Calibrating Spray Equipment

Purpose of Sprayer Calibration

Calibration of chemical application equipment enables the applicator of the equipment to determine the area (acres or square feet) treated by a given amount of spray. Knowing the area treated by a volume of spray, the applicator can determine from the pesticide label how much pesticide should be added to the spray mixture. Proper application of herbicides helps ensure crop safety, weed control performance, and cost effectiveness. For these reasons, **calibration and maintenance of spray equipment are essential.** Over-application of herbicides is costly and may result in crop injury or drift. Under-application may result in poor weed control. Similarly, sprayers that are not well maintained may deliver an uneven spray pattern, resulting in weedy “streaks” through the field.

Properly applied pesticides should be expected to return a profit. Improper or inaccurate application is usually very expensive and will result in wasted chemical, marginal pest control, excessive drift, or crop damage.

The procedures for maintaining and calibrating spray equipment are really quite simple and consist of four major steps:

- Selecting the proper nozzle tip,
- Ensuring a uniform discharge from each nozzle tip,
- Documenting the sprayer output in gallons per acres, and
- Determining the amount of pesticide to add to the tank.

The steps are performed in the order listed and with practice become quick and routine.
Selecting the proper nozzle tip.

There are many different nozzle tips available for applying herbicides. A number of new tips have recently been introduced that can reduce spray drift while maintaining herbicide activity. Nozzle tips come in many different shapes, sizes, and materials of construction. Selection of nozzles is dependent upon the job to be performed. No single nozzle is adequate for all types of applications.

Types of nozzles.

When viewed from the side, **Hollow Cone** nozzles produce a cone shaped pattern. When viewed from the bottom, the pattern looks like a ring with the center of the ring receiving no liquid. Hollow cone nozzles operate at higher pressure (40-60 psi) and produce small droplets. The ring shaped pattern causes turbulence and leaf movement making their use ideal for foliar application.

**Flat Fan** nozzles produce a fan shaped pattern, which tapers off at each edge. Because of the taper in their patterns, fan nozzles must be overlapped approximately 30% on each edge of the pattern. Flat fan nozzles are used primarily for broadcast applications. With proper orientation, they can be used in banding where two nozzles cover the band (such as post directed spraying of row crops).

Variations of the standard flat fan nozzle are available which produce good patterns over wider pressure ranges than the standard tip. Changes in pressure affect the droplet size produced. Low-pressure range produces relatively larger droplet sizes than high pressure. Special low-pressure nozzles have the advantage of maintaining a full pattern under reduced pressure conditions and should be chosen over standard flat fan nozzles when pressures of 25 psi or less are desired.

**Off Center** nozzles produce a modified flat fan shape pattern. They are used to extend the reach of a boom. Off center nozzles are also used for banding applications where spray must reach under a canopy to
reach the target. The pattern tapers at each edge. However, the largest concentration of flow is towards the nozzle side of the pattern as opposed to the center of the pattern in flat fan nozzles. These nozzles can be used in directed sprays where two nozzles spray under the crop canopy.

**Solid Cone** nozzles produce a cone shaped pattern when viewed from the side. When viewed from the bottom, the pattern would look like a circle with all parts of the circle receiving liquid. This nozzle generally operates at a lower pressure (15-40 psi) than the hollow cone type and produces larger droplets. It is generally used in broadcast herbicides applications where drift must be minimized and uniform coverage desired. This nozzle is often used for soil-incorporated herbicides because it produces uniform patterns at low pressures.

**Twin Nozzles** produce two flat fan shaped patterns from the same nozzle. This design helps penetrate the crop canopy, since the target receives spray from two distinct spray streams from a single pass of the boom. This nozzle is used in broadcast applications of foliar targets.

**Flooding Type** nozzles are used to apply fertilizers and soil incorporated herbicides. They are low pressure nozzles (15-25 psi). Generally nozzle spacing is 40 inches with 50% overlap at each edge of the pattern. They produce a wide angle flat pattern which tapers off at each edge.

**Disc Core** type nozzles produce cone shaped patterns at high pressures and larger flow rates. They are used mainly for foliar applied pesticide applications such as airblast sprayers and aerial applications. The pattern is hollow cone in shape, although cones can be selected which produce a solid cone shape. Disc Core nozzles have excellent wear properties and are useful for high pressures (4-400 psi).

