CATEGORY X: CALCULATION METHODS AND CONVERSIONS FOR PESTICIDE APPLICATIONS

The performance and safety of any pesticide depends on the application of the proper amount of the pesticide over a given area. Sprayers and spreaders are important tools for the pest control industry. The proper selection, calibration, use, and maintenance are very important for the efficent and effective application of pesticides, as well as for the protection of the environment.. While these issues are important to all pesticide applicators, they play a significant role to individuals conducting research and demonstrating the proper use of pesticides. It is critical that the proper amount of pesticide is applied to a specific area. The following are some important calculations and conversions used for these purposes.

CALCULATIONS TO DETERMINE APPLICATION CRITERIA

1. **To determine the amount of product needed to mix in the spray tank:**

$$\text{Number of gallons or pounds of formulation} = \frac{\text{number of acres to be sprayed X pounds active ingredient (AI) required per acre (A)}}{\text{pounds active ingredient per gallon or per pound of formulated product}}$$

2. **To determine the amount of pesticide needed to mix a spray containing a certain percentage of active ingredient:**

$$\text{Number of gallons or pounds of formulation (concentration)} = \frac{\text{gallons of spray desired X \% active ingredient wanted X 8.345 *}}{\text{(pounds active ingredient per gallon or per pound of formulated product) X 100}}$$

3. **To determine the percent active ingredient in a spray mixture:**

$$\text{Percent (Dry materials)} = \text{pounds of concentrate used (not just active ingredient)} \times \frac{\text{\% active ingredient in the concentrate}}{\text{Gallons of spray X 8.345}}$$

$$\text{Percent (Liquid)} = \frac{\text{Gallons of concentrate X active ingredient per gallon}}{\text{Gallons of spray X 8.345}}$$

* 8.345 is the weight in pounds of one gallon of water

4. **To determine the amount of pesticide needed to apply a dust with a given percent active ingredient:**

Pounds material

$$= \frac{\text{\% active ingredient wanted X pounds mixed dust wanted}}{\text{\% active ingredient inpesticide used}}$$

5. **To determine the pump capacity needed to apply a given number of gallons per acre:**

Pump capacity (Gallons per minute - GPM) for nozzles only **

$$= \frac{\text{gallons per acre desired X boom width (feet) X miles per hour (MPH)}}{495}$$

6. **To determine the nozzle capacity in gallons per minute at a given rate per acre and miles per hour:**

Nozzle capacity (Gallons per minute - GPM)

$$= \frac{\text{gallons per acre X nozzle spacing (inches) X miles per hour (MPH)}}{5{,}940}$$

7. **To determine acres per hour sprayed (100% field efficiency):**

Acres per hour

$$= \frac{\text{swath width (inches) X miles per hour}}{100}$$

8. **To determine the acreage sprayed per hour (70% field efficiency):**

Acres per hour

$$= \frac{\text{boom width (feet) X miles per hour}}{12}$$

(This allows 30% of the time for filling, turning, etc.)

9. **To determine the rate of speed in miles per hour:**

First measure off a distance of 300 to 500 feet.
Second measure in seconds the time it takes the tractor to go the marked-off distance:

Miles per hour

$$= \frac{\text{0.682 X distance (feet)}}{\text{seconds to travel distance}}$$

** Add requirement for jet agitation (if used) and increase total by 20 - 25% to provide reserve against reduced capacity due to wear to determine size of pump to buy.

10. To determine the nozzle flow rate:

First note the time in seconds necessary to fill a quart jar (32 fluid ounces) from a nozzle:

Gallons per minute per nozzle

$$= \frac{15}{\text{seconds to fill quart jar}}$$

11. To determine the the gallons per minute per boom:

Calculate the gallons per minute per nozzle X the number of nozzles

12. To determine the gallons per acre delivered:

Gallons per acre

$$= \frac{5{,}940 \text{ X gallons per minute per nozzle}}{\text{nozzle spacing (inches) X miles per hour}}$$

13. Spray tank capacity:

For cylindrical tanks:

Number of gallons = length (inches X diameter (inches) squared X 0.0034

For eliptical tanks:

Number of gallons = length (inches) X short diameter (inches) X long diameter (inches X 0.0034

