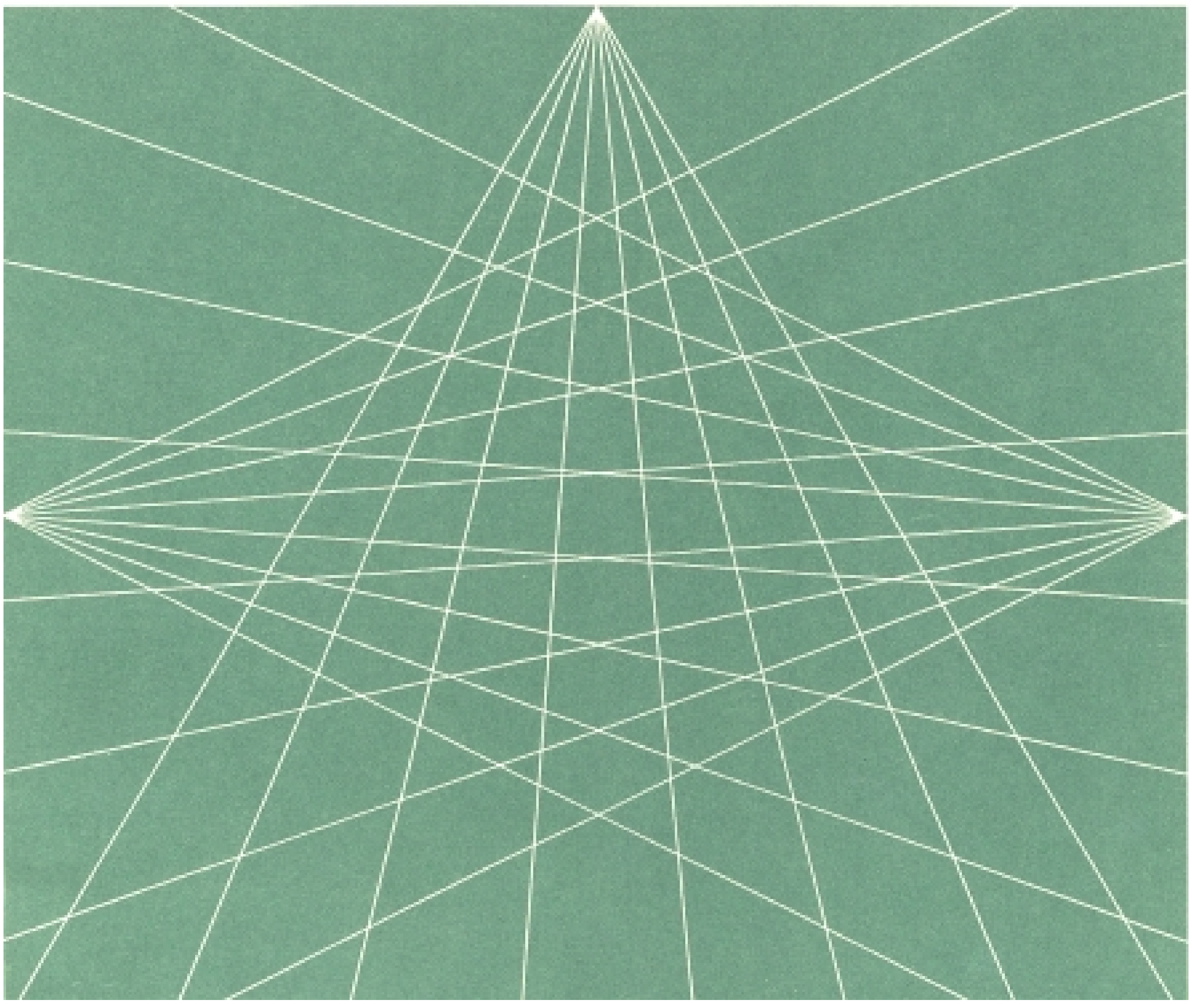
Equipment And Calibration For Low-Pressure Ground Sprayers



Alabama Cooperative Extension System, Auburn University, Alabama 36849-5612

CIRCULAR ANR-570

Equipment And Calibration For Low-Pressure Ground Sprayers

Charles B. Ogburn
Extension Agricultural Engineer

Agricultural pesticides must be applied accurately. Applying too much material will waste pesticides and can damage crops, as well as pose a threat to the environment. Likewise, applying too little material will fail to achieve the desired pest control. In order to obtain the desired results, application equipment must be functioning properly and calibrated correctly.

Equipment

More agricultural chemicals are applied with low-pressure ground sprayers than any other type of equipment. The basic components of these sprayers are:

- A tank.
- An agitation system.
- A flow control system.
- Strainers.
- A distribution system. A pump. Nozzles.

Figure 1 shows the basic layout of a low-pressure sprayer system.

Tanks

A desirable spray tank is one that:

- is large enough to prevent frequent refilling.
- is easy to fill and clean.
- is shaped suitably for mounting and effective agitation.
- is corrosion-resistant.
- has adequate openings for pump and hydraulic or mechanical agitation connections.

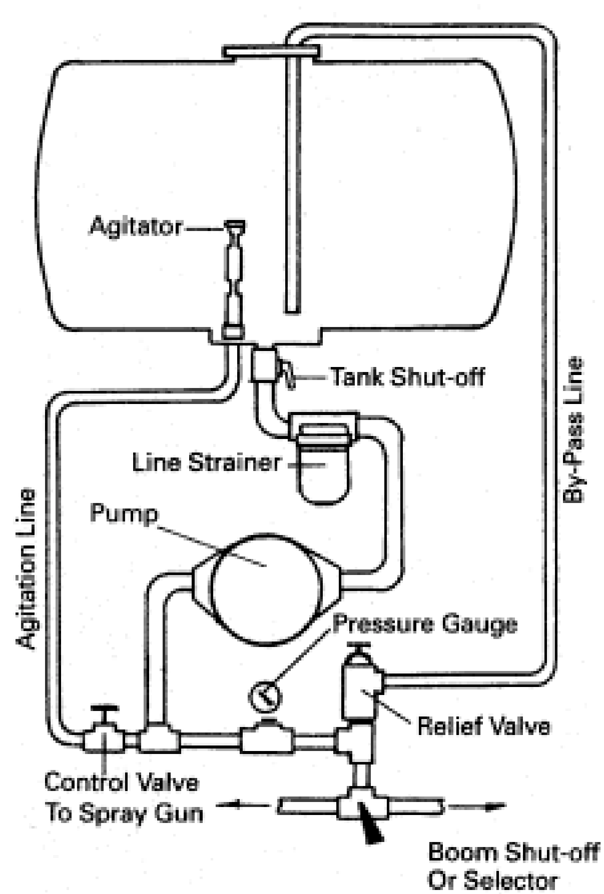


Figure 1. Basic components of a tractor-powered sprayer.