**Even Flat Fan** nozzles produce a defined uniform pattern across their entire width. They are used in banding situations where only one nozzle sprays on the band.
Formulas for nozzle selection.

To select the proper nozzle tip requires knowing the required gallons per acre to be sprayed, travel speed, nozzle spacing or bandwidth and desired pressure. A single formula may be used both for nozzle tip selection and sprayer calibration. The formula is:

\[
\text{GPM (per nozzle)} = \frac{\text{GPA} \times \text{MPH} \times W}{5940}
\]

Where:
- \( \text{GPM} \) = required output per nozzle in gallons per minute
- \( \text{GPA} \) = total carrier volume in gallons per acre
- \( \text{MPH} \) = ground speed in miles per hour
- \( W \) = Broadcast: Nozzle spacing in inches
  Band: Bandwidth in inches
- 5,940 = a constant for conversion of units

Speed and width proportionally affect the size of nozzle needed, for example:

Given: MPH = 3 miles per hour, W = 20 inches, GPA = 15 gallons/acre

\[
\text{GPM} = \frac{15 \times 3 \times 20}{5940} = 0.15 \text{ gallons per minute}
\]

Selecting nozzle tip size.

It may be difficult to match an exact speed, pressure and flow rate. It is better to have an acceptable range for each variable. By using manufacturers’ tables and formulas a nozzle can be found to satisfy desired conditions.

Once a total carrier volume and speed are decided on and the nozzle spacing is known, substitute those numbers in the above formula. Select a nozzle that will give the required flow rate when the nozzle is operated within the recommended pressure range. Recommended carrier volumes (GPA) usually are specified on all herbicide labels and typically range from 10 to 40 gallons per
acre. Ground speed (MPH) should be accurately determined, since speedometers on many tractors are unreliable.

**Calibrating the sprayer.**

Install the selected nozzle tips in the sprayer, turn the sprayer on, and collect the output from a single nozzle for one minute in a container marked in ounces. The number of ounces collected in one minute can be converted to GPM by dividing by 128 (1 gallon – 128 ounces). If the GPM collected from the nozzle is below that required by the above formula, then increase the spray pressure. Decrease pressure if the output is too large. Check each nozzle separately for the correct output. Ideally, they should all be within 5% of the correct output.

Sprayer calibration consists of three major steps:

1. Ensuring a uniform discharge from each nozzle tip
2. Documenting the sprayer output in gallons per acre
3. Determining the amount of pesticide to add to the tank

The three steps are performed in the order listed and with practice become quick and routine.

Calibration involves measuring nozzle output under field conditions. Measurement data is used to determine the amount of chemical to add to the tank. The sprayer must be checked under field conditions for several reasons. Speed will vary with soil conditions and actual speed may vary from tractor speedometer readings. A field check will confirm the nozzle size, pressure, speed and application rate combination selected in the sprayer setup. Finally, nozzles wear and need to be recalibrated with use.

**Items needed for calibration**

- 100 foot tape (minimum length)
- Stop watch or watch with second hand
- Collection tube with marks in ounces
- 2 flags or markers
- Ensuring a uniform discharge from each nozzle tip.

To prepare a sprayer for a specific application (at beginning of season or when type of spraying has changed) you must do the following:
1. Determine the best operating speed to suit the field surface, the crop condition, and the operator. Select a speed that is comfortable and that can be maintained for the entire operation.

2. Refer to nozzle manufacturer’s catalogs and select type and size of tips that will deliver the desired rate per acre at the selected speed.

3. Be sure tips selected deliver in the desired rate range, not above 40 lbs. pressure for herbicides or less than 60 lbs. pressure for insecticides. To reduce drift to sensitive plants and non-target areas, apply herbicides with lower pressure and fairly large droplet size. With insecticides and fungicides, small drops are often desirable to get penetration and more complete coverage of crop foliage.

4. Remove and clean all nozzle tips and screens. Do not use a pocketknife or wire on tips. Use a brush or a wooden toothpick, as they will not damage shape or size of orifice. Remove and clean suction strainer screen.

