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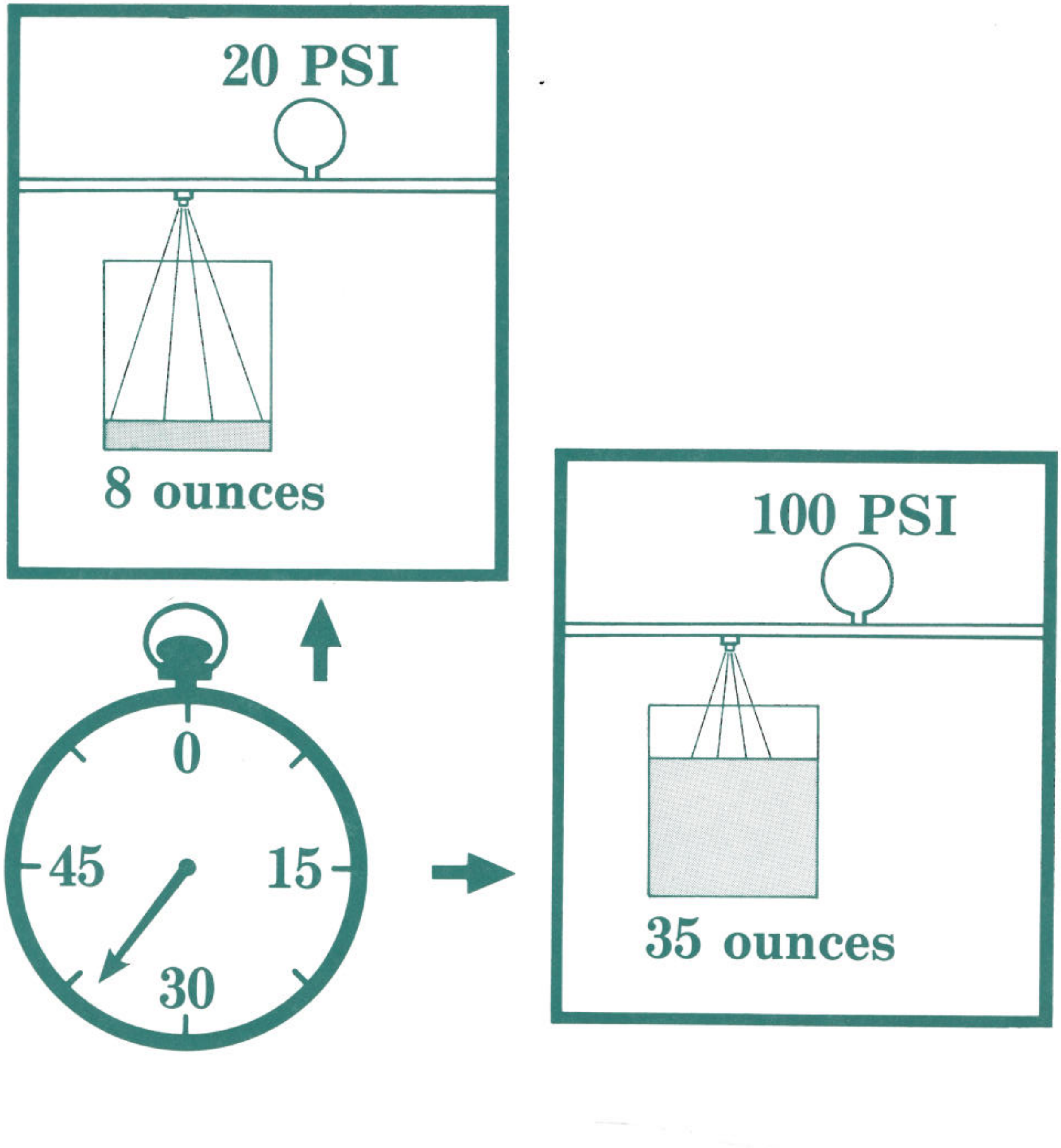
A Guide to Proper Sprayer Calibration



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A Guide to Proper Sprayer Calibration

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Sprayer calibration is simply the process of adjusting a sprayer and selecting a nozzle tip size that produces the desired application rate, and provides complete foliage coverage of the agricultural chemical used. Due to the expense of applying chemicals and the need to apply correct rates, applicators must calibrate and maintain spray equipment for optimum efficiency and accuracy. Many chemicals today are applied at rates as low as one to two ounces per acre. This requires even more attention to proper calibration and mixing of chemicals.