Capacity levels should be clearly marked on the tank. If the tank is not transparent, it should have a sight gauge or other external means of determining the fluid level.

The top opening should have a fitted cover that can be fastened to prevent spills. The opening should have a strainer to prevent foreign material from entering the tank. An easily accessible drain with a cut-off valve should be located in the bottom of the tank so it can be emptied completely. Tanks may be made from fiberglass, polyethylene, or stainless steel.

Pumps

The types of pumps that are normally used for sprayers are shown in Figure 2. Characteristics of these pumps are listed in Table 1.

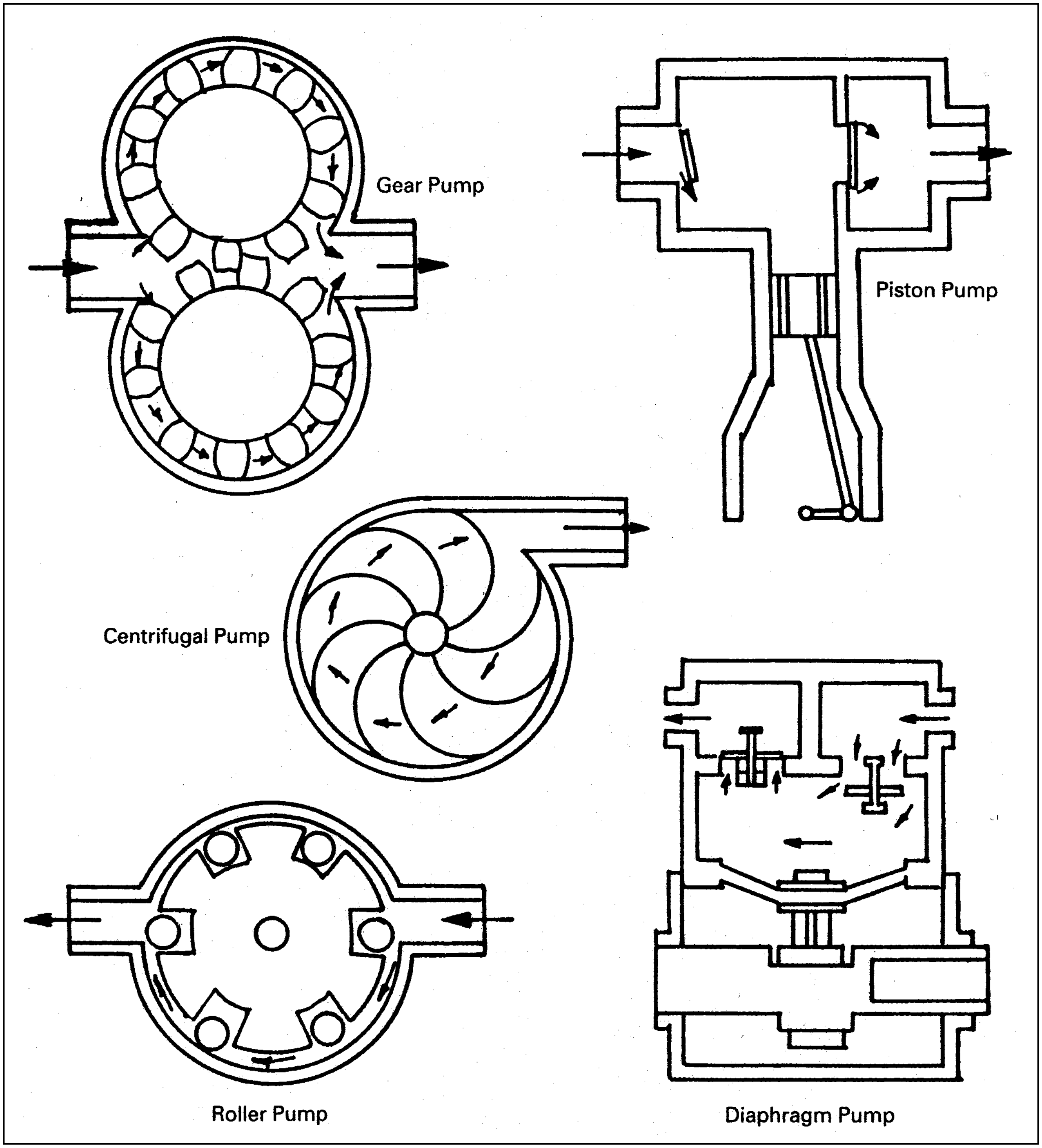


Figure 2. Types of pumps used for low-pressure ground sprayers.

Table 1. Characteristics Of Sprayer Pumps.

	Roller	Gear	Piston	Diaphragm	Centrifugal
Material Handled	Emulsions and non-abrasives	Emulsions and non-abrasives	Any material	Any material	Any material
Relative Purchase Price	Low	Low	High	Medium	Medium
Durability	Pressure and flow decrease with wear	Pressure and flow decrease with wear	Long life	Long life	Long life
Pressure Ranges (psi)	0-300	0-300	0-1,000	200-700	0-65
Flow Ranges (gpm)	0-30	0-48	0-60	0-60	0-120
Advantages	Low cost; easy to service,- operates at PTO speeds	Compact, easy to mount; easy to prime; low cost	Positive displacement; good priming; operates efficiently at 540 rpm	Handles corrosive abrasive material; medium cost; low mainten- ance; positive dis- placement works well 540 rpm; priming; pressure; light weight	Handles all materials; high volume; long life
Disadvantages	Sensitive to abrasive materials; may be damaged if run dry; wear reduces capacity; low volume	Sensitive to abrasive materials; wear reduces capacity; may be damaged if run dry; must oil or grease often; special tools needed for repair	High cost; need surge tank; heavy; low volume	Bulky design; generally not suitable for 1,000 rpm; low volume	Low pressure; not self-priming; requires speedup drive or high-speed hydraulic motor

Agitation System

Soluble liquids and powders generally do not require special agitation once they are in solution. However, emulsions, wettable powders, and liquid and dry flowables will generally separate if not continuously agitated. There are generally two types of agitation systems: mechanical and hydraulic.

