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Applying the correct amount of pesticide is a “must” for responsible, effective pest control. Pesticide and adjuvant labels provide information on recommended application rates. It is your job to:

1. determine the area to be sprayed,
2. determine the amount of spray solution to mix, and
3. calculate the amount of pesticide or adjuvant to be added to the spray solution to provide the appropriate application rate.

Unless you use the correct ratio of pesticide and diluent in your tank mix, even a correctly calibrated sprayer can apply the wrong amount of pesticide to the target.

Formulations such as wettable and soluble powders, emulsifiable concentrates, and flowables are sold as concentrates and must be diluted in the tank. Water is the most common diluent, but fertilizer and oils are sometimes used as the spray carrier. Consult the label to determine acceptable diluents to use and how much the formulation should be diluted.

You usually need to do some simple calculations based on the capacity of your sprayer, the spray volume your equipment is calibrated to apply per area, the size of area you want to treat, and the recommended application rate. This publication provides formulas needed to calculate dilutions in many ordinary situations and examples of how the formulas can be used.

The amount of spray solution the sprayer is calibrated to apply to a given area is referred to as the spray volume. Spray volume can vary considerably based on the type of pesticide being applied and the application site. The pesticide label will generally suggest a recommended application volume, such as gallons of spray per acre or 1,000 square feet.

Pesticides and adjuvant rates may be recommended in different ways, depending on the application site and the type of application equipment. Larger-scale field-application rates are generally recommended in terms of the amount of formulated product per acre, such as pints, quarts, or fluid ounces for liquid products and pounds or ounces for dry product per acre. Sometimes, pesticide labels also may make reference to pounds of active ingredient (a.i.) or acid equivalence (a.e.) per acre. To determine the pounds of a.i. or a.e. per acre, you need to know the concentration of the formulated product in terms of pounds of a.i. or a.e. per gallon of liquid products or percent a.i. or a.e. in dry products. Lawn products are often recommended in terms of the amount of formulated product per 1,000 square feet instead of per acre.

Adjuvants and spot treatments with handheld equipment often are recommended on a concentration basis in the spray solution. For example, surfactants usually are recommended at 0.25 percent volume/volume (v/v), which would be equal to 0.25 gallons or 1 quart of product per 100 gallons of spray solution. Dry adjuvants such as ammonium sulfate are sometimes recommended on percent weight/weight basis. Since 1 gallon of water weighs about 8.38 pound, a 1 percent w/w rate would be equal to 8.35 pounds of ammonium sulfate per 100 gallons of water, which is often rounded up to 8.5 pounds per 100 gallons of water.

Calculating Dry Formulations

Pounds of pesticide per 100 gallons

Directions for dry formulations, such as wettable or soluble powders, may be given in pounds of pesticide formulation per 100 gallons of diluent. You must know how many gallons your sprayer tank holds (or the number of gallons you will be adding to the tank if the job requires only a partial tank load). Then use the following formula:

Pounds needed in tank = Gallons in tank × pounds per 100 gallons recommended ÷ 100 gallons

Ammonium sulfate is a common adjuvant sprayed with glyphosate that is a good example of product typically recommended in this manner. AMS is recommended at 2 percent weight/weight (w/w), which equals 17 pounds per 100 gallons of spray (with a little rounding error).

Example No. 1:

Your spray tank holds 1,000 gallons. The labeling calls for 2 pounds of formulation per 100 gallons of water. How many pounds of formulation should you add to the tank to make a full tank load?

Hint: 100 gallons is 10 times less than what your tank holds, so you will need 10 times more than 2 pounds of formulation.

Pounds needed in tank = Gallons to be mixed (1,000) × pounds per 100 gallons (2) ÷ 100 gallons

$$\frac{1,000 \text{ gal.} \times 2 \text{ lbs.}}{100 \text{ gal.}} = 20 \text{ pounds needed in tank}$$

Example No. 2:

You need to spray 1 acre, and your equipment is calibrated to apply 60 gallons per acre. The labeling calls for 2 pounds of formulation per 100 gallons of water. How much formulation should you add to the tank to make 60 gallons of spray solution?

Hint: 60 gallons is slightly more than half of 100 gallons, so you will need slightly more than 1 pound (½ of the recommended 2 pounds) of formulation.