Pre-Calibration Activities

Accurate and proper calibration of a chemical sprayer requires several procedures. The first step in the calibration process, especially if it is the first calibration trial of the season, is to examine the chemical sprayer thoroughly for proper operation of all components. All nozzle tips and strainers should be removed and several gallons of clean water should be "sprayed" through the system with attention to line strainers and other possible obstructions to flow. Hoses, pipes and clamps should be examined for leaks, cracks, holes or other potential losses of spray materials. The pump should be checked to be sure it is maintaining constant pressure and fluid flow.

The calibration process includes the selection of the proper nozzle tip size and strainer for the desired application rate. The proper nozzle tip size is determined by the rate to be applied (see Publication 1233 available at your county Extension office). The total application rate in gallons per acre is normally determined from the label on the chemical product to be applied. In a situation where a tank mix of two or more products is to be used, an application rate in the recommended range of both chemicals is most desirable. As an example, if chemical A is recommended at 20-60 gallons per acre and chemical B is recommended at 40-80 gallons per acre, asuitable application rate might be 50 gallons per acre.

Once the application rate is determined, the next step is to select a speed of travel in the field to be sprayed which can be maintained under actual field conditions. Most spraying situations and field conditions will allow operation in the two to five miles per hour speed range. Many sprayer catalogs and application tables are prepared using these speeds. This does not mean that spraying at other speeds cannot be done safely or properly. In some instances, speed could be limited by field conditions and in other situations, the forward speed capabilities of the sprayer may be the limiting factor (see Table 1).

The next step in the calibration process is to determine the width of the sprayed area for each nozzle. If nozzles are mounted 20 inches apart on a broadcast boom, then the spray width is 20 inches. To use another example, if 36-inch rows are sprayed with three nozzles per row, the spray width is 36/3 or 12 inches per nozzle.

To summarize the above procedures in nozzle selection, we need to know or determine the following variables:

Example
1. Application rate in gallons per acre 50
2. Speed of travel in miles per hour 4
3. Sprayed width per nozzle in inches 20

When these values are known, we can calculate the nozzle flow rate needed using the equation:

$$\mathbf{GPM} = \frac{\mathbf{GPA \times W \times S}}{\mathbf{5940}}$$

GPM is flow rate of nozzle in gallons per minute
GPA is desired application rate in gallons per acre
W is sprayed width per nozzle in inches
S is speed of travel in miles per hour
5940 is a constant figure.

Using our example figures above, we will calculate the required flow rate for nozzle selection.

$$\mathbf{GPM} = \frac{\mathbf{50 \times 20 \times 4}}{\mathbf{5940}} = \mathbf{0.673}$$

We are now ready to select a nozzle that will give us the desired nozzle flow rate of 0.67 gallons per minute. The assumption is made here that the applicator is applying herbicides and has selected a flat fan type nozzle for this application situation. Therefore, we select a flat fan nozzle table from the desired manufacturer's catalog and look for a nozzle tip size that will deliver the flow rate calculated above.

(An example of a nozzle flow rate table is shown in Table 2. This table will be used to illustrate selection of a nozzle for the example problem given.)

Table 1. Tractor Speeds

Speed in MPH (miles per hour)	Time required in seconds to travel a distance of: 100 feet	200 feet
2.0	34	68
3.0	23	45
4.0	17	34
5.0	14	27
6.0	11	23

Table 2. Sample Table from Nozzle Manufacturer Catalog

Tip Number	Pressure	Flow Rate (GPM)
8005	20	0.35
	30	0.43
	40	0.50
	50	0.56
	60	0.61
8006	20	0.42
	30	0.52
	40	0.60
	50	0.67
	60	0.74
8008	20	0.57
	30	0.69
	40	0.80
	50	0.89
	60	0.98

Looking at the table, we see that a no. 8006 tip at 50 PSI will give us the desired flow rate. We could also use an no. 8008 tip at slightly less than 30 PSI and get 0.67 gallons per minute. If cone tips are being used, refer to the cone tip section of the manufacturer's catalog.

Checking Nozzle Output

When the desired nozzle tips have been selected and installed on the sprayer, all tips should be checked for uniform and consistent flow. Operate the sprayer in a stationary position at the desired operating pressure and measure the nozzle flow rate from each nozzle with a calibration container for 30 seconds. Record the rate from each nozzle and compare when all have been tested.

Variations in output rate of more than 10 percent are not desirable. To determine flow variation consider the following example:

Nozzle	Flow
1	43 ounces
2	45 ounces
3	43 ounces
4	41 ounces
5	56 ounces
6	43 ounces

Total — 271 ounces
Average — 45.2 ounces
10% of Average is 4.5 ounces

(Average = $\frac{\text{Total}}{\text{no. of nozzles}}$)

Thus, the allowable range of output is 40.7 (45.2-4.5) to 49.7 (45.2 4.5) ounces. Anything outside this range would give too much error in application rate.)