Mechanical agitators are propellers or paddles mounted on a shaft near the bottom of the tank and are rotated at about 100 to 200 rpm (revolutions per minute). Because of the cost and power required, mechanical agitators are generally not used except in large tanks, when the primary material sprayed is a wettable powder formulation, or on sprayers equipped with piston pumps.

Hydraulic agitation is most commonly used on low-pressure ground sprayers. This system operates by returning a portion of the pump's output back to the tank and discharging it under pressure through holes in a pipe along the bottom of the tank or through a special agitator nozzle (Figures 1, page 3, and 3, below).

The amount of flow needed for agitation depends on the chemical used, as well as the shape and size of the tank. For a simple orifice jet agitator, a flow of 5 to 6 gallons per minute (gpm) for every 100 gallons of tank capacity is usually adequate.

Flow Control System

The flow-control assembly for a roller pump and other positive displacement pumps usually consists of

- A by-pass-type pressure regulator or relief valve.
- A control valve.
- A pressure regulator.
- A boom shut-off valve.

The flow-control assembly is shown in Figure 3. Bypass pressure-relief valves usually have a spring-loaded ball, disc, or diaphragm that opens with increased pressure so that excess flow is by-passed back to the tank. This feature prevents damage to the pump and other components when the boom is shut off.

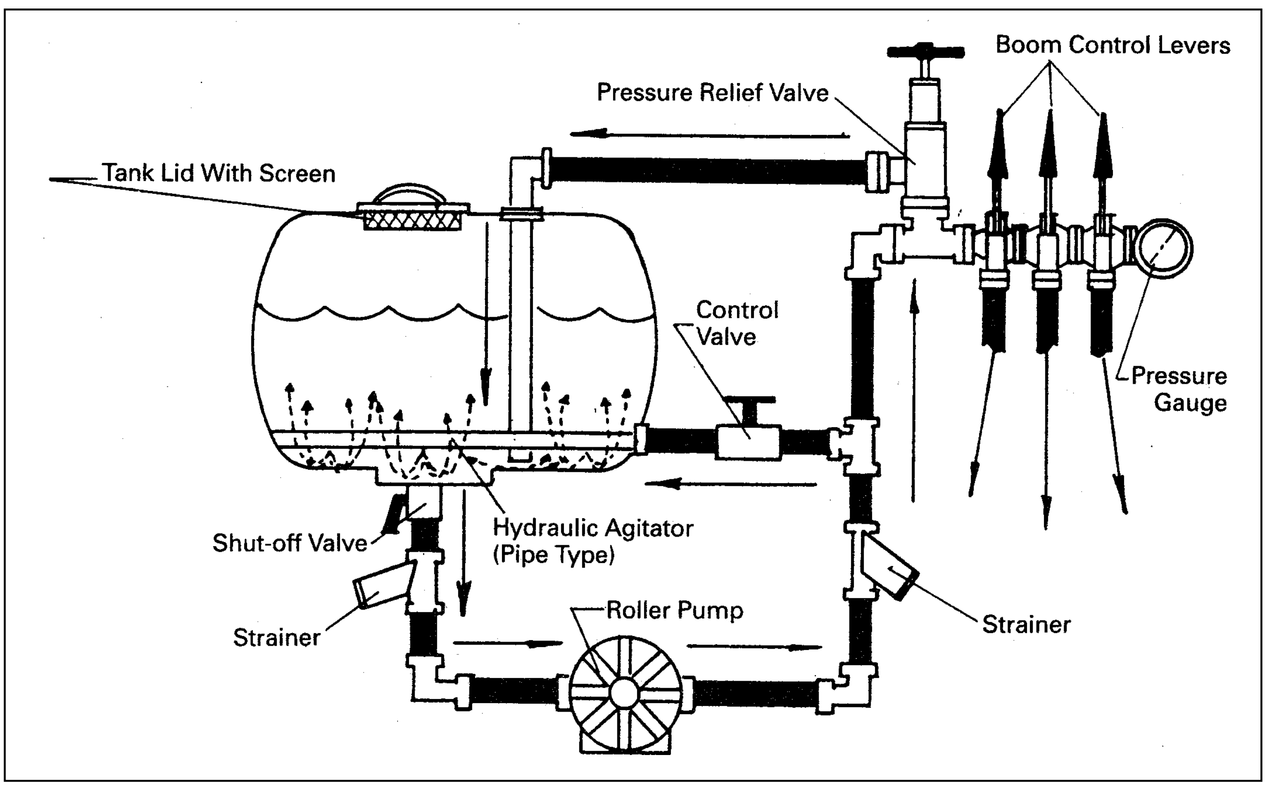


Figure 3. Typical roller pump spraying system.

Because the output of a centrifugal pump can be completely closed without damage to the pump, a pressure-relief valve and separate by-pass line are not needed (Figure 4). The spray pressure can be controlled with a simple gate valve or globe valve. It is preferable, however, to use special throttling valves that are designed to control the spraying pressure accurately. Electrically controlled throttling valves are becoming popular for remote pressure control.

A pressure gauge is necessary on every sprayer because nozzle tips are designed to operate within certain pressure limits. Without a gauge, it is impossible to know if the correct pressure is being maintained. The pressure gauge is also necessary for accurate calibration of the sprayer. The most desirable gauge is one designed for the pressure range at which the sprayer is normally operated. A range of 0 to 100 psi (pounds per square inch) is generally adequate for most agricultural chemicals. For accurate calibration of the sprayer, the pressure gauge should be located at the boom.

A boom shut-off valve allows the sprayer boom to be turned off while the pump and agitation system continues to operate. This feature allows the chemicals to be kept in solution when the boom is not operating and when moving from field to field.

Strainers

Strainers are designed to catch foreign material which may be in the spray solution before it can cause damage or plugging. Three types of strainers are generally used on low-pressure sprayers:

- Tank-filter strainers.
- Line strainers.
- Nozzle strainers.

Strainers are classified by mesh numbers (20-mesh, 50-mesh, etc.) which indicate the number of openings per inch. The higher the mesh number, the smaller the opening. A 16- to 20-mesh strainer is usually recommended for the tank-filter strainer.

Sprayers with a roller pump should have a suction-line strainer. This strainer should be 40- to 50-mesh. Sprayers with a centrifugal pump generally do not have a suction-line strainer because the inlet to a centrifugal. pump should never be restricted. With a centrifugal pump system, a fine strainer of about 50-mesh is placed on pressure side of the pump to protect the nozzle and agitation system.