Pounds needed in tank = Gallons to be mixed (60) × pounds per 100 gallons (2) ÷ 100 gallons

$$\frac{60 \text{ gal.} \times 2 \text{ lbs.}}{100 \text{ gallons}} = 1.2 \text{ pounds needed in the tank}$$

1.2 pounds × 16 ounces per pound = 19.2 ounces needed in tank

Pounds of pesticide per acre

Labeling may list the recommended rate as pounds of pesticide formulation per acre. If the job requires a full sprayer tank, you must know the spray tank capacity (gallons) and the application volume (gallons per acre). Then use these formulas:

$$\text{Acres sprayed per tank} = \frac{\text{Gallons to be mixed}}{\text{Gallons applied per acre}}$$

Pounds needed in tank = Acres sprayed per tank × pounds of formulation per acre

Example No. 3:

Your sprayer applies 15 gallons per acre and the tank holds 800 gallons. The label rate is 3 pounds of formulation per acre. How much formulation should be added to the tank to make a full tank load?

Hint: 800 gallons is much more than 15 gallons, so you will be able to spray many acres with a tankful and will need to add many pounds of formulation to the tank.

$$\text{Acres sprayed per tank} = \frac{\text{Gallons to be mixed (800)}}{\text{Gallons per acre (15)}}$$

$$\frac{800 \text{ gal.}}{15 \text{ gal. per acre}} = 53.33 \text{ acres sprayed per tankful}$$

Pounds pesticide needed in tank = Acres sprayed per tankful (53.33) × Pounds formulation per acre (3)

53.33 × 3 = 160 pounds needed in tank

Add 160 pounds of pesticide formulation to the tank.

If the job requires less than a full tank, you must know how many acres you want to treat and how many gallons your sprayer is delivering per acre. Calculate both the number of gallons needed in the tank and the pounds of formulation to add. Use these formulas:

Gallons to be mixed = Gallons per acre × Acres to be treated

Pounds pesticide needed in tank = Acres to be treated × Pounds of formulation per acre

Example No. 4:

You want to spray 3.5 acres. Your equipment holds up to 100 gallons and delivers 15 gallons per acre. The label rate is 3 pounds per acre. How much water needs to be added to the tank? How much pesticide should be added to the tank?

Gallons of water needed in tank = Gallons per acre (15) × Acres to be treated (3.5)

$$15 \text{ gal.} \times 3.5 \text{ acres} = 52.5 \text{ gallons}$$

Pounds formulation needed in tank = Acres to be treated (3.5) × Pounds formulation per acre (3)

$$3.5 \text{ acres} \times 3 \text{ lbs.} = 10.5 \text{ lbs. formulation}$$

Pounds of formulation per 1,000 square feet

If the application rate is listed as pounds or ounces of formulation per 1,000 square feet, use the following formula:

Amount of formulation in tank = Amount in tank × Rate per 1,000 square feet ÷ Amount equipment applies per 1,000 square feet

Example No. 5:

A sprayer tank holds 3 gallons and applies 2 quarts of spray per 1,000 square feet. The label directions indicate a rate of 4 ounces of formulation per 1,000 square feet is needed. How much formulation is needed to make a tankful of spray?

Hint: Your sprayer holds 3 gallons, which is equal to 12 quarts; 16 ounces equals 1 pound.

Amount formulation in tank = Amount in tank (3 gal or 12 quarts) × rate per 1,000 square feet (4 oz.) ÷ Amount equipment applies per 1,000 square feet (2 quarts)

$$\frac{12 \text{ quarts} \times 4 \text{ oz.}}{2 \text{ quarts}} = 24 \text{ oz.}$$

$$\frac{24 \text{ oz.}}{16 \text{ oz. per lb.}} = 1.5 \text{ lbs. needed in tank}$$

Pounds of active ingredient per acre

If the recommended rate is given as pounds of active ingredient (a.i.) per acre, you must first convert that figure to pounds of formulation per acre. Use the following formula:

Pounds of formulation per acre = Pounds of a.i. per acre × 100 ÷ Percent of a.i. in formulation

Then follow the formulas listed above under the heading “Pounds of pesticide per acre” to determine pounds of pesticide to add to your tank.

Example No. 6:

You want to apply 2 pounds of active ingredient per acre. Your formulation is 80 percent wettable powder (WP). How much formulation is needed per acre?

Hint: Your formulation is less than 100 percent, so you will need a little more than 2 pounds of formulation.