5. With clean water in the supply tank, start pump and flush hoses and boom.

6. Replace all screens and tips. Make sure that all tips are of the correct size and type for the desired spray pattern and that flow is uniform from all nozzles. Check all connections for leaks.

7. Check flow from each nozzle for 20 seconds. If any nozzle flow is 10% over the flow of a new nozzle, it needs to be replaced. A new nozzle can be placed in the boom to establish the benchmark for comparisons.

8. Finally, adjust the pressure relief valve until pressure on the gauge is about 15 pounds above the pressure you will be using for spraying. Slowly open the control valve on the agitation lines until the gauge drops to the desired spraying pressure. Now all pump output that is not discharged through the spray nozzles is being re-circulated through the jet agitators or the relief valve. The pressure at the jet agitator is determined by the amount of liquid flowing through it. One jet agitator is sufficient for tanks up to 100-gallon capacity; use two in larger tanks.

Daily checks of sprayer performance must be conducted to monitor wear and other physical damage that may have occurred. A daily procedure should include step #7 as a minimum. Daily checks of nozzle flow will indicate when recalibration and/or replacement of nozzles is needed.

**Finding sprayer output in gallons per acre.**
Reference is made to field acres vs. treated acres in the calibration methods. FIELD ACRES refers to the crop acres and is the normal reference such as 20 acres of corn. TREATED ACRES refers to the amount of land being sprayed. This distinction is made to help ensure the proper amount of chemical is added to the spray tank. When banding, only a portion of the total crop acres receives spray. Calibration is based upon the actual treated acres, to ensure the proper concentration of spray is applied. The amount of field acres covered by a tank of spray solution is then determined by using the ratio of row width to band width as explained more fully later in STEP 3.

Before you can accurately spray any material at the desired chemical rate per acre, you must determine the volume of liquid discharged per acre under specific field conditions. Gallons per acre applied depend upon:

- orifice size of the nozzle tip
- pressure of the liquid at the tip
- speed nozzle tip is moved across the field
- the number of nozzle tips and the viscosity of the liquid being sprayed

A variation in any of these factors will vary the rate of application per acre.

**Calibration Methods.**

<table>
<thead>
<tr>
<th>Calibration Method</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>40.84 Method</td>
<td>Easy to remember.</td>
<td>Calculations required.</td>
</tr>
<tr>
<td></td>
<td>Only measure 100 feet.</td>
<td></td>
</tr>
<tr>
<td>1/128th Method</td>
<td>No calculations.</td>
<td>May require relatively large course area.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Requires use of table.</td>
</tr>
<tr>
<td>Volume Method</td>
<td>Easy to understand.</td>
<td>Calculations required.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hard to be accurate.</td>
</tr>
</tbody>
</table>

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The 40.84 Method.

This method uses a formula to determine gallons per acre. The multiplication factor 40.84 is used to convert flow (ounces) and width (inches) into a rate (gallons per acre).

1. Make sure selected nozzles produce the correct spray pattern, have an adequate droplet size range, and minimize drift. Nozzles should be in good working order and be positioned to obtain a uniform coverage over the target area.

2. Measure off 100 feet in the field to be sprayed. Clock the number of seconds it takes the spray rig to cover this distance in the gear and at the throttle setting selected for spraying. Mark the throttle setting. Make several runs over the distance and average the time it takes.

3. With the rig standing still, engage the power take-off and set the throttle at the marked spraying position. Set the sprayer pressure within the range recommended for the nozzles used.

BROADCAST: Collect the ounces from one nozzle or average the ounces of spray from several nozzles for the time measured in Step 2.

BANDING: Collect the ounces of spray for all the nozzles spraying on the band. (For two nozzles per band, collect the total from the two nozzles; for three nozzles per band, collect the total from the three nozzles.)

4. Gallons per acre is calculated by the following formula:

\[ \text{GPTA} = 40.84 \times \frac{\text{oz}}{w} \]

Where: \( \text{oz} \) = ounces collected (ounces)

\( w \) = nozzle spacing or band width (inches)

\( \text{GPTA} \) = gallons per treated acre
The 1/128th Method.

This method uses a table to find a spraying area equal to 1/128th of an acre. Flow in ounces is collected for the time required to travel 1/128th of an acre. Because a gallon is 128 ounces and the area is 1/128th of an acre, ounces collected = gallons per acre.

