spray tube and nozzle is held at varying angles.

Step 6: Turn the engine off and/or carefully release the pressure valve. Empty the remaining water from the tank or hopper into a container and measure (in fluid ounces). Enter this number in the Field Sheet under "Rep 1".

Note: Use a bucket or similar to capture all water remaining in the hopper and use a graduated cylinder or measuring cup or container to measure the remaining water volume.

Step 7: Repeat steps 4-6 for Rep 2 and Rep 3. Enter information into the appropriate spaces for Reps 2 and 3. The Field Sheet can then be taken indoors or to a computer or phone to finish the remaining steps.

Step 8: Using the "Sprayer Calibration" Excel spreadsheet or by hand, calculate how much water was sprayed on the trees in fluid ounces (e.g. 192 fl oz) (Fig. 6). Enter the results in the Field Sheet.

Step 9: Calculate the gallons of water per acre (GPA) sprayed and enter these results in the Field Sheet.

Step 10: Calculate the average GPA for the three repetitions and enter the results in the Field Sheet.

Step 11: Calculate the total amount of water needed to spray all acreage and enter the results in the Field Sheet.

Optional but suggested: Compare the actual spray results to your sprayer calibration estimates. If you run out of spray solution before completing the application or have excess spray solution remaining in the tank at the completion of spraying (e.g. +/– 5% difference), consider redoing the calibration. Use the publication section on "Examples of When to Calibrate" to help you determine why the difference was so great and adjust as necessary when recalibrating the sprayer.

Summary

Proper sprayer calibration is a necessary step for pesticide use. All appliers of pesticides are required to know how much product is sprayed on a targeted crop.

Spraying too much or too little pesticide wastes money. Spraying too much pesticide could lead to citations, fines and even jail time. Problems can be caused to the crop, as well as to human and environmental health. Spraying too little pesticide leads to limited to no pest control, the need to re-treat, and lowered crop yields and quality. Misuse of pesticide products can ultimately result in pesticide resistance and the loss of products for pest control, and lead to greater farm costs and losses.

Sprayers should be calibrated prior to use when there are changes in spray equipment, applicator, tree size, density and spacing, etc. that influence water use per acre. Consider new sprayer equipment and accessories that can help improve the efficacy and consistency of sprayer calibration and pesticide application.

Always read and follow the label of the pesticide you are applying. For more information, contact the Hawai'i Department of Agriculture's Pesticide Branch or your nearest UH-CTAHR Cooperative Extension.

Disclaimer

Mention of a trademark or proprietary name does not constitute an endorsement, guarantee, or warranty by the University of Hawai'i at Mānoa's College of Tropical Agriculture and Human Resources, its employees, or affiliated partners or funding agencies or organizations and does not imply a recommendation to the exclusion of other suitable products. Pesticide use is governed by state and federal regulations. Read the pesticide label to be sure that the intended crop site is included on it and follow all label directions.

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References

Cromwell, R. (2002). 1/128 of an acre method of sprayer calibration. University of Florida. AE-5. https://ufdcim-ages.uflib.ufl.edu/IR/00/00/14/94/00001/AE01200.pdf.

Ferrell, M.A. (1998). 1/128 Method of calibration calibrating hand sprayers and high pressure hand guns. College of Agriculture, University of Wyoming fact sheet. MP-93.3. http://www.wyomingextension.org/agpubs/pubs/MP93_Series/mp93-3.pdf.

Ballew J. Calibrating Sprayers: 128th of an Acre Method. Clemson (SC): Clemson Cooperative Extension, Land-Grant Press by Clemson Extension; 2020 Feb. LGP 1036. https://lgpress.clemson.edu/publication/calibrating-sprayers-128th-of-an-acre-method/.

Uyeda, J., M. Kawate, J. Coughlin, J. Kam, J. Sugano, S. Fukuda, R. Shimabuku, and K.H. Wang. (2015). Sprayer calibration using the 1/128th method for motorized back-pack mist sprayer systems. Honolulu (HI): University of Hawai'i. 5p. (Pesticide Risk Reduction Education Series; PRRE-9). https://www.ctahr.hawaii.edu/oc/freepubs/pdf/PRRE-9.pdf.