Nozzle number 5 is more than 10 percent from the average flow rate of the other nozzles. Therefore, it should be replaced with a nozzle that has a flow rate between 40.7 and 49.7 ounces.

Nozzle Materials

Brass or aluminum nozzles have a short useful lifetime when compared to ceramic or hardened stainless steel nozzle tips. Wettable powders and similar abrasive chemical formulations greatly reduce the useful life of brass and aluminum nozzles. For this reason, it is a desirable practice to compare the flow rate of all types of used nozzles to the flow rate of a new nozzle of the same tip size and type every 20 hours or so of use. Nozzles which flow at 50 percent or 1.5 times more than the flow rate of a new nozzle should be replaced with new tips. Increased wear will not only affect the flow rate, but also the shape of the pattern and the uniformity of the application rate across the full width of the pattern. This can result in overapplication and potential injury to crops and excessive residue on the crop and soil. Ceramic nozzles will usually last the lifetime of the sprayer and should not need replacement unless abused or damaged or used excessively. For this reason, vegetable or fruit growers who apply fungicides or insecticides frequently should use ceramic nozzles.

Methods of Calibration

There are many correct and accurate ways to calibrate chemical sprayers. One method involves filling the sprayer tank and spraying a measured area of land. The amount of liquid required to refill the tank to its original level is then determined to be the amount applied to the sprayed acreage. Another method involves catching and measuring the output from individual nozzles and calculating the application rate. The type of sprayer, area to be sprayed and several other variables may determine the most desirable method to use. For example, when using an air blast sprayer, it is usually more convenient to use the tank-fill method for calibration. On the other hand, either method will work well for small hand sprayers.

Calibration is the process of adjusting a sprayer to give the desired application rate with uniform coverage of foliage or soil. Depending upon the method used, a given area of land is sprayed and the amount of material applied is usually determined on the basis of ounces or gallons per acre. As there are 43,560 square feet in an acre, often the area sprayed for calibration purposes is usually some easy-to-calculate fractional portion of an acre, such as 1/10th or 1/100th of an acre. Errors in computation of desired application rates can cause serious errors in actual application rates. Therefore, take care to avoid miscalculations which result in application errors. From the above statement, it would appear that any calibration methods which involve few or no calculations would be most desirable. For that reason, the two following methods of calibration have been used in Tennessee for several years and have been popular because of the simplicity of calibration procedures.

SP-240 Method

The SP-240 is a sprayer calibration guide furnished by the Agricultural Extension Service in the form of a slide-rule type device. The SP-240 consists of an outer cover with windows labeled for assorted row spacings. The windows permit viewing of figures on an internal sliding card within the cover. This method requires no mathematical calculation on the part of the user and a standard calibration course length of 150 feet is used for all calibrations regardless of row spacing, nozzle spacing or band width sprayed. Instructions for using the guide are printed on the outside cover of the guide. Copies of SP-240 are available from Extension agents in all Tennessee counties.

1/128th Acre Method

The 1/128th acre method of calibration is also popular, as no calculations are needed to determine the application rate. This measurement may appear at first to be an odd and difficult ratio with which to work. The fact that a gallon of liquid contains 128 fluid ounces is the basis for this method. If an area equal to 1/128 of an acre is sprayed for calibration purposes, the number of fluid ounces applied is equal to the application rate in gallons per acre. This eliminates the use of mathematical equations. The key to successful use of this method is selecting the proper length of travel for the calibration trial. The length of the course can be calculated easily enough by dividing 340 square feet (1/128th of 43,560 square feet) by the width in feet of the sprayed area covered by one nozzle. Since 20 inches is a very common width for mounting nozzles, we will use this distance for our example calculation.

20 ÷ 12 inches = 1.67 feet
340 feet ÷ 1.67 feet = 203.6 or 204 feet

Several sources of tables giving the course length for calibration based upon given swath widths are available in pocket-size card versions. Extension agents, the Tennessee Agricultural Chemical Association, the University of Tennessee Extension agricultural engineering department and several chemical companies make these tables available. But in the absence of a table, or if you have an uncommon nozzle width, you can easily calculate the proper course length for calibration.

The following table is representative of the tables found on the above mentioned pocket size cards.

Width sprayed by each nozzle in inches	Course length in feet to travel
10	408
12	340
14	292
16	255
18	226
20	204
40	102
60	68
80	51

Let's work through some examples to demonstrate how the 1/128th acre method works:

Example 1: An applicator desires to apply gramoxone with a boom (broadcast) sprayer with a nozzle spacing of 20 inches. What length of course would be measured off for calibration purposes?