1. Make sure selected nozzles produce the correct spray pattern, have an adequate droplet size range, and minimize drift. Nozzles should be in good working order and be positioned to obtain a uniform coverage over the target area.

2. Use the table below to select the calibration distance. For broadcast application use the nozzle spacing. For band applications use the band width.

<table>
<thead>
<tr>
<th>Band width or Calibration Distance</th>
<th>Band width or Calibration Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nozzle spacing (in)</td>
<td>Distance (ft)</td>
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<tr>
<td>48</td>
<td>85</td>
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<tr>
<td>40</td>
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<td>32</td>
<td>128</td>
</tr>
<tr>
<td>30</td>
<td>136</td>
</tr>
</tbody>
</table>

3. Measure off the distance in the field to be sprayed from Step 2. Check the number of seconds the spray rig takes to cover this distance in the gear and at the throttle setting selected for spraying. Make several runs over the distance and average the time it takes. Mark the throttle setting.

4. With the rig standing still, engage the power take-off and set the throttle at spraying position. Set the sprayer pressure within the range recommended for the nozzles used.

   BROADCAST: Collect the spray from one nozzle for the time recorded in Step 3. The amount collected in ounces equals gallons per treated acre directly.

   BANDING: Collect the spray from all nozzles used to spray the band (i.e., two nozzles per band—collect the total from the two nozzles; three nozzles per band—collect the total from the three nozzles). The amount collected in ounces equals gallons per treated acre directly.

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The Volume Calculation Method

This method directly measures the amount of spray discharged over a 660 feet course. A formula is used to relate the gallons used and spray width to find gallons per acre.

1. Make sure selected nozzles produce the correct spray pattern, have an adequate droplet size range, and minimize drift. Nozzles should be in good working order and be positioned to obtain a uniform coverage over the target area.
2. Measure off one-eighth mile (660 feet or 40 rods) in the field to be sprayed.
3. Start with the tank full of water. Spray the test run of one-eighth mile, using the spray, pressure, and tractor speed that will be used in actual spraying. Mark the throttle setting used.
4. Refill the tank, carefully measuring the volume of water required to refill the tank. Make sure the sprayer is level when checking water volumes. The refilling should occur at the same location as when filled in Step 3.
5. Use the following formulas:

   \[
   \text{GPTA} = \frac{66 \times g}{W} \quad \text{BROADCAST}
   \]
   \[
   \text{GPTA} = \frac{66 \times g}{nb \times bw / 12} \quad \text{BAND}
   \]

   Where: \( GPTA = \text{gallons per treated areas} \)

   \( g = \text{gallons used} \)

   \( w = \text{width of sprayer in feet} \)

   \( nb = \text{number of bands} \)

   \( bw = \text{band width in inches} \)

CALIBRATION AND MIXING

To apply pesticides properly, the correct amount of a pesticide must be mixed with the correct amount of diluent (dill-you-ent). A diluent is anything used to dilute a pesticide concentration before application. In most cases this is WATER unless a label specifies otherwise. Before you can figure out the correct proportions to mix, you must first determine a sprayer’s application rate. This process is called calibration. Calibration is a series of steps to determine how much
liquid a sprayer will apply per acre. How much liquid a sprayer will apply depends on the types of nozzles installed on the sprayer, sprayer pressure, sprayer design, and sprayer speed. The best way to figure the application rate is to conduct a calibration test -- a trial run over a small area. You can then determine the actual application rate in gallons applied per acre (GPA). Once the actual application rate is known, the acres that a full tank or part of a tank will cover can be determined. Based on pesticide label instructions, we then can determine the proper amount of pesticide to add to the tank.

Prior to calibrating a sprayer, make sure nozzles are all made of the same material. Some materials, like brass, wear faster than stainless steel. Thoroughly clean all nozzles, screens and filters to ensure uniform application. Make sure that all nozzle tips produce a uniform spray pattern and deliver roughly the same volume of liquid. Finally, select an operating or field speed appropriate for the conditions of your equipment. When spraying, be sure to maintain the same field speed and pressure you used when you calibrated your equipment.