Uyeda, J., J. Sugano, S. Fukuda, M. Kawate, R. Shimabuku, and K.H. Wang. (2013). Sprayer calibration using the 1/128th method for handheld spray gun systems. Honolulu (HI): University of Hawai'i. 4p. (Pesticide Risk Reduction Education Series; PRRE-7). https://www. ctahr.hawaii.edu/oc/freepubs/pdf/PRRE-7.pdf.

Figure 1: Examples of handheld sprayer systems used on orchard crops. Backpack mist blower (top) and motorized tank sprayer with hose and wand attachment (bottom).

Figure 2: Coffee berries and leaves showing phytotoxicity and injury (brown spots) due to over-application of a pesticide.

Figure 3: Using a contractor's measuring wheel can help to calculate field area and acreage.

Figure 4: Raising and lowering the sprayer hose and nozzle on a mist blower will result in varied spray solution output so calibration for taller versus shorter trees may be necessary.

Figure 5: An example of a pressure pump kit installed on a mist blower to maintain consistent output.

Figure 6: Measuring the amount of water remaining in the tank or hopper will help you calculate the amount of water used to spray the sample trees as well as to estimate water usage in gallons per acre.

Appendix 1: Preparing and Applying the Pesticide Spray Solution

Calculating the Amount of Product per Gallon and Tankful with the Spreadsheet

Follow the steps below and utilize the spreadsheets in the "Sprayer Calibration for Orchard Crops" Excel Workbook to compute the amount of pesticide product per gallon or per tankful of water for handheld sprayers used on orchard crops. When using the spreadsheets, many of the steps are automatically calculated. As an alternative to the spreadsheets, use Appendix 4 to calculate the pesticide amounts by hand.

Read and follow all pesticide label directions prior to use and wear proper personal protective equipment (PPE) whenever handling, measuring, mixing, and applying pesticides.

To begin, click and open the appropriate spreadsheet. If the label rate recommends pints per acre, use the spreadsheet labeled "Liquid – Pints per Acre"; if pounds per acre, use "Dry – Pounds per Acre"; if dilution ratio or percent by volume, use "Liquid – Dilution or % Rate", etc.

Step 1: Determine the rate (volume if liquid or weight if dry product) of pesticide product per acre or per volume of water as directed on the label for your targeted crop and pest. Enter the product name and rate in the green boxes.

Step 2: Enter the number of acres to be sprayed and the gallons of water to be used. Note that the sheet provides the information used in the sprayer calibration.

Step 3: The spreadsheet calculates the amount of product needed per gallon of water, in order to apply the pesticide at the desired rate per acre.

Step 4: Enter the amount of water per tankful in the green box. The amount of product per tankful and for the total acreage are calculated by the spreadsheet.

Step 5 (Optional but suggested): The sheet estimates the gallons of water and number of tankfuls needed to spray the total tree acreage. Compare your actual spray results to these sprayer calibration estimates. If you run out of spray solution before completing the application or have excess spray solution remaining in the tank at the completion of spraying (e.g. +/– 5% difference), consider redoing the calibration. The publication section on "Examples of When to Calibrate" might help to find a cause and how to adjust for it.

Mixing and Spraying Pesticides

Always clean the spray tank, hose and/or nozzle before and after use and follow all label directions for tank mixing. If the proper order of mixing is not followed, such problems as plant phytotoxicity, physical incompatibility or dilution of the spray solution, and partial or complete reduction of pesticide effectiveness, can occur.

Step 1: Set the sprayer or tank on a level surface and fill the tank or hopper with about half the volume of water needed per tankful.

Step 2: Check the label instructions and adjust the water pH prior to tank mixing as needed.

Step 3: Measure out the proper amount of product. Add and mix well when incorporating the pesticide into the tank (containing water) and maintain agitation. Read and follow all pesticide label directions prior to adding and mixing other products such as adjuvants, surfactants, stickers, fertilizers, etc. to the tank mix.

Note: For wettable powders and dry flowables, use a separate container and create a slurry at a 2:1 water to pesticide ratio before adding to the partially filled spray tank.

Step 4: Fill the remainder of the tank with water to the proper gallonage needed and continue agitation for even distribution of the pesticide.