Solution: From the above table, the proper course length would be 204 feet. To proceed with calibration, we would then complete the folowing steps.

1. Measure and clearly mark off a course length of 204 feet with surface conditions similar to the area to be sprayed.

2. Select a ground speed and engine RPM speed that will permit safe and efficient operation of the sprayer during the spraying operation.

3. After setting spraying pressure to the desired pressure, bring the sprayer to operating speed before you reach the marker representing the beginning of the 204 feet course. As the sprayer passes the start marker, start timing the sprayer with a stop watch or a watch with a second hand. Continue timing until the same part of the sprayer reaches the end marker for the course. Repeat this timing process in the opposite direction and average the two times.

Example:
Trip 1 — 23 seconds
Trip 2 — 21 seconds
Average — 22 seconds

4. Park the sprayer, and with the engine running at the same RPM speed and the same pressure setting, catch the output from several or all nozzles on the boom for 22 seconds each. Measure the output in fluid ounces. The number of ounces caught from each nozzle represents the application rate for that nozzle.

Example:

Nozzle	Ounce	Application Rate*
1	32	32 GPA
2	31	31 GPA
3	32	32 GPA
4	33	33 GPA
5	32	32 GPA

**Gallons per Acre*

What you catch in ounces is your application rate in gallons per acre. Easy!

Suppose that in the above example we caught 32 ounces average for a 32 gallon per acre rate. However, we wanted to apply 40 gallons per acre. What can be done to increase the application rate?

1. The pressure can be increased.
2. Sprayer speed can be reduced.
3. A larger nozzle tip can be installed.

To reduce the rate of application, one or more of the following can be done.

1. Decrease the pressure.
2. Increase forward travel speed.
3. Install smaller nozzle tips.

If you require more than 25 percent change in the application rate after the initial calibration run, changing the nozzle tip size is usually the most satisfactory way to accomplish an adequate rate change.

After calibration, to determine how many acres of land can be sprayed with each tank of spray mixture, divide the tank size in gallons by the application rate in gallons per acre.

Example:

$$\frac{\textbf{250 gallon tank}}{\textbf{32 gallons/acre}} = \textbf{7.81 acres/tank}$$

Band Spraying

Probably the most confusing procedure to many spray applicators is calibrating a sprayer for band application (strip application) of chemicals rather than broadcast spraying the entire width of an area.

If a given chemical recommendation is for X gallons per acre and only a band of Y inches in width is sprayed, confusion usually results.

Possibly a better term to use in band spraying is gallons per treated (sprayed) acre rather than gallons per field acre since the total land area is not sprayed when banding.

Let's look at a typical banding situation and determine the proper way to calibrate and use the 1/128th acre method.

Example 2:

A farmer has 200 acres of corn in 38 inch rows and wants to band a herbicide in 12 inch bands over the rows at 25 gallons per acre application rate.

Question 1: What course length to use for calibration?

Solution: Using the 1/128th acre calibration table, we find that for 12 inch widths, a course length of 340 feet is needed (340/1 = 340).

Question 2: How many treated acres are covered for each total acre driven over?

Solution: This can be easily calculated by dividing the width of the band by the width of the row.

$$\frac{\textbf{12 inches (Band)}}{\textbf{38 inches (rows)}} = \textbf{0.316 acre}$$

Therefore, for every acre the sprayer drives over, only 0.316 acres is treated.

The following table can be used to save calculations for many common situations of banding.

Row Spacing (Inches)	Treated Area Per Field Acre Band Width (Inches) 8	10	12	16	20
20	.400	.500	.600	.800	1.00
24	.333	.426	.500	.666	.833
30	.266	.333	.400	.533	.666
32	.250	.312	.375	.500	.625
34	.235	.294	.353	.470	.588
36	.222	.278	.333	.444	.555
38	.210	.263	.316	.421	.526
40	.200	.250	.300	.400	.500
42	.190	.238	.286	.381	.476
48	.166	.208	.250	.333	.417
60	.133	.167	.200	.267	.333

Using the above table or the simple calculation of division of the band width by the row width, we can calculate what portion of an acre is treated or sprayed for each field acre driven over. How can we use this figure to assist us in other band spraying needs?

In Example 2 above, the farmer had 200 acres of corn in 38-inch rows to be banded in 12-inch bands at 25 gallons per treated acre. How many acres of the 200 total acres are to be treated or sprayed?

