MONTGUIDE
MT 2000-14 Agriculture

Calculations and Conversions For Pesticide Applications

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1. Determining the Gallon per Minute (GPM) required of nozzles to achieve a given Gallon per Acre (GPA)

Example 1

You want an output of 20 GPA. Your nozzles are 20" apart. Your field speed is 5 MPH. How much do you need to collect from each nozzle to achieve 20 GPA?

$$\frac{20 \text{ GPA} \times 5 \text{ MPH} \times 20}{5940} = \frac{2000}{5940}$$

= 0.336 GPM per nozzle

Formula #1

$$GPM = \frac{GPA \times MPH \times W}{5940}$$

GPM = *Gallons Per Minute from one nozzle*

GPA = *Gallons Per Acre*

W = *nozzle spacing (inches) or;*

= *spray width (inches) if using a broadjet or;*

= *row spacing (inches) divided by the number of nozzles per row.*

MPH = *Field speed in Miles Per Hour*

5940 = *a constant*

a. Converting Gallons per Minute (GPM) to Ounces per Minute (OPM)

OPM = GPM X 128 **Formula 1a**

Remember! *There are 128 ounces in one gallon.*

Example 1a

From Example 1 you have collected 0.336 GPM from each nozzle. 0.366 x 128 = 43 OPM per nozzle.

b. Convert OPM to GPM.

GPM = OPM ÷ 128 **Formula 1b**

Example 1b

You have collected 43 OPM from each nozzle.
43 OPM ÷ 128 = 0.336 GPM

2. Determining GPA when given nozzle GPM, spacing between nozzles and field speed

$$GPA = \frac{GPM \times 5940}{MPH \times W}$$ **Formula #2**

Example 2

Nozzle spacing = 20''. Field speed = 5 MPH. You collected liquid from all of the nozzles for one minute and obtained an average of 51 ounces per minute ***per nozzle***. Convert 51 OPM to GPM! 51 OPM ÷ 128 = 0.398 or 40 GPM per nozzle.

$$\frac{0.398 \text{ GPM} \times 5940}{5 \text{ MPH} \times 20} = \frac{2364.12}{100}$$

= 23.64 or 24 GPA

3. Determining required speed when you know GPA, GPM and spacing between nozzles or broadjet swath

$$MPH = \frac{GPM \times 5940}{GPA \times W}$$ **Formula #3**

Note: *For this example, W = broadjet width in inches. (feet x 12 = inches)*

Example 3a

Nozzle output = 10 GPM. Swath width = 35 feet (420 inches). Desired GPA = 30 GPA. What speed do you need to be traveling to achieve 30 GPA?

$$\frac{10 \text{ GPM} \times 5940}{30 \text{ GPA} \times 420} = \frac{59{,}400}{12{,}600}$$

= 4.7 or 5 MPH

Note: *This is a broadjet example. If you had nozzles that were 20" apart and GPM was .40 GPM, your answer would be 3.96 or 4 mph!*

b. Determining new field speed when output is not correct to achieve a desired GPA.

(Using formula #1 and #3.)

Example 3b

You want 30 GPA with a field speed of 7 MPH and nozzle spacing is 30". Using formula # 1, you determine that you need to collect 1 GPM from each nozzle. When you check the nozzles, the output is actually 1.5 GPM. You can either change the nozzles or adjust your field speed to achieve 30 GPA.

$$\frac{1.5 \text{ GPM} \times 5940}{30 \text{ GPA} \times 30"} = \frac{8{,}910}{900}$$

= 9.9 or 10 MPH as the new field speed

4. How much area can my sprayer cover (acres)?

Volume in tank / GPA = Acres treated **Formula #4**

Example 4

Your sprayer is calibrated at 30 GPA. You have a sprayer with a 500 gallon tank. How many acres can you treat with 500 gallons? How many can you treat with 250 gallons?

$\frac{500 \text{ gallons}}{30 \text{ GPA}}$ = 16.6 acres treated

$\frac{250 \text{ gallons}}{30 \text{ GPA}}$ = 8.3 acres treated

5. How much total solution do you need in order to spray a given acreage?

Acres to spray x GPA = Gallons required **#5**

Example 5

You want to spray 10 acres and your sprayer is calibrated to 25 GPA. How much total solution do you need in your sprayer tank?

10 acres x 25 GPA = 250 gallons

6. How much pesticide, dry or liquid, do you add to the tank when rate is given on a per acre basis?

Acres treated x labeled rate = Amount of pesticide to add to the tank **Formula #6**

Example 6a

Your sprayer can treat 30 acres and the label calls for a rate of 1 pint/per acre. How much pesticide do you add to the tank?

30 acres x 1 pint = 30 pints or 3-3/4 gallons (30 ÷ 8) (8 pints per gallon)

Example 6b

Using the information in Example 6a, you are using *Busted ™ WP,* a wettable powder, at a labeled rate of 10 ounces per acre. How much pesticide do you add to the tank to treat 30 acres? (Remember you are dealing with dry ingredients: 16 oz./lbs.)

