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?

\[
20 \text{ GPA} \times 5 \text{ MPH} \times 20 = \frac{2000}{5940} = 0.336 \text{ GPM per nozzle}
\]

\[
\text{GPM} = \frac{\text{GPA} \times \text{MPH} \times W}{5940}
\]

\[
\text{MPH} = \text{Field speed in Miles Per Hour}
\]

\[
5940 = \text{a constant}
\]

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

\[
\text{GPA} = \frac{\text{GPM} \times 5940}{\text{MPH} \times W}
\]

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!

\[
\frac{51 \text{ OPM}}{128} = 0.398 \text{ or 40 GPM per nozzle.}
\]

\[
0.398 \text{ GPM} \times 5940 = 2364.12
\]

\[
5 \text{ MPH} \times 20 = 100
\]

\[
= 23.64 \text{ or 24 GPA}
\]

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

\[
\text{MPH} = \frac{\text{GPM} \times 5940}{\text{GPA} \times W}
\]

\[\text{Note: For this example, W = broadjet width in inches. (feet x 12 = inches)}\]

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?

\[
10 \text{ GPM} \times 5940 = 59,400
\]

\[
30 \text{ GPA} \times 420 = 12,600
\]

\[
= 4.7 \text{ or 5 MPH}
\]

\[\text{Note: This is a broadjet example. If you had nozzles that were 20” apart and GPM was .40 GPM, your answer would be 3.96 or 4 mph!}\]
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.

\[
\frac{1.5 \text{ GPM} \times 5940}{30 \text{ GPA} \times 30”} = 8.910 \\
= 9.9 \text{ or } 10 \text{ MPH as the new field speed}
\]

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

**Volume in tank** = **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?

<table>
<thead>
<tr>
<th>Volume in tank</th>
<th>Acres treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 gallons</td>
<td>250 gallons</td>
</tr>
<tr>
<td>30 GPA</td>
<td>30 GPA</td>
</tr>
<tr>
<td>= 16.6 acres treated</td>
<td>= 8.3 acres treated</td>
</tr>
</tbody>
</table>

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

**Acres to spray x GPA** = **Gallons required**  
**Formula #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** = **Gallon amount to apply**  
**Amount of a.i. per gallon**  
**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?

0.50 lb a.i./acre = 0.25 gallon (1 quart) per acre  
2 lb a.i./gallon

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** = **lbs. of formulation/acre**  
**% a.i. per lbs of formulation**  
**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.)

0.2 lbs. per acre ÷ 0.25 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.

<table>
<thead>
<tr>
<th>Nozzle</th>
<th>Output in Oz.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>43</td>
</tr>
<tr>
<td>2</td>
<td>44</td>
</tr>
<tr>
<td>3</td>
<td>47</td>
</tr>
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<td>4</td>
<td>42</td>
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<td>5</td>
<td>46</td>
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<td>6</td>
<td>44</td>
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<tr>
<td>7</td>
<td>50</td>
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<tr>
<td>8</td>
<td>41</td>
</tr>
<tr>
<td>9</td>
<td>42</td>
</tr>
<tr>
<td>10</td>
<td>42</td>
</tr>
</tbody>
</table>

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. [\text{Number of nozzles on the boom}] = \text{Average Nozzle Output}

\text{Average Nozzle Output} \times 0.05 = \text{amount to add and subtract from the Average Nozzle Output to make an error range of 5%}. \quad \text{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.

\% \text{ of spray mix} \times \frac{\text{gallons of spray mix}}{100} = \text{Gal. adjuvant needed} \quad \text{Formula #10a}

\text{Example 10a}

Total spray mix = 500 gallons. Adjuvant rate is 1\% of the finished spray volume. 0.01 \times 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.

\text{Adjuvant needed} = \frac{\text{adjuvant rate}}{\text{acres to be treated}} \times \text{acres to be treated} \quad \text{* See formula #4.} \quad \text{Formula #10b}

\text{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 \div 30 \text{ GPA} = 10 \text{ acres} \times 1 \text{ pint per acre} = 10 \text{ pints of adjuvant added along with pesticide to make a 300 gallon solution.}

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

\text{Adjuvant needed} = \frac{\text{rate per 100 gallons}}{100} \times \frac{\text{gallons of spray mix}}{	ext{Formula #10c}}

\text{Example 10c:}

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

\frac{2 \text{ quarts}}{100 \text{ gallons}} \times 400 \text{ gallons total mix} = 8 \text{ quarts of adjuvant to add along with pesticide to make a 400 gallon solution.}


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

\begin{align*}
\text{C}_1 \times V_1 &= \text{C}_2 \times V_2 \\
\text{C}_1 &= \% \text{ of a.i. in concentrate} \\
V_1 &= \text{quantity of concentrate needed} \\
\text{C}_2 &= \% \text{ a.i. desired in final mixture} \\
V_2 &= \text{quantity of final mixture}
\end{align*}

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

\text{Example 11a}

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

\begin{align*}
50 \times V_1 &= 1.5 \times 100; \quad V_1 = 3 \text{ gallons}
\end{align*}

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

<table>
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<th>Multiply By</th>
<th>To Get</th>
<th>Multiply By</th>
<th>To Get</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acres 43.560</td>
<td>Square Feet</td>
<td>Miles Per Hour 1.467</td>
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</tr>
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<td>Quarts</td>
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<td>Pints (liquid) 0.5</td>
<td>Quarts (liquid)</td>
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<td>Pounds Per Cu. Foot</td>
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<td>Pounds</td>
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<td>Pints</td>
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<td>Liters</td>
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<td>Ounces (liquid)</td>
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<td>Gallons</td>
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<td>Pints (liquid)</td>
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<td>Pints (Liquid)</td>
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<td>Tablespoons 0.5</td>
<td>Ounces (liquid)</td>
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<td>Teaspoons 60</td>
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<td>Meters 100</td>
<td>Centimeters</td>
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<td>Kilometers</td>
<td>Temperature (C°) C° + 17.98 1.8 Temperature (F°)</td>
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</tr>
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<tr>
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<td>Kilograms</td>
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<tr>
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<td>Yards</td>
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<td>Meters</td>
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<td>Miles Per Hour 88</td>
<td>Feet Per Minute</td>
<td>Yards</td>
<td>0.914</td>
</tr>
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</table>

### For More Information Contact:

Your local office of the Montana State University Extension Service

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

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