Nozzle strainers usually are necessary for nozzles with flow rates of less than 1 gpm. In general, 100-mesh strainers are recommended for most nozzles with flow rates below 0.2 gpm, and 50-mesh strainers are recommended for nozzles with flow rates between 0.2 and 1.0 gpm.

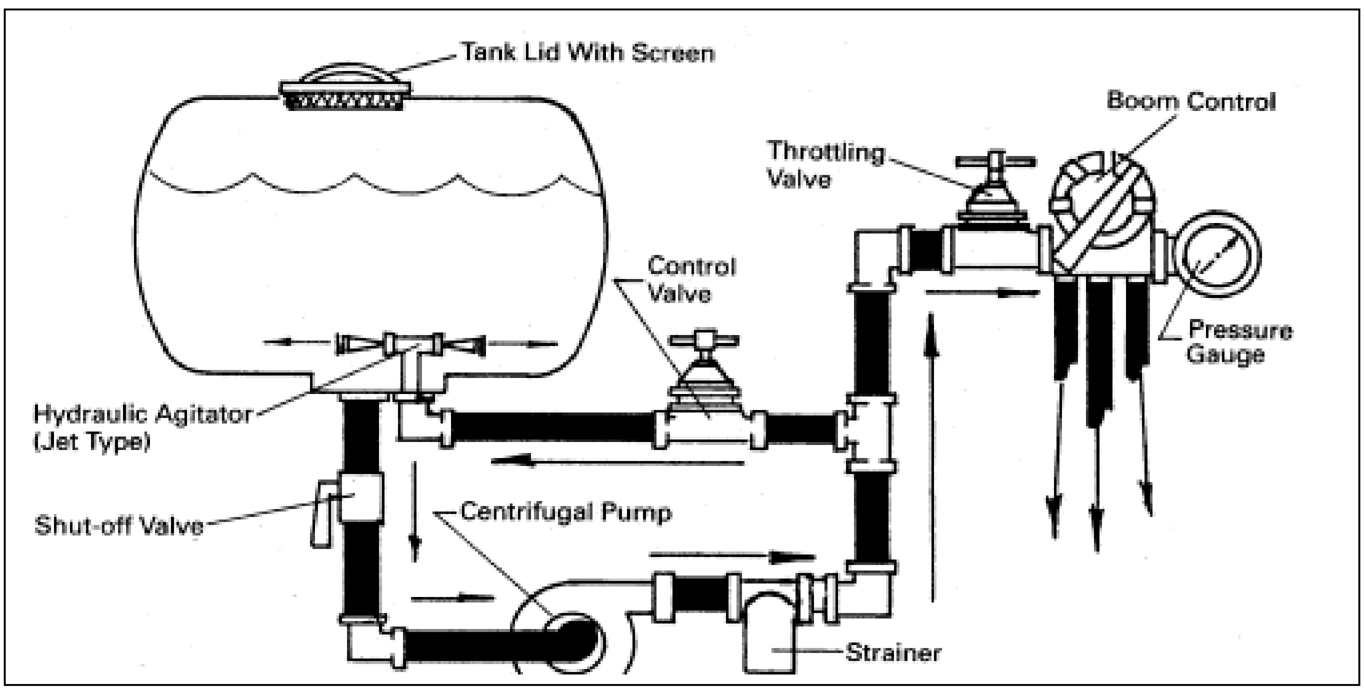


Figure 4. Typical centrifugal pump spraying system.

Distribution System

A good hose for sprayers is flexible, durable, and resistant to sunlight, oil, chemicals, and general abuse (such as twisting and vibration). Spray lines and suction hoses must be the proper sizes for the systems. The suction hose should be air-tight, non-collapsible, and as short as possible. It should have the same diameter as the pump intake opening.

Other lines, especially those between the pressure gauge and the nozzles, should be as straight as possible, with a minimum of restrictions and fittings. The proper size of these lines will vary with the size and capacity of the sprayer. A high, but not excessive, fluid velocity should be maintained throughout the system. If the lines are too large, the velocity will be so low that the pesticide may settle out and clog the system. If the lines are too small, an excessive pressure drop will occur. Suggested hose sizes for various pump flow rates are listed in Table 2.

Nozzles

The spray nozzle tip determines the spray distribution pattern and the spray volume delivered. Therefore, nozzle tips must be the correct size and must deliver the best distribution pattern for the job.

Nozzle tips are made from a variety of materials such as brass, stainless steel, nylon and other synthetics, and ceramic. Brass tips are the most common and least expensive. But, they also wear faster than other tip materials, especially when applying abrasive materials. Nylon and other synthetics are resistant to corrosion and abrasion but may swell when exposed to some solvents. Stainless-steel tips resist corrosion and abrasion and have a long life, but their big disadvantage is cost. Ceramic tips also have very long life but are also very expensive. Manufacturers are now making a nozzle with only a small portion of the tip made of ceramic material for long life and lower cost. Nozzle tips are classified by capacity, type, and angle for spray pattern. Some common spray patterns are shown in Figure 5.

Table 2. Recommended Hose Sizes For Pump Output.

Pump Output (gpm)	Hose Size	
	Suction	Pressure
0 to 6	¾”	½”
6 to 12	¾“	5/8”
12 to 25	1”	¾“
26 to 50	1¼ “	1”
50 to 100	1¼“	1½“

For preemergence broadcast herbicide application, flat fan-type nozzles with 650 to 110' angles are used. Tips with an 800 angle are most commonly used. The pressure range for this type of nozzle is 30 to 60 psi. There are flat fan tips that produce good patterns with pressures ranging from 15 to 60 psi. When banding a pre-emergence herbicide, use the even-flow fan-type nozzle which applies uniform coverage across the band width. This type of nozzle is designated with an "E" in the tip number (8004 E). The "E" series tips should only be used for banding.