**THE CALIBRATION TEST STRIP METHOD** – The calibration test strip method can be used to calibrate almost any piece of pesticide application equipment. It is a simple procedure and requires that the applicator have a calculator, know how to divide, know how to multiply, and know how to determine area. Area is nothing more than length times width. Also know that there are 43,560 ft\(^2\) in one acre.

**Example 1**: Swath width is 40 feet. Test strip distance is 200 feet. The area of the test strip in feet is 8,000 ft\(^2\) (40 x 200). Test area is 0.184 acres. (8,000 ft\(^2\) ÷ 43,560 ft\(^2\)). Remember there are 43,560 ft\(^2\) in one acre.
**Example 2:** A 2-gallon hand sprayer needs to be calibrated. A test strip of 15 feet by 15 feet is established. The test strip area is 225 ft² (15 x 15). Test area is 0.0052 acres. (225 ft² ÷ 43,560 ft²).

**Step 2: Measure the amount of liquid applied to the test strip** — Collect liquid from the sprayer for the same amount of time it takes to spray the test strip at field speed. Or, you can refill the tank back to a set mark to determine how much liquid is applied to the test strip. Remember, in most cases, ONLY WATER is used for the calibration of liquid sprayers.

**From Example 1:** Swath width is 40 feet. Test strip distance is 200 feet. It takes 27 seconds to drive the test strip at field speed. The sprayer is stopped and for 27 seconds, 5 ½ gallons of liquid is collected from the all the nozzles at the prescribed sprayer pressure.

**From Example 2:** While timing yourself, you spray the 15 feet X 15 feet test strip with water. Using the same pressure, you spray into a 5 gallon bucket for the same amount of time and collect 46 ounces. Since you want Gallons Per Acre, you need to convert to gallons. Simply divide 46 ounces by 128 ounces in a gallon. In gallons, you collected 0.359 or 0.36 gallons.

**Step 3: Set up a simple ratio** — By using the calibration strip method, you can spray a small area, measure the gallons it takes and then convert it to a per acre basis. We can do this by using a simple ratio: Test strip gallons is to test strip acres; as gallons is to one acre. Simply put:

\[
\frac{\text{Gallons applied to test strip}}{\text{Test strip acres}} = \text{Gallons Per Acre (GPA)}
\]

**From Example 1:** Swath width is 40 feet. Test strip distance is 200 feet. The area of the test strip in feet is 8,000 ft² (40 x 200). Test area is 0.184 acres. (8,000 ft² ÷ 43,560 ft²). It takes 27 seconds to drive the test strip at field speed. The sprayer is stopped and for 27 seconds, 5 ½ gallons of liquid is collected from the all the nozzles at the prescribed sprayer pressure.

\[
\frac{\text{Gallons applied to test strip}}{\text{Test strip acres}} = \text{Gallons Per Acre (GPA)}
\]
5.5 gallons
0.184 acres = 29.89 or 30 GPA

From Example 2: A 2-gallon hand sprayer needs to be calibrated. A test strip of 15 feet by 15 feet is established. The test strip area is 225 ft² (15 x 15) or 0.0052 acres. (225 ft² ÷ 43,560 ft²). While timing yourself, you spray the test strip with water. Using the same pressure, you spray into a 5-gallon bucket for the same amount of time. A total of 46 ounces is collected. In gallons, you collected 0.359 or 0.36 gallons (46 ounces ÷ 128 ounces in one gallon).

Gallons applied to test strip
Test strip acres = Gallons Per Acre (GPA)

0.36 gallons
0.0052 acres = 69.2 or 69 GPA

BACKPACK & HAND HELD SPRAYERS – Use the procedure as noted above. Keep in mind that the accurate calibration of handheld and backpack sprayers is more difficult. This is because speed and sprayer pressure are hard to keep constant. Always try to keep both pressure and spraying technique consistent between calibration and actual application.

BROADJET SPRAYERS - Broadjet or boomless sprayers enable a wide swath to be sprayed without using a series of nozzles across a boom. Calibration of these sprayers is easy, as there are generally only one or two nozzles.

Example 3: A Boom Buster Model 437 spray nozzle covers 30 feet of swath. The test strip distance is 200 feet.

The area of the test strip in feet is 6,000 ft² (30 x 200). It takes 34 seconds to drive the test strip at field speed. A total of 10.4 gallons was collected from the nozzle for 34 seconds.