30 acres x 10 ounces = 300 ounces
or 18-3/4 pounds (300÷16 oz. per pound)

7. How much liquid pesticide do you add to the tank when the rate is given according to pounds of active ingredient (a.i.) per acre such as with university recommendations?

Labeled Rate Per Acre / Amount of a.i. per gallon = Gallon amount to apply **Formula #7**

Example 7a

A university bulletin recommends that you apply 3 lb/acre of the active ingredient (a.i.) found in *Smashem EC*™ insecticide. This insecticide contains 8 lbs. of a.i. per gallon of formulation.

3 lbs. per acre ÷ 8 lbs. a.i per gallon = 0.375 gallons per acre ***or*** 1-1/2 quarts per acre (0.375 x 4) ***or*** 3 pints per acre (0.375 x 8).

Example 7b

You have calibrated a 300 gallon sprayer. It can spray 7.5 acres per tank at 40 GPA. A recommendation indicates to apply 1/2- pound a.i. of *schnozaline* per acre to control weeds. The label for *schnozaline* indicates that it contains 2 pounds of a.i. per gallon. How much *schnozaline* will you add to the tank to spray 7.5 acres?

$\frac{0.50 \text{ lb a.i./acre}}{2 \text{ lb a.i./gallon}}$ = 0.25 gallon (1 quart) per acre

7.5 acres/tank x 1 quart per acre = 7.5 quarts

8. How much dry pesticide do you apply per acre when the rate is given as a percentage of a.i.?

Recommended rate / % a.i. per lbs of formulation = lbs. of formulation/acre **Formula #8**

Example 8

A recommended rate of 0.2 lbs. a.i./acre of a 25% wettable powder (WP) is recommended. (One pound of formulation contains 0.25 lbs. a.i.)

$\frac{0.2 \text{ lbs. per acre}}{0.25 \text{ lbs. a.i.}}$ = 0.80 lb formulation per acre

To convert to ounces: 0.80 lbs. x 16 ounces/ lbs. (dry) = 12.8 ounces per acre.

9. Check the output of boom nozzles.

All nozzles across a boom need to be applying roughly the same amount of liquid within a certain error range (usually 5% on either side of the average). Clean and/or replace any nozzles that fall outside of your given error range.

Example 9

You have a 10 nozzle boom and you have collected from under each nozzle for one minute. You noted the following nozzle outputs.

Nozzle	=	1	2	3	4	5	6	7	8	9	10
Output in Oz.	=	43	44	47	42	46	44	50	41	42	42

= 441 oz. Total

Average Nozzle Output = 441 oz. ÷ 10 = 44.1 oz.
For 5% error: 44.1 oz x 0.05 = 2.2 oz. to add and subtract from the average.

Nozzle 1 output + nozzle 2 output + etc.
Number of nozzles on the boom
= Average Nozzle Output

Average Nozzle Output x 0.05 = amount to add and subtract from the Average Nozzle Output to make an error range of 5%. **Formula #9**

Error range (5% on either side of the average) = 41.9 oz. to 46.3 oz. Nozzles 3, 7, and 8 need to be cleaned or replaced. Note: If a nozzle's output is lower, it may be plugged and only need to be cleaned. Repeat this exercise until all nozzles fall within the error range

10. Adding Adjuvants to the Spray Tank.

Pesticide labels often suggest adding adjuvants to the spray mix, listing the rate of the adjuvant in terms of percentage of the spray mix, volume per acre, or volume per quantity of spray mix.

a. When the rate is expressed as a percentage of the spray mix.

% of spray mix x gallons of spray mix
100
= Gal. adjuvant needed **Formula #10a**

Example 10a

Total spray mix = 500 gallons. Adjuvant rate is 1% of the finished spray volume. 0.01 x 500 = 5 gallons of adjuvant added along with pesticide to make a 500 gallon solution

b. When the rate is expressed as a volume per acre.

Adjuvant needed = **Formula #10b**
adjuvant rate x acres to be treated*
**** See formula #4.***

Example 10b

Your sprayer is calibrated to 30 GPA and you plan on using 300 gallons of solution. An adjuvant calls for a rate of 1 pint per acre. 300 gallons ÷ 30 GPA = 10 acres x 1 pint per acre = 10 pints of adjuvant added along with pesticide to make a 300 gallon solution.

c. When the rate is expressed in quarts per 100 gallons.

Adjuvant needed = **Formula #10c**
rate per 100 gallons x gallons of spray mix
100

Example 10c:

Adjuvant rate = 2 quarts per 100 gallons. A total of 400 gallons of spray mix will be used.

$$\frac{\text{2 quarts}}{\text{100 gallons}} \times \text{400 gallons total mix}$$

= 8 quarts of adjuvant to add along with pesticide to make a 400 gallon solution.