Step 5: Direct the spray to the crop and pest and apply the pesticide with good spray coverage technique.

Step 6: Repeat Steps 1–5 until all acreage is sprayed.

Appendix 2. Field Sheet for Sprayer Calibration

Farm/Field_____ **Sprayer & equipment**_____ **Date:**_____

Sprayer Calibration				
Step #	**Activity**	**Actual**		
Step 1:	Determine the total crop acreage to be sprayed.	_____ acres		
Step 2:	Determine the total number of trees per acre to be sprayed.	_____ trees per acre		
		Rep 1	Rep 2	Rep 3
Step 3:	Select representative trees, count, and mark or flag. Record the number of trees.	_____ trees	_____ trees	_____ trees
Step 4:	Fill sprayer tank ⅔ - ¾ full of water and measure.	_____ fl oz	_____ fl oz	_____ fl oz
Step 5:	Spray the tagged trees. No half or partially sprayed trees.			
Step 6:	Empty and measure the remaining water (in fluid ounces) from the hopper or tank.	_____ fl oz	_____ fl oz	_____ fl oz
Step 7:	Repeat steps 4–6.			
Step 8:	Calculate how much water was sprayed on the trees in fluid ounces.	_____ fl oz	_____ fl oz	_____ fl oz
Step 9:	Calculate the gallons of water per acre (GPA) sprayed.	_____ GPA	_____ GPA	_____ GPA
Step 10:	Average GPA for the three repetitions.	_____ ave. GPA		
Step 11:	Total amount of water needed to spray all acreage.	_____ total gals		
Optional but suggested: Compare results to actual spraying.				
	Actual amount of water sprayed on total acreage.	_____ total gals		
	If you run out of spray solution before completing the application or have excess spray solution remaining in the tank at the completion of spraying (e.g. +/– 5% difference), consider redoing the calibration.	_____ gals too many _____ gals short		

Notes:

Save this sheet for your records

Appendix 3. Hand Calculations and Example for Sprayer Calibration

Use the field sheet for your answers.

Sprayer Calibration				
Step #	**Activity**	**Result**		
Step 1:	*Determine total crop acreage to be sprayed.* Two acres are planted in coffee.	2 acres		
Step 2:	*Determine total number of trees per acre to be sprayed.* The trees are planted at 8 x 8 ft spacing, so s/he estimated the number of trees per acre using the table.	676 trees per acre		
Step 3:	*Select representative trees and tag. Record number of trees.* The farmer selects 10 coffee trees that are representative of the farm and flags these trees for the Rep 1 spray. Twenty additional coffee trees are flagged for Reps 2 and 3 (10 trees each).	10 trees	10 trees	10 trees
Step 4:	*Fill sprayer tank with water ⅔ - ¾ full and measure.* The farmer sets the sprayer on level ground and decides to measure and put in 2 gallons, or 2/3 full. Each gallon is 128 fluid ounces, so 2 gals equals 256 fl oz.	256 fl oz	256 fl oz	256 fl oz
Step 5:	*Spray tagged trees*. The farmer sprays the first set of 10 flagged coffee trees, obtaining good spray coverage on these trees.	Spraying completed		
Step 6:	*Empty and measure the remaining water.* After spraying the 10 trees, the farmer turns the sprayer off and empties the remaining volume of water in the tank into a bucket. He/she measures the remaining liquid to be 188 fluid ounces.	188 fl oz	200 fl oz	195 fl oz
Step 7	The farmer repeats steps 4–6 for Rep 2 and 3. Rep 2: The farmer again fills the spray tank with 256 fluid ounces of water and sprays 10 more coffee trees that were flagged in step 3. He/she measures the remaining volume of water in the tank at 200 fluid ounces. Rep 3: The farmer fills the spray tank with 256 fluid ounces of water for the third time and sprays the last set of 10 coffee trees. He/she measures the remaining volume of water in the tank at 195 fluid ounces			
Step 8:	*Calculate how much water was sprayed.* The farmer calculates the amount of fluid sprayed by subtracting the volume remaining from the starting volume of water. *(starting water volume) – (ending water volume) = amount of water sprayed*	68 fl oz	56 fl oz	61 fl oz