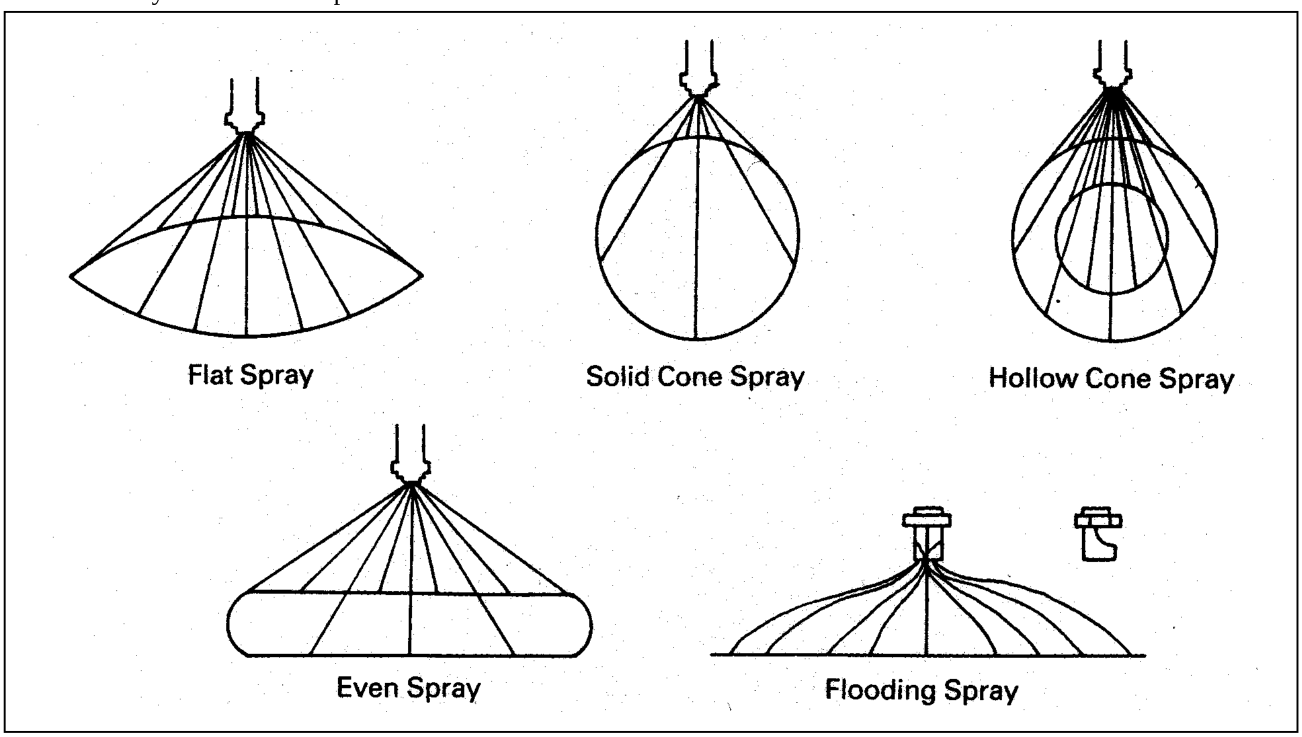


Figure 5. Nozzle spray patterns.

For postemergence herbicide application, 65° to 110° fan-type nozzle tips are used at pressures of 15 to 40 psi. Directed spray equipment may use fan-type, off-center type (OC series), or cone-type nozzles but should be equipped according to equipment manufacturers' recommendation.

For insect control, cone-type nozzle tips are arranged with the required number per row to give complete coverage of plants. One or two nozzles per row may be used for small plants, but for large plants, three or more nozzles may be required. For fungicide application, hollow-cone type nozzle tips are used with a sufficient number per row to give good coverage. Pressure of at least 70 psi provides good penetration of foliage.

Nozzle Arrangement On The Boom

Nozzle spacing and alignment on the boom are important for uniform coverage. The height of the nozzle tip above the ground or plant surface to be sprayed, nozzle spacing, and the angle of spray pattern are all related and should be carefully considered when spraying (Table 3). The nozzle height for band spraying can be adjusted to give the desired band width.

Table 3. Relationships Between Spray Angle, Nozzle Spacing, And Tip Height.

Spray Angle of Nozzle Tip	Nozzle Spacing on Boom: 20" Spacing	30" Spacing
	Spray Height	
65°	22" to 24"	33" to 35"
80°	17" to 19"	26" to 28"
110°	10" to 12"	14" to 18"

NOTE: This table is for nozzles spraying at 40 psi.

The boom and nozzle relationship is very important for maintaining even coverage; Figure 6 shows several problems that can occur. If the boom droops, it will cause uneven coverage and skips Figure 6a). If nozzle tips with different spray angles are used along the boom, non-uniform coverage will result (Figure 6b). When nozzle tips are plugged or when operating pressure is higher or lower than recommended, distribution will skip haphazardly (Figure 6c). Although the required amount of material per acre may be discharged in the first two illustrations, all three would result in uneven coverage.