From the above table, we find that a 12-inch band on a 38-inch row is 0.316 acre sprayed for each full acre covered. Two-hundred acres x 0.316 = 63.2 acres actually treated or sprayed in the 200 acre field.

Example 3:
Question: How much chemical is needed to treat the area in our example above if the recommended rate is 4 pounds active ingredient per acre on a broadcast basis?

Solution: Since only 63.2 acres of the total 200 acres will be sprayed, we can multiply 63.2 acres x 4 lbs/acre. We would need 252.8 pounds of active ingredient of the chemical to treat 63.2 acres.

Calibration Using Multiple Nozzles Per Row

Row cropping requires the use of more than one nozzle per row of crop for adequate foilage coverage of fungicides or insecticides in many situations. Calibration for these situations is no more difficult than it is for the one-row/one-nozzle situations.

Consider the following illustration of a tomato sprayer in which several nozzles are used to spray each row of the crop. The first step in the calibration process is to determine the row spacing or the distance between the rows. This distance becomes the W value in the equation:

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

This is the equation used to calculate the proper nozzle size to select when application rate (GPA) and speed(s) are known. The only difference when using multiple nozzle arrangements vs single nozzle setups is to keep in mind that several nozzles will apply the spray material rate (GPM) rather than only one nozzle. To determine the amount needed from each nozzle we use the equation:

$$\frac{\text{Application Rate (GPM)}}{\text{Number of Nozzles per Row}} = \text{GPM of Individual Nozzles}$$

Example: Using the above illustration and an application rate of 120 GPA at 250 psi 48 inch rows, and speed of 3 MPH.

$$GPM = \frac{120 \times 48 \times 3}{5940} = 2.91 \text{ GPM}$$

NOTE: We are using 8 nozzles per row.

$$\frac{2.91}{8} = 0.36 \text{ GPM per Nozzle}$$

During the actual calibration process when flow from the nozzles is collected for a specified time (depending on method used) to determine the flow rate, material collected from all eight nozzles should be added together to get the application rate per row. Example: Collection time is 33 seconds.

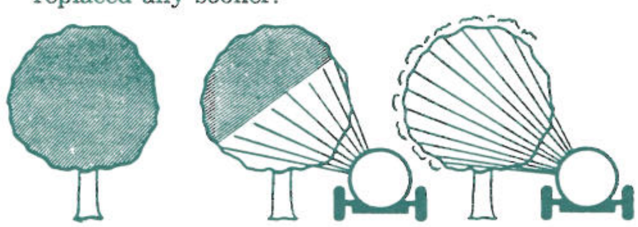
Nozzle	Amount Collected
1	15 oz.
2	16 oz.
3	15 oz.
4	15 oz.
5	15 oz.
6	14 oz.
7	15 oz.
8	15 oz.

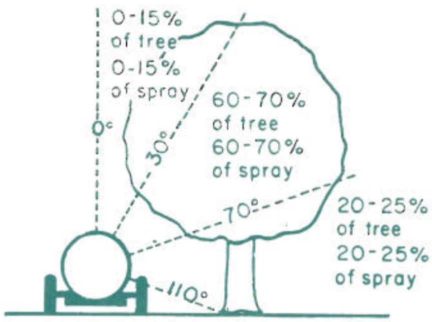
TOTAL = 120 oz. total for one row

The remainder of the calibration process is the same as for one-row/one nozzle procedures.

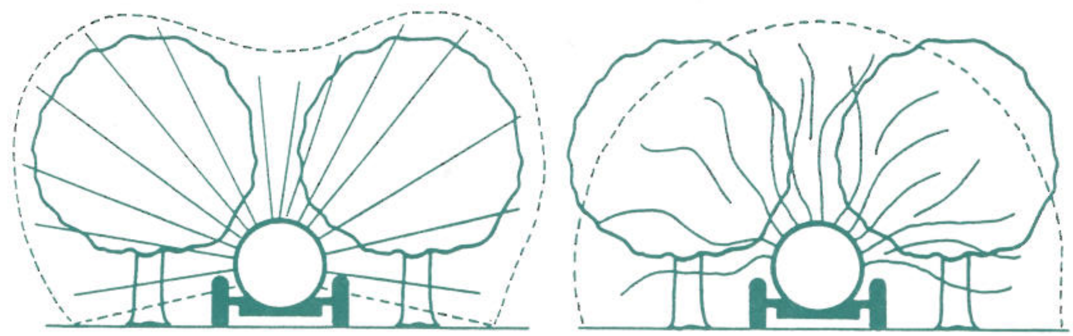
Calibration of Air Blast Sprayers for Use on Trees