Gallons applied to test strip
Test strip acres = Gallons Per Acre (GPA)

10.4 gallons
0.138 acres = 75.4 or 76 GPA

EFFICIENT USE OF YOUR CALCULATOR Refer to the basic calibration formula or ratio. Calculations can be simplified, streamlined, and made more accurate by using a set of calculator keystrokes. Basically, we have incorporated the calibration ratio and the test strip conversion from square feet to acres into one set of easily remembered calculator key strokes.

Example 3: A Boom Buster Model 437 spray nozzle covers 30 feet of swath and delivers 10.4 gallons of water per test strip. The test strip distance is 200 feet long

\[
\frac{10.4 \text{ gallons}}{30 \text{ feet}} \div 200 \text{ feet} \times 43,560 \text{ ft}^2 = 75.5 \text{ or } 76 \text{ GPA}
\]

BOOM SPRAYERS WITH MULTIPLE NOZZLES - The calibration of multi-nozzle boom sprayers is complicated by the fact that if any one nozzle is providing more or less liquid, then the pattern of the pesticide application may be affected.

CHECKING NOZZLE OUTPUT - To verify that all nozzles are spraying the same volume of liquid, collect from under each nozzle for a standard amount of time. Then take the average flow of all the nozzles. If the flow of any nozzle varies by more than five percent on either side of the average of all the nozzles, then those nozzles should be cleaned or replaced. It is easy to find five percent. First, find a 10% error by simply taking the average and move the decimal place one place to the left. Now divide that number in half to find a five percent error.

The average nozzle output is 40 ounces (240 ounces ÷ 6 nozzles) Ten percent is then four ounces.

A five percent error for 40 ounces is two ounces (half of four ounces is two ounces). The error range is 38 and 42 ounces. All nozzles fall within the acceptable five percent on either side of the average.

To find 10%

\[
40 \text{ oz.} = 4 \text{ oz.}
\]

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Dry Pesticide Application (Pellets and Granular Formulations)

The technique for calibrating dry pesticide application equipment is similar in many ways to calibrating liquid spray equipment. The difference being that granular application equipment must be calibrated with the actual pesticide formulation.

So always wear the label-prescribed Personal Protective Equipment (PPE) when calibrating dry pesticide application equipment. Example 4: A granular spreader makes a 10-foot wide swath. A 20-foot long plastic sheet is placed on the ground. At the desired field speed the equipment is operated across the plastic. Granules are swept up from the plastic and weighed. Four ounces of dry granules are collected. Since this is a dry formulation, and there are 16 ounces in a dry pound, 0.25 pounds is collected (4 ounces ÷ 16 ounces per dry pound).

**Step 1:** Test area is 200 ft² (10 ft x 20 ft) or 0.0046 acres (200 ft² ÷ 43,560 ft²)

**Step 2:** A total of 0.25 pounds of granules are applied to the test area.

0.25 lbs applied in test strip

0.0046 acres in Test Area = 54.3 or 54 pounds applied per acre

**ADJUSTING OUTPUT** – If you calibrate your sprayer at a certain speed or pressure, make sure you use the same speed and pressure when you apply the pesticide. Pesticide labels can be very specific as to what is required to improve pesticide performance, pesticide uptake and for drift prevention. You may have calibrated your sprayer only to find that its GPA is either too high or too low according to label directions.

**Speed** - As you slow down, you apply more. As you speed up, you apply less. The decision to use speed, and the adjustments that need to be made, should be done before you mix and begin spraying. If you adjust “on the fly” you may be applying the pesticide in excess of the labeled rate or at too low a rate for good pest control.

**Nozzles** - Larger nozzle tips (larger nozzle tip openings or orifices) increase volume, while smaller ones reduce the output and volume. The changing of nozzle tips usually alters the pressure of the system requiring an adjustment of the pressure regulator. Be aware that changes in nozzle tip size will also affect droplet size and spray pattern. Low-volume nozzle tips will
generally increase the number of small droplets, thereby increasing the chance of drift. Whenever you change nozzle tips, recalibrate the sprayer and refigure the new output.