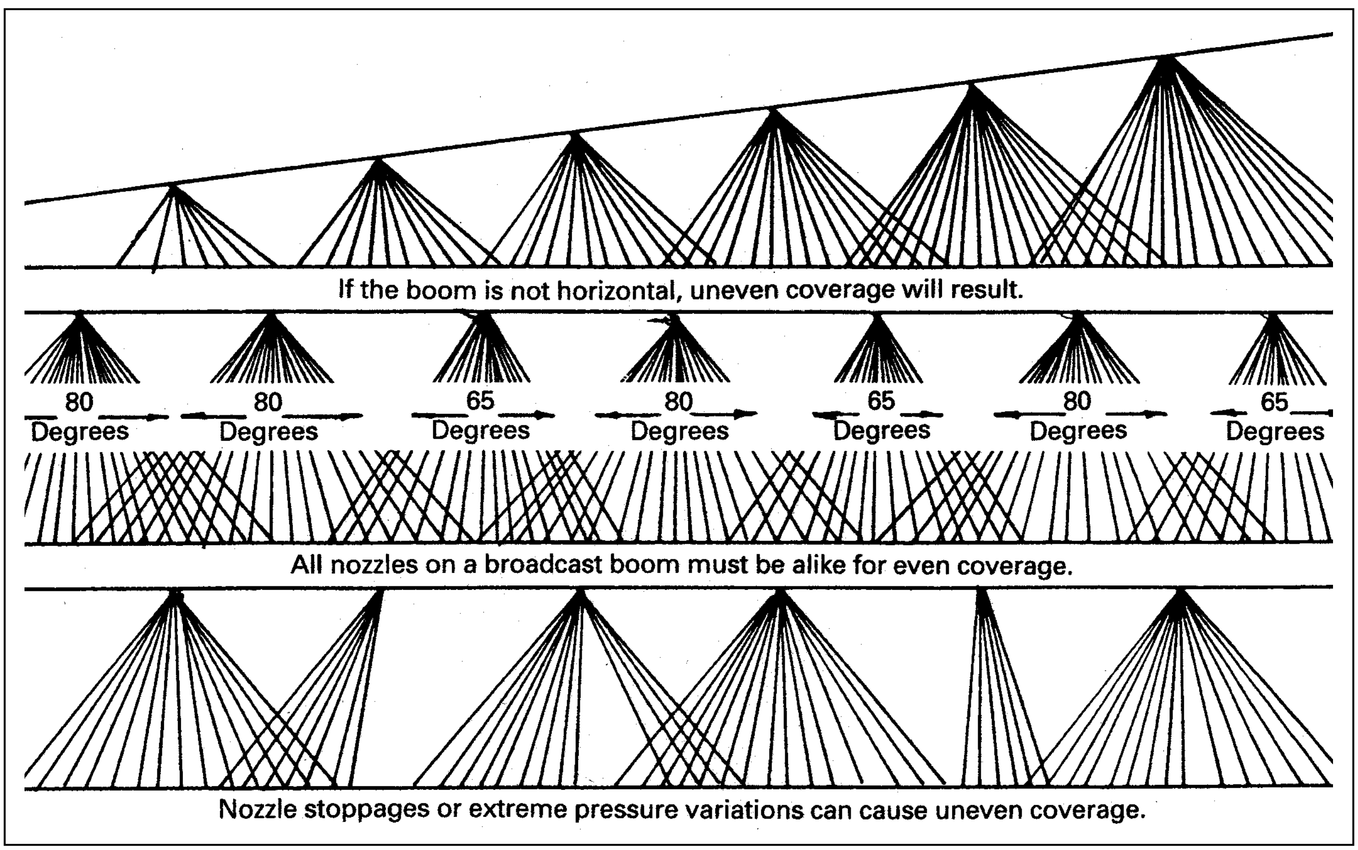


Figure 6. Nozzle and boom relationships.

Misalignment of nozzle tips is a common cause of uneven coverage (Figure 7). Be sure fan-type spray patterns are almost parallel with the boom when installing nozzle tips. Manufacturers are now making connectors for nozzle tips which, for the most part, will eliminate problems with misalignment. Figure 8 shows four arrangements of nozzles on a boom; Figures 8b, 8c, and 8d are drop-nozzle arrangements.

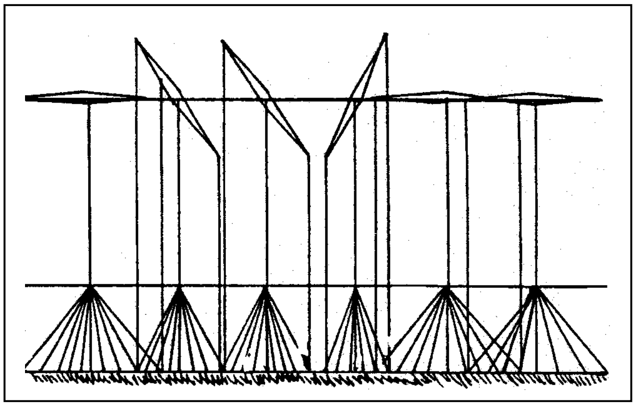


Figure 7. Poor Nozzle Alignment.

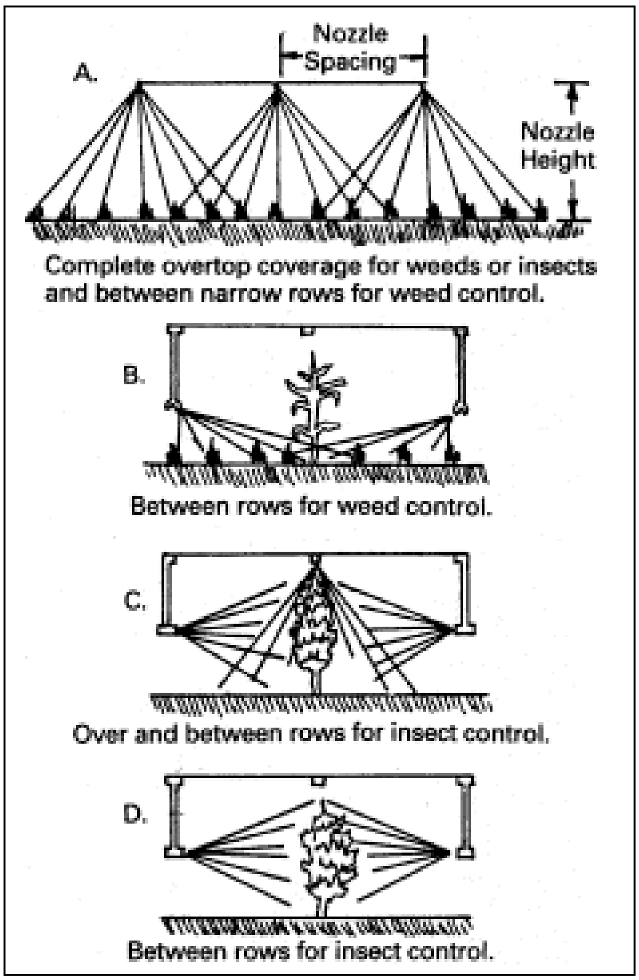


Figure 8. Methods of arranging nozzles on boom.

Boomless Sprayers

A boomless sprayer is different from other sprayers because of its nozzle arrangement. A special nozzle or cluster of nozzles is used to give a wide spray path. This sprayer has fewer nozzles and is better adapted to rough or steep terrain than a boom type. However, it is harder to get uniform coverage and accurate placement with a boomless sprayer because the spray material simply falls onto the plants, while the conventional boom type sprayer forces the material into the plant foliage. The slightest wind disrupts the spray pattern of a boomless sprayer, causing drift and uneven distribution.

Directed Sprayers

Directed spraying can be a very effective and inexpensive way of controlling weeds in crops that grow tall fairly rapidly. The crop must be taller than the weed so the spray can be directed toward the base of the crop plants and strike the foliage of the weeds (Figure 9). The nozzles must be mounted below and to the side of the crop foliage. They must also be supported and directed toward the base of the plant.