1. The most important factor in efficient spraying is the applicator. It is impossible to have a good insect and disease control program if the applicator is not alert, conscientious, and knowledgeable about equipment, orchards, and pesticides.
2. Coordinate the pruning program with the spray program. High trees with bush interiors and low-hanging limbs cannot be completely covered by any practical method of spraying.
3. Have the correct equipment. Buying a sprayer which is larger than the job calls for is less costly than buying a sprayer which is too small to do a good job in a reasonable time. Since an airblast sprayer uses air to give spray mist coverage, it is important for the air in a tree to be completely replaced with spray-laden air from the sprayer. A large sprayer will replace the air in a tree's canopy faster than a small sprayer, thus enabling the operator to drive faster. Injecting more spray material into the airstream is of no value since the air within the tree will not be replaced any sooner.





a.



Correct

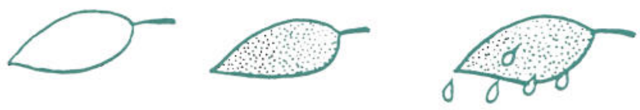
b.

Incorrect

4. Be sure your sprayer is in peak condition before the spraying seasons begins.
   (a) Nozzle size and placement should be made to assure correct spray displacement in the tree.
   (b) The sprayer should be adjusted to give the correct spray pattern.
5. The objective of spraying is to get a pesticide distributed over all of the above ground parts of a tree. This may be done utilizing either a dilute or a low-volume spray.
   (a) Dilute — the amount of spray per acre will vary with tree size and spacing as well as with the application equipment used. Dilute sprays may be applied using either high pressure sprayers or airblast sprayers. The tree is sprayed to the point where the material is almost ready to drip. When a tree is sprayed to the point where the material does drip, spray material is being wasted.
   (b) Low volume — also called concentrate spraying; the application of pesticides at a lower gallonage per acre but at more than the normal 1X concentration. The volume of spray is lowered in proportion to the increase in concentration used. The amount of pesticides applied per acre or per tree should be about the same for each method.

   Low volume sprays must be applied with an air-blast sprayer. Advantages of low-volume sprays are that less labor, water and time are required than with dilute sprays. Low-volume spraying requires very careful sprayer calibration, precise speed control, good drying conditions, open trees and increased operator alertness.

   Some sprays, such as dormant oils, thinners and growth regulators may not give satisfactory results when applied in low-volume sprays.



unsprayed *correctly sprayed* *over-sprayed*

Dilute mixtures are referred to as "1X concentration."

Calculating Gallons per Acre

Correct pesticide application depends on knowing how much spray to apply to a given orchard and having the correct equipment that is adjusted properly. Dilute applications are figured at the rate of 400 gallons of water per acre for trees averaging 19½ feet high and 23½ feet wide. Smaller orchards do not need to be sprayed at this rate. It is important to know how much spray should be applied to each orchard to avoid wasting pesticides with excessive applications or obtaining poor control from inadequate applications. As trees grow, it is not possible to shut off the sprayer between trees in a row. Instead, the entire row is sprayed as one unit. This gives rise to the "tree row volume" concept. The row has a definite length, width and height. These measurements are used to calculate tree row volume, from which the minimum dilute gallons per acre may also be calculated.

1. Tree Row Volume = W x H x L where:
   W = the distance between trees in a row. Values for W change in regard to tree shape. Substitute the correct W factor in the formula to account for the shape of the trees:

   H = the tree height
   (the average height of the larger trees)
   L = 43,560 ÷ distance between rows.

Open Center = W

Circular = W

Slope Sided = ¾W

Wedge = ½W

2. Once tree row volume has been determined, calculate the minimum dilute gallonage per acre using the following formula:

Minimum Dilute Gallons per Acre =
0.7 x (Tree Row Volume ÷ 1,000)

Example 1:

Peach trees trained to open center (W)

Tree height (H) =8 feet
Spacing =18 feet between trees, 22 feet between rows
Tree Row Volume =W x H x L
=18 x 18 x (43,560 ÷ 22)
=18 x 8 x 1980
=285,120 cubic feet

Minimum Dilute Gallons per Acre =0.7 x (Tree Row Volume ÷ 1,000)
=0.7 x (285,120 ÷ 1,000)
=0.7 x 285.12
=199.5 gallons

Example 2.

Apple trees trained to central leader (wedge = ½ W)
Tree height (H) =12 feet
Spacing =16 feet between trees, 24 feet between rows.
Tree Row Volume =½ W x H x L
=½ (16) x 12 x (43,560 ÷ 24)
=8 x 12 x 1815
=174,240 cubic feet

Minimum Dilute Gallons per Acre =0.7 x (Tree Row Volume ÷ 1,000)
=0.7 x (174,240 ÷ 1,000)
=0.7 x 174.24
=121.9 gallons

In converting from dilute concentration spraying to low volume spraying, use 85 percent of the dilute gallonage to compensate for reduced runoff. Then divide by the concentration desired.