For rectangular tanks:

Number of gallons = length (inches) X width (inches) X depth (inches) X 0.004329

14. To determine the acres in a given area:

Number of acres = length in feet X width in feet X 0.000023

15. To calibrate a knapsack sprayer:

Spray a measured square rod area (272.25 square feet) for one minute

Gallons per acre = 20 X pints caught in one minute

AREA AND VOLUME CONVERSIONS

LINEAR MEASURE

1 foot = 12 inches
1 yard = 3 feet
1 rod = 5.5 yards = 16.5 feet
1 mile = 1,760 yards = 5,280 feet

SQUARE MEASURE

1 square foot = 144 square inches
1 square yard = 9 square feet
1 square rod = 272.25 square feet
1 acre = 43,560 square feet = 4,840 square yards = 160 square rods
1 square mile = 640 acres
1 acre = 209 square feet

CUBIC MEASURE

1 cubic foot = 1,728 cubic inches = 29.922 quarts = 7.48 gallons
1 cubic yard = 27 cubic feet
1 cubic foot of water = 62.4 pounds

LIQUID MEASURE

1 tablespoon = 3 teaspoons
1 fluid ounce = 2 tablespoons
1 cup = 8 fluid ounces
1 pint = 2 cups = 16 fluid ounces
1 quart = 2 pints = 32 fluid ounces
1 gallon = 4 quarts = 8 pints = 128 fluid ounces

WEIGHT MEASURE

1 pound = 16 ounces
1 hundredweight = 100 pounds
1 ton = 2,000 pounds = 20 hundredweight

METRIC CONVERSIONS

1 gram = .325 ounces
1 kilogram = 2.2. pounds
1 quintal = 100 kilograms = 221 pounds
1 metric ton = 1,000 kilograms = 2,205 pounds
1 hectare = 2.47 inches
1 meter = 39.4 inches
1 kilometer = 0.062 miles
1 liter = 1.056 quarts = 33.79 ounces

TEMPERATURE CONVERSIONS

°F	°C	°F	°C
32.0	0	78.8	26
35.6	2	82.4	28
39.2	4	86.0	30
42.8	6	89.6	32
46.4	8	93.2	34
50.0	10	96.8	36
53.6	12	100.4	38
57.2	14	104.0	40
60.8	16	122.0	50
64.4	18	140.0	60
68.0	20	158.0	70
71.6	22	176.0	80
75.2	24	194.0	90
		212.0	100

CONVERSION FORMULAS

Volume of a sphere = $(\text{diameter})^3 \times 0.5236$

Diameter = circumference X 0.31831

Area of a circle = $(\text{diameter})^2 \times 0.7854$

Area of an ellipse = wide diameter X narrow diameter X 0.7854

Volume of a cone = area of base $\times \frac{\text{height}}{3}$

Pressure in pounds per square inch = height (depth) of water X 0.433

Parts per million (ppm) = percentage X 10,000

Percentage = $\frac{\text{parts per million (ppm)}}{10{,}000}$

The formula for conversion from Centigrade to Fahrenheit is:

$$°F = \frac{(°C \times 9)}{5} + 32 \quad \text{or} \quad °F = (°C \times 1.8) + 32$$

The formula for conversion from Fahrenheit to Centigrade is:

$$°C = (°F - 32) \times \frac{5}{9} \quad \text{or} \quad °C = (°F - 32) \times 0.556$$

CONVERSION FACTORS

To Convert From	To	Multiply By
cubic feet	gallons	7.48
cubic feet	liters	28.30
gallons	millimeters	3,785.00
grams	pounds	0.0022
grams/liter	parts/million (ppm)	1,000.00
grams/liter	pounds/gallon	0.00834
liters	cubic feet	0.0353
milligrams/liter	parts/million	1.00
milliliters	gallon	0.00026
ounces	grams	28.35
parts/million	grams/liter	0.001
parts/million	pounds/million gallons	8.34
pounds	grams	453.59
pounds/gallon	grams/liter	119.84