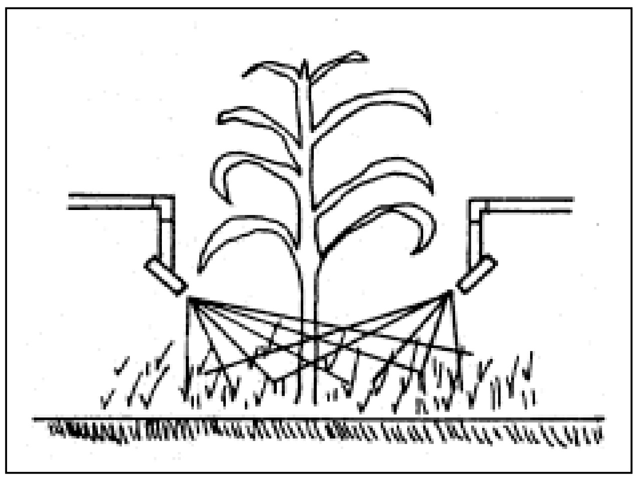


Figure 9. Directed spray.

Several types of equipment are available to support the spray nozzles. Manufacturers' recommendations should be followed when selecting and mounting the nozzles. Making a directed spray with nozzles mounted on the sweeps of a cultivator is a very economical way to control weeds.

Pre-Calibration Procedure

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 sprayer thoroughly to make certain that all components are operating properly. All nozzle tips and strainers should be removed and several gallons of clean water should be "sprayed" through the system to check in-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 the proper strainer for the desired application rate. The proper nozzle tip size is determined by the gallonage to be applied. The total sprayer application rate in gallons per acre (gpa) is normally determined from the pesticide label. 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. For example, if chemical A is recommended at 20 to 60 gpa and chemical B is recommended at 40 to 80 gpa, a suitable sprayer application rate would be 50 gpa.

Once the application rate of the sprayer is determined, the next step is to select a travel speed. Most spraying situations and field conditions will allow operation in the 2 to 5 mile per hour (mph) 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. In other situations, the forward speed capabilities of the sprayer may be the limiting factor (Table 4).

Table 4. Tractor Speeds.

Time (In Minutes) Required To Travel A Distance Of: 100 Feet	200 Feet	Speed (in mph)
34	68	2.0
23	45	3.0
17	34	4.0
14	27	5.0
11	23	6.0

The next step in the calibration process is to determine the spray width for each nozzle tip. If the nozzle tips are mounted 20 inches apart on a broadcast boom, then the spray width for each tip is 20 inches, if the boom is raised to the appropriate height (see Table 3, page 4).

Example 1: Nozzle Selection

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

Example 1:

1. Application rate of the sprayer, in gpa	19
2. Ground speed, in mph	4
3. Spray width per nozzle tip, in inches	20

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

$$gpm = \frac{gpa \times W \times S}{5940}$$

Where:
- gpm = the desired sprayer application rate in gallons per acre.
- Gpa = the flow rate of the nozzle in gallons per minute.
- W = the spray width per nozzle, in inches.
- S = the ground speed, in miles per hour.
- 5940 = a constant figure.

Using the figures from our example, we can calculate the required flow rate for nozzle selection:

$$Gpm = \frac{19 \times 20 \times 4}{5940} = 0.26$$

So, the required flow rate is 0.26 gallons per minute.

We are now ready to select a nozzle tip that will give the desired nozzle flow rate of 0.26 gpm. The assumption is made here that the applicator is applying herbicides and has selected a flat fan-type tip 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 desired flow rate.

A sample nozzle flow rate table is shown in Table 5. This table will be used to illustrate selection of a nozzle for the example problem. Looking at the table, we see that a No. 8003 tip at 30 psi will give a flow rate of 0.26
gpm.

Table 5. Sample Table From Nozzle Manufacturer's Catalog.

Tip Number	Pressure	Flow Rate (gpm)
8002	30	0.17
	40	0.20
	50	0.23
	60	0.25
8003	30	0.26
	40	0.30
	50	0.34
	60	0.37
8004	30	0.35
	40	0.40
	50	0.45
	60	0.49

Checking Nozzle Output

When the appropriate 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 rate of flow from each nozzle for 30 seconds. Record the volume measured for each nozzle, and compare them when all have been tested.

Example 2: Nozzle Output

Variations in volume of more than 10 percent are not desirable. To determine variation in volume, consider the following example:

Example 2:

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

Total volume of all nozzles	271 ounces
Average volume/nozzle	45.2 ounces
10% of average	4.5 ounces

Average nozzle volume = Total volume of all nozzles / No. of nozzles

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.

Calibration Methods

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. The type of sprayer, the 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.

The area sprayed for calibration purposes is often some easy-to-calculate fractional portion of an acre, such as 1/10 or 1/100 of an acre. Errors in calculation can cause serious errors in application rates of sprayers. So, care must be taken to avoid miscalculations. A calibration method which involves few or no calculations is generally best. For that reason, the following are popular methods of calibrating sprayers in Alabama.

Refill Method. There are many accurate and easy 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.

The 1/128-Acre Or "Ounce" Method. The 1/28-acre method of calibration requires no calculations to determine the application rate of the sprayer. 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 of the sprayer in gpa. This eliminates the need for mathematical equations.

Example 3. Calculation Of Course Length

The key to the successful use of this method is selecting the proper length to travel for the calibration trial. The length of the course can be easily calculated by dividing 340 square feet (128 of 43,560 square feet or 1 acre) by the spray width in feet of one nozzle of nozzle spacing. Since 20 inches is a very common width for mounting nozzles on boom type sprayers, we will use this distance for our example calculation.

Example 3:
20 inches ÷ 12 inches = 1.67 feet
340 square feet ÷ 1.67 feet = 203.6 or 204 feet

Table 6 gives you the necessary course length to equal 1/128 of an acre for some of the more common spray-tip widths. For an uncommon width, the course length can be easily calculated using the formula above.

Table 6. Calibration Course Length.

Band Width or Nozzle Tip Spacing on Broadcast Boom	Course Length to Travel (Feet)
10	408
12	340
14	292
16	255
18	227
20	204
22	185
24	170
28	146
30	136
32	127
34	120
36	113
38	107
40	102
60	68
80	51

Example 4. Using The 1/128-Acre Method

The following are examples of how the 1/128-acre or "ounce" method works:

Example 4:

An applicator wants to apply Gramoxone with a boom (broadcast) sprayer using a nozzle spacing of 20 inches. What course length should be measured off for calibration?