Example 3.

Convert 122 gallons of dilute spray to the gallons needed for a 4X concentration:

122 x .85 =103.7
103.7 ÷ 4 =25.9 gallons per acre

Air-Blast Sprayer Calibration

Determine the rate of travel at which the sprayer will be pulled through the orchard. Ground speeds of 2 or 2-3/4 mph are recommended: however, 3 mph may be used for small apple or low-growing stone fruits.

Refer to table (p. 10) to determine the number of gallons of spray output needed per minute from both sides of the sprayer to give the desired amount per acre. The figure given in the table should be divided by two to determine the amount for each side of the sprayer.

Determine the sprayer nozzle pressure to be used in calculating sprayer output.

Obtain from the sprayer dealer a data table showing the capacity of the nozzle used in the sprayer in gallons per minute (gpm). Note that the capacity of the nozzle varies with the pressure, with the capacity of the whirl plate or whirler used in some nozzle assemblies and with the size of the hole or orifice in the disc.

Select from the disc sizes (and whirl plates, if needed) those required to obtain the necessary output in gallons per minute. Disc sizes should be selected and distributed along the manifold to allow a delivery of 85 percent of the spray volume from the upper two-thirds of the active airstream. Fifty percent of this volume should be delivered from the top third of the nozzles.

EXAMPLE:

A sprayer with 10 nozzles per side requires 12.9 gpm for both sides of the machine to deliver 100 gpa at 2 mph with 32 ft. spacing. Thus, 12.9 divided by 2 = 6.45 gpm per side; 6.45 x 0.50 = 3.2 gpm distributed among the top three nozzles: 6.45 x 0.85 = 5.5 gpm distributed among the top seven nozzles including the top three; 6.45 x 0.15=0.95 gpm distributed among the bottom three nozzles.

After the discs have been placed in the nozzles, fill the sprayer with water and determine the time necessary to spray out the entire contents. The theoretical time required can be calculated by dividing the number of gallons of water in the tank by the total spray output per minute. Thus a spray emitting 12.9 gpm should deliver 500 gallons in 38.76 minutes. It is quite common for this check to show that the machine is not delivering the calculated amount of spray. Check the machine to see that it is operating properly, and then adjust the nozzle sizes until the rate of delivery is correct.

Sprayer Output in GPM Needed for Various Rates per Acre at Three Ground Speeds

Row Width in feet	Gallons Per Acre 20	30	40	50	60	80	100	400
Sprayer output needed for a ground speed of 2.0 mph								
18	1.5	2.2	2.9	3.6	4.4	5.5	7.3	29.1
20	1.6	2.4	3.2	4.0	4.9	6.5	8.1	32.3
22	1.8	2.7	3.6	4.4	5.3	7.1	8.9	35.6
24	1.9	2.9	3.9	4.9	5.8	7.8	9.7	38.8
26	2.1	3.2	4.2	5.3	6.3	8.4	10.5	42.0
28	2.3	3.4	4.5	5.7	6.8	9.1	11.3	45.3
30	2.4	3.6	4.9	6.1	7.3	9.7	12.1	48.5
32	2.6	3.9	5.2	6.5	7.8	10.4	12.9	51.8
34	2.8	4.1	5.5	6.9	8.2	11.0	13.7	55.0
36	2.9	4.4	5.8	7.3	8.7	11.6	14.5	58.1
38	3.1	4.6	6.1	7.7	9.2	12.3	15.4	61.4
Sprayer output needed for a ground speed of 2.5 mph								
18	1.8	2.7	3.6	4.6	5.5	7.3	9.1	36.4
20	2.0	3.0	4.0	5.1	6.1	8.1	10.1	40.4
22	2.2	3.3	4.4	5.6	6.7	8.9	11.1	44.4
24	2.4	3.6	4.9	6.1	7.3	9.7	12.1	48.5
26	2.6	3.9	5.3	6.6	7.9	10.5	13.1	52.6
28	2.8	4.2	5.7	7.1	8.5	11.3	14.1	56.6
30	3.0	4.6	6.1	7.6	9.1	12.1	15.2	60.6
32	3.2	4.9	6.5	8.1	9.7	12.9	16.2	64.6
34	3.4	5.2	6.9	8.6	10.3	13.8	17.2	68.7
36	3.6	5.5	7.3	9.1	10.9	14.6	18.2	72.7
38	3.8	5.8	7.7	9.6	11.5	15.4	19.2	76.8
Sprayer output needed for a ground speed of 3.0 mph								
18	2.2	3.3	4.4	5.5	6.5	8.7	10.9	43.6
20	2.4	3.6	4.9	6.1	7.3	9.7	12.1	48.5
22	2.7	4.0	5.3	6.7	8.0	10.7	13.3	53.3
24	2.9	4.4	5.8	7.3	8.7	11.6	14.5	58.1
26	3.2	4.7	6.3	7.9	9.5	12.6	15.8	63.1
28	3.4	5.1	6.8	8.5	10.2	13.6	17.0	67.9
30	3.6	5.5	7.3	9.1	10.9	14.6	18.2	72.7
32	3.9	5.8	7.8	9.7	11.6	15.5	19.4	77.5
34	4.1	6.2	8.3	10.3	12.4	16.5	20.6	82.5
36	4.4	6.6	8.7	10.9	13.1	17.5	21.8	87.3
38	4.6	7.0	9.2	11.5	13.9	18.3	23.0	92.1