	Rep 1: 256 – 188 = 68 fluid ounces sprayed on 10 coffee trees Rep 2: 256 – 200 = 56 fluid ounces sprayed Rep 3: 256 – 195 = 61 fluid ounces sprayed. Rep1: ____ - ____ = ____ fl oz sprayed Rep2: ____ - ____ = ____ fl oz sprayed Rep3: ____ - ____ = ____ fl oz sprayed	*Enter answers into field sheet*		
Step 9:	*Calculate the gallons of water per acre (GPA).* He/she calculates the volume of water sprayed per acre. There are 128 fluid ounces per gallon. *(Water sprayed / number of trees sprayed) x trees per acre = water needed for one acre in fl oz* *Water needed for one acre in fl oz / 128 = gallons per acre* Rep1: (68 / 10) x 676 = 4596.8 fl oz / 128 = 35.9 gallons per acre Rep2: (56 / 10) x 676 = 3785.6 fl oz / 128 = 29.6 gals per acre Rep3: (61 / 10) x 676 = 4123.6 fl oz / 128 = 32.2 gals per acre Rep1: ____ / ____ x _____ = _____ / 128 = _____ gals per acre Rep2: ____ / ____ x _____ = _____ / 128 = _____ gals per acre Rep3: ____ / ____ x _____ = _____ / 128 = _____ gals per acre	35.9 GPA	29.6 GPA	32.2 GPA
		Enter answers into field sheet		
Step 10:	*Average GPA for the three repetitions.* He/she calculates the average volume of water per acre by adding up the for the three reps, then dividing the sum by three. *(GPA1 + GPA2 + GPA3) / 3 = average gallons per acre* (35.9 + 29.6 + 32.2) / 3 = (97.7) / 3 = 32.57 gallons of water per acre _____ + _____ + _____ = (_____) / 3 = _____ gallons per acre	32.6 gallons ave GPA		
		Enter answers into field sheet		
Step 11:	*Total amount of water needed to spray all acreage.* The farmer calculates the total amount of water needed to spray all two acres. *Gallons per acre x acres to spray = total water needed* 32.57 x 2 = 65.1 gallons of water	65.1 gallons of water for two acres		
		Enter answers into field sheet		

Optional: Compare results to actual spraying. Enter your answers into field sheet.		
	Actual amount sprayed. The farmer estimated that s/he actually used 54.2 gallons to spray the two acres	54.2 total gals
	Compare the results. What is the difference between the estimate and the actual amount of water need to spray the total acreage? *Step 11 minus the actual amount of water sprayed.* 65.1 estimate – 54.2 actual = 10.9 gallons difference In this case, the farmer actually used nearly four tankfuls less water than estimated and the amount of chemical was also lower than the selected label rate. The farmer is considering redoing the calibration after thinking about what might have caused the difference and adjusting for it.	10.9 gals difference The estimate is greater (less water was actually sprayed than had been estimated).

Unit Conversions

Area:
1 acre = 43,560 square feet
1 hectare = 2.47105 acres = 107,639 square feet

Liquid measure:
1 gallon = 4 quarts = 8 pints = 16 cups = 128 fluid ounces
1 gallon = 3.785 liters = 3,785.1 milliliters
1 liter = 1000 milliliters = 0.264 gal = 33.814 fluid ounces
1 quart = 2 pints = 4 cups = 32 fluid ounces
1 pint = 2 cups = 16 fluid ounces
1 cup = 8 fluid ounces = 16 tablespoons
1 fluid ounces = 2 tablespoons = 6 teaspoons = 29.574 milliliters
1 tablespoon = 3 teaspoons = 1/2 fluid ounces = 14.787 milliliters
10 milliliters = 0.338 fluid ounces

Dry measure:
1 pound = 16 ounces = 454 grams
1 ounce = 28.35 grams

Note on Measurements:
Fluid ounces, gallons, ounces, pounds, etc. is used because these units of measurement correspond with different pesticide labels.