11. Dilution Rule.

To obtain any desired percentage of a mixture from a concentrate, use this formula:

$C_1 \times V_1 = C_2 \times V_2$ **Formula #11**

C_1 = % of a.i. in concentrate
V_1 = quantity of concentrate needed
C_2 = % a.i. desired in final mixture
V_2 = quantity of final mixture

It is important that the units used are all the same:
i.e. percent x pounds = percent x pounds
or percent x volume = percent x volume

Example 11a

How much of a 50% concentrate is needed to make 100 gallons of a 1.5% spray?

$$50 \times V_1 = 1.5 \times 100; \quad V_1 = 3 \text{ gallons}$$

The final mixture (V2) is the amount of the concentrate (V1) plus the required amount to make up to V2. If V1 = 3 gallons and the required amount is 100 gallons, add 97 gallons of water to 3 gallons of concentrate.

Hints on Percentage Mixing

A pesticide label may tell you to mix up a concentration or percentage of the product in water. For example, mix 1 part of the pesticide concentrate and 99 parts water. This makes a 1 percent mixture. Since there are 128 fluid ounces in one gallon, 1.28 ounces of a concentrate mixed into 1 gallon of water will make approximately a 1 percent mixture. (Hint: 1 tablespoon is about 1/2-ounce.)

The label may also instruct you to make a spray solution with a specific percentage of active ingredient (a.i.), for example, a one percent a.i. solution for ants. If the pesticide is formulated as an emulsifiable concentrate (EC) containing 57 percent active ingredient. To make a 1 percent a.i. spray solution from this formulation, you would add 1 part of the pesticide to 56 parts of water.

Conversion Factors

Multiply	By	To Get	Multiply	By	To Get
Acres	43.560	Square Feet	Miles Per Hour	1.467	Feet Per Second
Acres	4,840	Square Yards	Miles Per Minute	88	Feet Per Second
Acres	0.405	Hectares	Miles Per Minute	60	Miles Per Hour
Cubic Feet	1,728	Cubic Inches	Milliliters	0.0338	Ounces
Cubic Feet	0.037	Cubic Yards	Ounces (dry)	0.063	Pounds
Cubic Feet	7.481	Gallons	Ounces (liquid)	0.063	Pints (liquid)
Cubic Feet	59.84	Pints(liquid)	Ounces (liquid)	0.031	Quarts (liquid)
Cubic Feet	29.92	Quarts (liquid)	Ounces (liquid)	480	Drops
Cups	8	Ounces (liquid)	Ounces (liquid)	29.573	Milliliters (ml)
Cups	16	Tablespoons	Ounces (liquid)	0.02957	Liters
Cups	48	Teaspoons	Ounces	2	Tablespoons
Gallons	3.785	Liters	Ounces	6	Teaspoons
Gallons	128	Ounces	Parts Per Million	0.001	Grams Per Liter
Gallons	8	Pints	Parts Per Million	0.05842	Grains Per Gallon
Gallons	4	Quarts	Parts Per Million	1	Milligrams Per Liter
Gallons	8.345	Pounds of Water	Parts Per Million	0.0001	Percent
Gallons Per Acre	9.354	Liters Per Hectare	Parts Per Million	1	Milligram Per Kilogram
Grams	0.001	Kilograms	Pints	0.125	Gallons
Grams	1000	Milligrams	Pints	0.473	Liters
Grams	0.035	Ounces	Pints	2	Cups
Grams Per Liter	1000	Parts Per Million	Pints (liquid)	16	Ounces (liquid)
Hectares	2.47	Acres	Pints (liquid)	0.5	Quarts (liquid)
Hundredweight (CWT)	100	Pounds	Pounds	453.392	Ounces
Inches	2.54	Centimeters	Pounds	0.01	Hundredweight (CWT)
Kilograms	1000	Grams	Pounds Per Gallon	7.48052	Pounds Per Cu. Foot
Kilograms	2.205	Pounds	Quarts	2	Pints
Kilometers	3.281	Feet	Quarts	0.25	Gallons
Kilometers	0.621	Miles	Quarts	0.946	Liters
Kilograms Per Hectare	0.892	Pounds Per Acre	Quarts (liquid)	32	Ounces (liquid)
Liters	0.264	Gallons	Quarts (liquid)	2	Pints (liquid)
Liters	2.113	Pints (Liquid)	Tablespoons	3	Teaspoons
Liters	1.057	Quarts (Liquid)	Tablespoons	0.5	Ounces (liquid)
Liters Per Hectare	0.107	Gallons Per Acre	Teaspoons	60	Drops
Meters	100	Centimeters	Teaspoons	0.33	Tablespoons
Meters	3.281	Feet	Teaspoons	0.1666	Ounces (liquid)
Meters	1000	Kilometers	Temperature (C^o) C^o + 17.98	1.8	Temperature (F^o)
Meters	39.37	Inches			
Meters	1.094	Yards	Temperature (F^o) F^o - 32	0.55	Temperature (C^o)
Miles	5,280	Feet			
Miles	1,760	Yards	Tons	907.185	Kilograms
Miles Per Hour	88	Feet Per Minute	Yards	0.914	Meters

For More InformationContact:

Your local office of the Montana State University Extension Service

Montana Pesticide Education Program (406) 994-3518 http://mtpesticides.org

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