**Pressure** - In order to double output using pressure, you will need to increase pressure by four times as much. Increasing pressure can lead to drift problems, the increased incidences of equipment failure, improper coverage and improper placement of the pesticides. It is best to use pressure to fine tune a sprayer’s output and use speed or different nozzles for major adjustments.

**CALCULATIONS FOR MIXING PESTICIDES**

When preparing to apply pesticides, it is most important to mix the correct amount of a concentrated pesticide with a diluent, usually water. But first, you should also have a working knowledge of basic weights and measures.

**HOW MUCH PESTICIDE TO ADD TO THE TANK**

The accurate mixing of pesticides is dependent upon two major factors: (1) the area covered, usually in acres, and (2) the proper product or labeled rate as determined from the pesticide label - 1 pint/acre, 1 quart/acre, etc.

**Step 1:** Determine how much area that can be sprayed with a given volume in the spray tank. The area is usually expressed in acres. You must first know your sprayer’s application rate in GPA.

**Gallons to be used in the spray tank**

\[
\text{Application rate in GPA} \times \frac{\text{Gallons to be used in the spray tank}}{\text{Acres treated}}
\]

**Example:** Your sprayer is calibrated to 25 GPA and you are going to use a full 500-gallon tank.

\[
\frac{500 \text{ gallons}}{25 \text{ GPA}} = 20 \text{ acres}
\]

**Example:** Your sprayer is calibrated to 25 GPA and you are using 250 gallons of a 500-gallon tank.

\[
\frac{250 \text{ gallons}}{25 \text{ GPA}} = 10 \text{ acres}
\]
Example: Your 2 gallon backpack sprayer is calibrated at 35 GPA and you plan on using a full 2-gallon tank.

\[
\begin{align*}
2 \text{ gallons} &= 0.057 \text{ acres} \\
35 \text{ GPA}
\end{align*}
\]

This formula can also be used to fill out your restricted-use application records. One requirement is that you fill out the area sprayed. For example, suppose your sprayer is calibrated at 25 GPA and you just sprayed 500 gallons of a pesticide and water solution. By using the formula, you can determine you have sprayed 20 acres.

Or suppose you know you have a 20-acre pasture and your sprayer is calibrated at 25 GPA. If you back-multiply, you will find that you need 500 gallons of solution to cover that 20-acre pasture. \((20 \text{ acres} \times 25 \text{ GPA})\)

Step 2: Once you have determined how many acres you can spray with a given volume, you then can determine how much pesticide you need to add to the spray tank.

\[
\text{ACRES} \times \text{LABELED RATE} = \text{HOW MUCH PESTICIDE YOU NEED TO ADD TO A GIVEN VOLUME IN THE TANK}
\]

Example: A pesticide label calls for a rate of 1 pint/acre to be applied for the control of perennial noxious weeds. The sprayer to be used is calibrated to apply 25 Gallons Per Acre \((25 \text{ GPA})\). A 20-acre field is to be broadcast sprayed with 500 gallons of a pesticide and water mix \((500 \text{ gallons} \div 25 \text{ GPA} = 20 \text{ acres})\).

\[
20 \text{ ACRES} \times 1 \text{ PINT/ACRE} = 20 \text{ PINTS}
\]

You will then be adding 20 pints in a 500-gallon mixture. There are 8 pints in a gallon so you will need to add 2 ½ gallons of pesticide to the tank \((20 \text{ pints} \div 8 \text{ pints per gallon})\). Fill the tank with half the desired volume of water. Add the pesticide, surfactants, and then add water until you have reached the desired volume in the spray tank.
Example: Suppose you have that a backpack that can treat 0.057 acres with 2 gallons of water (2 gallons ÷ 35 GPA = 0.057 acres). The label recommends a 1-pint per acre rate to control a particular pest. One pint equals 16 ounces so:

0.057 acres x 16 oz. = 0.912 or 1 ounce of pesticide added to water to make 2 gallons of mix.

It is helpful to note that one tablespoon is ½ ounces.

The above formula will also help you fill out your restricted-use application records. Another requirement is that you document how much undiluted restricted-use pesticide is used. If you just sprayed 20 acres and you accurately mixed at the labeled rate of 1 pint per acre, then you most likely sprayed out 20 pints of the undiluted pesticide.