CONVERSION RATES OF APPLICATION

1 ounce per square foot	= 2,722.5 pounds per acre
1 ounce per square yard	= 302.5 pounds per acre
1 ounce per 100 square feet	= 27.2 pounds per acre
1 pound per 100 square feet	= 435.6 pounds per acre
1 pound per 1,000 square feet	= 43.6 pounds per acre
1 gallon per acre	= 3 ounces per 1,000 square feet
5 gallons per acre	= 1 pint per 1,000 square feet
100 gallons per acre	= 2.3 gallons per 1,000 square feet, or
	= 1 quart per 100 square feet
100 pounds per acre	= 2.3 pounds per 1,000 square feet

PARTS PER MILLION (ppm) RELATIONSHIPS

1 gram in 100 milliliters of water	= 10,000 ppm	= 1.0%
1 gram in 1 liter	= 1,000 ppm	= 0.1%
1 gram in 10 liters	= 100 ppm	= 0.01%
1 gram in 100 liters	= 10 ppm	= 0.001%
1 gram in 1,000 liters	= 1.0 ppm	= 0.0001%
1 gram in 10,000 liters	= 0.1 ppm	= 0.00001%

100 parts per million (ppm) = 1.33 ounces (weight) per 100 gallons

OR

0.1 grams per liter
1.0 gram per 10 liters
10.0 grams per 100 liters
100.0 grams per 1,000 liters

METRIC EQUIVALENTS

100 liters	= 105.7 quarts	= 26.43 gallons
100 gallons	= 378.5 liters	
1 ounce	= 28.35 grams	
1 gram	= 0.035 ounces	
10 grams	= 0.35 ounces	
100 grams	= 3.53 ounces	

QUANTITIES OF PESTICIDE IN LIQUID FORMULATION FOR EQUIVALENCE BETWEEN 100 GALLONS AND 1 GALLON

Pounds of Active Ingredient (AI) per Gallon of Formulation	Teaspoons per Gallon to Equal 1 Pound per 100 Gallons of Dilute Spray
1	8
2	4
3	3
4	2
6	1½
8	1

CONVERSION TABLES FOR SMALL AREA SPRAYING

Dry Materials

Rate per Acre	Rate per 1,000 Square Feet
1 lb	0.4 oz
2 lb	0.7 oz
3 lb	1.1 oz
4 lb	1.5 oz
5 lb	1.8 oz
6 lb	2.2 oz
8 lb	2.9 oz
10 lb	3.7 oz
20 lb	7.4 oz
40 lb	14.7 oz
50 lb	18.4 oz
100 lb	36.7 oz
200 lb	73.5 oz
300 lb	110.2 oz
400 lb	147.0 oz
500 lb	183.7 oz

Liquid Materials

Rate per Acre	Rate per 1,000 Square Feet
1 pt	0.4 fl oz
1 qt	0.7 fl oz
1 gal	2.9 fl oz
2 gals	5.9 fl oz
3 gals	8.8 fl oz
5 gals	14.7 fl oz
10 gals	29.4 fl oz
15 gals	2.8 pts
20 gals	3.7 pts
25 gals	2.3 qts
50 gals	4.6 qts
75 gals	6.9 qts
100 gals	9.2 qts
200 gals	18.4 qts

TRACTOR SPEED AND SPRAY RATES

$$\text{Tractor Speed (mph)} = \frac{\text{gallons per minute x 495}}{\text{gallons per acre X width of spray (feet)}}$$

$$\text{Gallons per Acre} = \frac{\text{gallons per minute X 495}}{\text{miles per hour X width of spray (feet)}}$$

$$\text{Tractor Speed (mph)} = \frac{\text{0.682 X distance in feet}}{\text{seconds}}$$

$$\text{Gallons per Minute} = \frac{\text{gallons per acre X miles per hour X nozzle spacing in inches}}{\text{5,940}}$$

CALIBRATION OF NOZZLE FLOW RATES

Gallons per Minute	Seconds for 1 Pint	Gallons per Minute	Seconds for 1 Quart
0.05	150	0.175	86
0.06	125	0.20	75
0.07	107	0.225	67
0.08	94	0.25	60
0.09	84	0.30	50
0.10	75	0.325	46
0.11	68	0.35	43
0.12	63	0.40	38
0.13	58	0.425	35
0.14	54	0.45	33
0.15	50	0.50	30