Pounds of formulation per acre = Pounds of a.i. per acre (2) × 100 ÷ % a.i. in formulation (80)

$$\frac{2 \text{ lbs.} \times 100}{80 (\% \text{ a.i.})} = 2.5 \text{ lbs. formulation per acre}$$

Percent of active ingredient in tank

If the recommended rate is a percentage of active ingredient in the tank, another formula is necessary. First find the number of gallons of spray in the spray tank (either the tank capacity or gallons needed for the job if less than tank capacity). Then:

Pounds formulation needed in tank = Gallons to be mixed × % a.i. wanted × weight of carrier (lbs. per gal.) ÷ % a.i. in formulation

Example No. 7:

Your directions call for a spray containing 1.25 percent active ingredient. You need to mix 4 gallons of spray for the job. The pesticide is 60 percent soluble powder (SP) and you will use water as the diluent. How much formulation do you need to add to the tank?

Hint: Your product has 60 percent a.i. and your spray mixture is to be much less, only 1.25 percent. You will need to add only a small amount of formulation per gallon.

Pounds formulation needed in tank = Gallons to be mixed (4) × % a.i. needed (1.25) × weight of water/gal (8.3) ÷ % a.i. in formulation (60)

$$\frac{4 \text{ gal.} \times 1.25\% \text{ a.i.} \times 8.3 \text{ lbs.}}{60\% \text{ a.i. in formulation}} = 0.69 \text{ pounds formulation}$$

0.69 lbs. × 16 oz. per lb. = 11 oz. formulation needed in tank

Calculating Liquid Formulations

Application rates for liquid formulations such as emulsifiable concentrates (EC) and flowables (F) are often listed as pints, quarts, or gallons per 100 gallons of diluent or per acre. To make these calculations, use the same formulas you use for calculating dilutions for dry formulations, but substitute the appropriate liquid measure for “pounds” in the formulas.

Pints/quarts/gallons per 100 gallons

Use the following formula:

Quantity formulation needed in tank = Gallons to be mixed × Amount per 100 gallons recommended ÷ 100 gallons

Example No. 8:

The labeling rate is 2 pints of pesticide formulation per 100 gallons of water. Your spray tank holds 30 gallons. How much pesticide formulation do you need to add to the tank?

Hint: Since your tank holds about 1/3 of the 100 gallons, you will need about 1/3 of the 2 pints per 100 gallon rate.

Pints of formulation needed in tank = Gallons to be mixed (30) × Pints per 100 gal. (2) ÷ 100 gallons

$$\frac{30 \text{ gal.} \times 2 \text{ pints}}{100 \text{ gal.}} = 0.6 \text{ pints formulation}$$

0.6 pints × 16 oz. per pint = 9.6 oz. of formulation needed in tank

Pints/quarts/gallons of formulation per acre

Use these formulas:

Acres sprayed per tankful = Gallons to be mixed ÷ Gallons applied per acre

Amount formulation needed in tank = Acres sprayed per tank × Amount formulation per acre

Example No. 9:

Your sprayer applies 22 gallons per acre and the tank holds 800 gallons. The label rate is 1.5 quarts per acre. How much pesticide formulation should be added to make a full tank?

Hint: 22 gallons per acre will treat just under 5 acres with 100 gallons, so 800 gallons will treat just under 40 acres. Therefore, your answer should be less than 40 acres × 1.5 quarts per acre, so less than 60 quarts.

Acres sprayed per tankful = Gallons to be mixed (800) ÷ Gallons per acre (22)

$$\frac{800 \text{ gal.}}{22 \text{ gal. per acre}} = 36.4 \text{ acres sprayed per tankful}$$

Formulation needed per tank = Acres per tank (36.4) × Amount formulation per acre (1.5 qts.)

36.4 acres × 1.5 qts. = 54.6 (54 qts, 1 pint, 3.2 oz.) per acre (1 qt. = 32 oz. therefore 32 oz. × .6 = 19.2 oz.)

Pints/quarts of formulation per 1,000 square feet

If the application rate is listed as pints or quarts of formulation per 1,000 square feet, use the following formula:

Formulation needed in tank = Amount in tank × Rate per 1,000 sq. ft. ÷ Amount equipment applies per 1,000 sq. ft.

Example No. 10:

Your sprayer tank holds 10 gallons and applies 1.5 quarts of spray per 1,000 square feet. The label directions indicate a rate of 5 tablespoons per 1,000 square feet. How much formulation do you need to make a tankful of spray?

Hint: Your sprayer holds 10 gallons, which is 40 quarts, and 64 tablespoons = 1 quart.