Appendix 4. Hand Calculations and Example for Pesticide Calculations, Mixing and Application

Enter your answers in the spaces provided on this sheet

Pesticide Calculations		
Background: The grower determines that the farm needs to be treated for anthracnose, cercospora and coffee leaf rust. A mist blower with a 3-gallon tank will be used. S/he decides to use Badge X2. According to the label, 2.5 pounds per acre should be sprayed.		
Step #	**Activity**	**Result**
Step 1:	*Determine the rate of pesticide product.* In accordance with the label, the proper product and rate is selected by the farmer to control anthracnose, cercospora and coffee leaf rust on coffee.	Label rate: 2.5 pounds of Badge X2 per acre
Step 2:	*Using the pesticide label rate, convert units.* The farmer converts the per acre rate for ease of measuring. S/he has a choice of ounces or grams. *Label rate in lbs x 16 oz = ounces of product per acre* *or* *Label rate in lbs x 454 grams = grams per acre* 2.5 lbs x 16 oz per lb = 40 ounces of Badge X2 per acre, or 2.5 lbs x 454 grams per lb = 1,135 grams of Badge X2 per acre	Converted label rate: 40 ounces or 1,135 grams of Badge X2 per acre Your answer:
Step 3:	*Determine the water use rate per acre (GPA) and calculate the amount of product per gallon.* The farmer uses the gallons per acre (GPA) rate from the sprayer calibration and calculates the amount of Badge X2 per gallon of water. *Prod. label rate per acre in oz, g or fl oz ÷ GPA = amount of prod. per gal of water* *(prod. label % rate) x 1.28 = amount of prod. per gal of water* For ounces: 40 ÷ 32.6 = 1.2 ounces of Badge X2 per gallon of water, or For grams: 1,135 ÷ 32.6 = 34.8 grams of Badge X2 per gallon of water	GPA: 32.6 Gallons Your answer: Gallons Product per gallon: 1.2 ounces or 34.8 grams of Badge X2 per gallon of water Your answer per gallon of water
Step 4:	*Determine amount of water per tankful then calculate amount of product per tankful.* The farmer's mist blower holds a total of 4-gallons of water, but the farmer only wants to fill the hopper/tank with 3 gallons of solution. S/he calculates how much product to add to 3 gallons of water.	Gals per tank 3 gallons per tank Your answer

	Amount of product per gallon of water (from step 3) x (gallons of water per tankful) = amount of product per tankful For ounces: 1.2 x 3 = 3.7 ounces of Badge X2 per tankful (3 gallons), or For grams: 34.8 x 3 = 104.5 grams of Badge X2 per tankful (3 gallons)	Product per gallon 3.7 ounces or 104.5 grams of Badge X2 per tankful Your answer Per tankful
Step 5: *Optional*	The farmer is curious as to how many times he/she needs to refill the tank with pesticide and water to spray the 2 acres. S/he uses the results from step 11 of the calibration to get total gallons needed. *Total gallons needed ÷ gallons per tankful = tanks needed* 75.2 ÷ 3 = 21.7 tanks to spray 2 acres	21.7-tankfuls needed to spray 2 acres of coffee. The farmer considers purchasing a larger spray tank and sprayer to reduce the time to refill and mix each tankful of pesticide solution.
Spray Solution Mixing and Application		
Steps	**Activity**	**Result**
Step 1:	The farmer sets the mist blower on a level surface and fills the tank with 1.5 gallons of water.	Completed
Step 2:	S/he checks the water pH and decides that no adjustment is needed.	pH = 7.2
Steps 2 & 3:	S/he weighs 3.7 ounces of Badge X2 with a scale, adds about 8 fluid ounces of water to create a slurry, and then adds the pre-mixed slurry to the tank while stirring and agitating the water.	Completed
Step 4:	The farmer then fills the tank with water to the 3-gallon mark and closes the tank lid.	Completed
Step 5 & 6:	S/he continues agitating the mix throughout spraying and achieves good coverage as practiced during the calibration runs.	Completed
Optional:	After spraying, the farmer totals amount of spray solution applied to the two acres including the volume discharged from the final tankful. Eighteen tankfuls plus about 26 fluid ounces were discharged. The farmer takes note that he/she used a total of 54.2 gallons of solution to spray the 2 acres of coffee which was less than the water amount estimated during calibration.	Actual water use was less than estimated, and the amount of pesticide was less than the selected label rate. The farmer notes that if purchased, a new sprayer would need to be calibrated prior to use.