Sample Problems to Improve Your Calibration Know-How

Situation:
1. 400 acres total area
2. 30 gallons per treated acre rate
3. 4 miles per hour travel speed
4. Banding 10" band on 32" rows
5. 2 quarts per acre of chemical
6. Nozzles mounted 32 inches apart

Find:
1. Nozzle tip size
2. Course length for calibration using the 1/128th acre method
3. Acreage to be treated of the total 400 acres
4. Amount of chemical to buy

Solutions:
1. $\frac{30 \times 40 \times 10}{5940} = .202$ gallons/acre

(You will have to use a sprayer nozzle catalog to select the tip size.)

2. From the table on page 9, the course length should be 408 feet.
3. From the table on page 13, for each acre covered, 0.312 acre is treated.

400 x 0.312=124.8 acres will be sprayed.

4. 124.8 acres treated x 2 quarts/acre = 249.6 quarts or 62.4 gallons.

Boom Height for Nozzle Spray Angles

Spray Angle	Boom or Nozzle Height for Spraying	
	20" spacing	30" spacing
65°	21-23"	32-34"
73°	20-22"	27-29"
80°	17-19"	24-26"

Spray Coverage at Various Heights (40 PSI)

Spray Height	65° Angle Nozzle	80° Angle Nozzle
	(inches)	(inches)
6	7.6	10.1
9	11.5	15.1
12	15.3	20
15	19.1	25
18	23	30
21	27	35
24	31	40

Rates of Flow ... for calibrating spray tips

GPM	Seconds to Collect 1 Quart	GPM	Seconds to Collect 1 Quart
.05	300	.20	75
.06	250	.225	67
.07	214	.25	60
.08	188	.30	50
.09	167	.35	43
.10	150	.40	38
.11	136	.50	30
.12	125	.60	25
.13	115	.70	21
.14	107	.80	19
.15	100	.90	17
.17	88	1.0	15

Important: Replace all worn tips and those with streaky or uneven patterns.

Worksheet for Calibration Calculations

		EXAMPLE		YOUR FIGURES
I.	**NOZZLE SELECTION**	**EXAMPLE**		**YOUR FIGURES**
	Application Rate (GPA)	20		______
	Speed of Travel (MPH)	5		______
	Nozzle Spacing (inches)	20		______

Calculate nozzle size needed for above situation.

EXAMPLE

$$GPM = \frac{20 \times 20 \times 5}{5940} = 0.34\ GPM$$ ______

Now, use manufacturer's catalog to select a nozzle that will give the calculated application rate.

II. COURSE LENGTH FOR 1/128 ACRE METHOD

Nozzle spacing in inches 20 ______

EXAMPLE

20/12 = 1.67 ft. ______
340/1.67 = 204 ft. ______

III.	**TIMING SPRAYER**	**EXAMPLE**	YOUR FIGURES
	Trip 1	37 secs.	______
	Trip 2	36 secs.	______
	Average	36 or 37	______

IV. MEASURING APPLICATION RATE EXAMPLE

Nozzle	Ounces Caught	Rate	YOUR FIGURES
1	22	22 GPA	______
2	19	19 GPA	______
3	21	21 GPA	______
4	20	20 GPA	______

Visit the Agricultural Extension Service Website at http://www.utextension.utk.edu

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COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS
The University of Tennessee Institute of Agriculture, U.S. Department of Agriculture, and county governments cooperating in furtherance of Acts of May 8 and June 30, 1914.
Agricultural Extension Service Charles L. Norman, Dean