Formulation needed in tank = Amount in tank (10 gal. or 40 qts.) × Rate per 1,000 sq. ft. (5 Tbsp.) ÷ Amount equipment applies per 1,000 sq. ft. (1.5 qts.)

$$\frac{40 \text{ qts.} \times 5 \text{ Tbsp.}}{1.5 \text{ qts.}} = 133 \text{ Tbsp.}$$

$$\frac{133 \text{ Tbsp.}}{64 \text{ Tbsp. per qt.}} = 2 \text{ qts. plus } 5 \text{ Tbsp. (2.08 qts.) formulation needed in tank.}$$

Pounds of active ingredient per acre

The recommendation for the liquid formulation may be listed as pounds of active ingredient (a.i.) per acre. You must first calculate how many gallons of formulation would be needed per acre to achieve that rate. The label of a liquid formulation always tells how many pounds of active ingredient are in a gallon of the concentrated formulation (4 EC has approximately 4 pounds of active ingredient per gallon; 6 EC contains approximately 6 pounds per gallon, etc.). Use the following formula:

$$\text{Gallons of formulation per acre} = \frac{\text{Pounds a.i. to apply per acre} \div \text{Pounds a.i. per gallon formulation}}$$

Then use the formulas above under "Pints/quarts/gallons of formulation per acre" to calculate the dilution.

Example No. 11:

The recommendation is for 1 pound of a.i. per acre. You purchased an 8 EC that contains 8 pounds of active ingredient per gallon. Your tank holds 500 gallons and is calibrated to apply 25 gallons per acre. How many acres per tankful can you treat? How much formulation would you need for a full tank?

$$\text{Amount per acre} = \frac{\text{Pounds a.i. to apply per acre (1)} \div \text{Pounds a.i. per gallon (8)}}$$

$$\frac{1 \text{ lb. a.i. per acre}}{8 \text{ lbs. a.i. per gal.}} = 0.125 \left(\frac{1}{8}\right) \text{ gal. per acre}$$

$$\text{Acres per tankful} = \frac{\text{Gallons to be mixed (500)} \div \text{Gallons per acre (25)}}$$

$$\frac{500 \text{ gal.}}{25 \text{ gal. per acre}} = 20 \text{ acres per tankful}$$

$$\text{Gallons to add to tank} = \text{Acres per tankful (20)} \times \text{Gallons per acre } \left(\frac{1}{8} \text{ or } 0.125\right)$$

$$20 \text{ acres} \times 0.125 \text{ gal. per acre} = 2.5 \text{ gal. to add to tank}$$

Percent of active ingredient in tank

If the recommended rate is a percentage of active ingredient in the tank, use this formula:

$$\text{Gallons of formulation to add} = \frac{\text{Gallons to be mixed} \times \% \text{ a.i. wanted} \times \text{weight of water (8.3 lbs./gal.)} \div \text{Pounds a.i. per gallon of formulation} \times 100}$$

Example No. 12:

You want to make 100 gallons of a 1 percent spray, using water as the diluent. You have a 2 EC formulation (pesticide label tells you this is 2 pounds active ingredient per gallon). How many gallons of the 2 EC should you add to the 100 gallons of water in the tank?

$$\text{Gallons of formulation to add} = \frac{\text{Gallons to be mixed (100)} \times \% \text{ a.i. wanted (1\%)} \times \text{weight of water (8.3)} \div \text{Pounds a.i. per gallon of formulation (2)} \times 100}$$

$$\frac{100 \text{ gal.} \times 1\% \times 8.3}{2 \text{ lbs.} \times 100} = 41.5 \text{ gal. formulation to add to tank}$$

Weight and Measures Conversions

Weight

16 ounces = 1 pound = 453.6 grams

1 gallon water = 8.34 pounds = 3.78 liters

Liquid Measure

1 fluid ounce = 2 tablespoons = 29.57 milliliters

16 fluid ounces = 1 pint = 2 cups

8 pints = 4 quarts = 1 gallon

Length

3 feet = 1 yard = 91.44 centimeters

16.5 feet = 1 rod

5,280 feet = 1 mile = 1.61 kilometers

320 rods = 1 mile

Area

9 square feet = 1 square yard

43,560 square feet = 1 acre = 160 square rods

1 acre = 0.405 hectare

640 acres = 1 square mile

Speed

88 feet per minute = 1 mph

1 mph = 1.61 kilometer per hour

Volume

27 cubic feet = 1 cubic yard

1 cubic foot = 1,728 cubic inches = 7.48 gallons

1 gallon = 231 cubic inches

1 cubic foot = 0.028 cubic meters

Common Abbreviations and Terms

FPM = feet per minute

GPA = gallons per acre

GPH = gallons per hour

GPM = gallons per minute

mph = miles per hour

psi = pounds per square inch

RPM = revolutions per minute

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