Solution:

From Table 6, we see that 204 feet is the course length that is necessary. To proceed with the calibration, we would complete the following steps:

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

2. Select the ground speed and engine rpm speed that will permit safe and efficient operation of the sprayer.

3. After setting the spray system pressure to the desired pressure, bring the sprayer to operating speed before you reach the marker representing the beginning of the 204-foot course. As the sprayer passes the start marker, start timing 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.

4. Repeat this timing process in the opposite direction and average the two times.

Sample Times: Trip 1 = 23 seconds
Trip 2 = 21 seconds
Average = 22 seconds

5. Park the sprayer, and, with the engine running at the same rpm speed and the same pressure setting, catch the water output from several 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 in gpa.**

Sample Volumes:

Nozzle	Ounce	Application Rate (gpa)
1	32	32
2	31	31
3	32	32
4	33	33
5	32	32

In the sample above, the average volume caught was 32 ounces, which represents a 32-gpa sprayer application rate.

What if we had wanted to apply 40 gpa? What could be done to increase the rate?

- The pressure could be increased.
- Sprayer speed could be reduced.
- A larger nozzle tip could be installed.

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

- Decrease the pressure.
- Increase speed of the sprayer.
- Install smaller nozzle tips.

If more than a 25-percent change in sprayer output is required after the first calibration run, changing the nozzle tip size is usually necessary.

After any change is made, another calibration run should be made.

Example 5. Determining Acres Per Tank

After the calibration has been completed, the number of acres that can be sprayed with each tank of spray mixture can be determined by dividing the size of the tank in gallons by the application rate of the sprayer in gpa.

Example 5:

$$\frac{\text{250 gallon tank}}{\text{32 gpa}} = \text{7.81 acres per tank}$$

Band Spraying

One of the most confusing procedures to many farmers is calibrating the sprayer for band application (strip application) of chemicals rather than broadcast spraying the entire area of a field. If a given chemical recommendation is for X gallons per acre and only a band Y inches in width is sprayed, confusion usually results. Possibly, a better term to use in band application is gallons per treated acre rather than gallons per field acre, because the total land area is not sprayed during band application.

Example 6. Using the 1/128-Acre Method For Banding

The following is an easy way to calibrate and use the 1/28-acre method in a typical banding situation.

Example 6:

A farmer has 200 acres of corn in 36-inch rows and wants to apply herbicide in 12-inch bands over the rows at 25 gallons per treated acre.

Question 1: What course length should be used for calibration?
Solution: Using the 1/28-acre calibration table (Table 6, page 7), a course length of 340 feet is required for 12-inch band width (340 square feet + 1 foot = 340 feet). The number of ounces caught from a single nozzle tip spraying a 12-inch band in the time it takes to cover 340 feet is the sprayer output per treated acre.

Question 2: What part of an acre is accurately sprayed?

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

$$\frac{\text{12 inches (Band) x 1 acre}}{\text{36 inches (Row)}} = \text{0.333 or ½ acre}$$

So, for every field acre the sprayer is driven over, only 0.333 acre is sprayed. Using Table 7, or the simple process of dividing the band width by the row width, you can calculate what portion of an acre is treated for each field acre driven over.

Table 7. Treated Area Per Field Acre.

Row Spacing (inches)	Band Width (inches)				
	8	10	12	16	20
20	.400	.500	.600	.800	1.000
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

How do you use this figure? In Example 6 above, the farmer had 200 acres of corn in 36-inch rows to be banded in 12-inch bands at 25 gpa.

Question 3: How many acres of the 200 field acres are to be treated or sprayed?
Solution: From Table 7, the ratio of a 12-inch band on a 36-inch row is 0.333.

200 acres x 0.333 = 66.6 acres

The 66.6 acres are the actual treated or sprayed acres in the 200-acre field.

Question 4: How many treated acres can be sprayed per tank using the information in Example 6?
Solution:

$$\frac{\text{250 gallon tank}}{\text{25 gallons per treated acre}} = \text{10 treated acres per tank}$$

Question 5: How much chemical should be added per tank if the broadcast rate is 4 pounds of chemical per acre?

Solution:

10 acres/tank x 4 lb. chemical/acre = 40 lb. chemical/ tank

Question 6: How many pounds of chemical will be needed to spray the area in Example 6?

Solution: Since 66.6 acres will be treated or sprayed at 4 pounds per acre, the total pounds of chemical needed will be:

66.6 acres x 4 lb. chemical/acre = 266.4 lb.

Calibration Using Multiple Nozzles Per Row

When row cropping, it is often necessary to use more than one nozzle per row for effective coverage of foliage with fungicides and insecticides. Calibration in these situations is no more difficult than it is for the one-row/one-nozzle situations.

Example 7. Multiple Nozzles

Consider this example of a tomato sprayer in which several nozzles are used to spray each row. The first step is to determine the row spacing, or the distance between rows. This row width becomes the W value in the equation:

$$\text{gpm.} = \frac{\text{gpa x W x S}}{5940}$$

This is the equation used to calculate the proper nozzle tip size when the sprayer application rate (gpa) and speed (S) are known. The only difference when using multiple nozzle instead of single nozzle arrangements is that several nozzles will be applying the spray material rate (gpm) rather than only one nozzle. To determine the output rate for each nozzle, use the following equation:

$$\text{gpm of individual nozzles} = \frac{\text{Flow Rate}}{\text{Number of Nozzles/Row}}$$

Question 1: Using the above illustration and a sprayer application rate of 120 gpa at 250 psi, 48-inch rows, and a speed of 3 mph, what is the application rate in gpm?

Solution:

$$\text{gpm} = \frac{\text{120 gpa x 48 inches x 3 mph}}{5940} = 2.91 \text{ gpm}$$

Question 2: For the example above, and with 5 nozzles per row, what is the application rate in gpm for each nozzle?

Solution:

$$\frac{\text{2.91 (Flow Rate in gpm)}}{\text{5 nozzles}} = 0.582 \text{ gpm/nozzle}$$

During the actual calibration process, when flow from the nozzles is collected for a specified time (depending on the method used) to determine the flow rate, the amounts of material collected from all five nozzles should add up to the application rate per row. The remainder of the calibration process is the same as that for one-row/one-nozzle procedures.

ALABAMA COOPERATIVE Extension SYSTEM

ANR-570

For more information, call your county Extension office. Look in your telephone directory under your county's name to find the number.

The author expresses his appreciation to Dr. John W Everest, Dr. Michael G. Patterson, and Mr. Steve Brown for their suggestions and guidance in reviewing the manuscript for this publication.

UPS, 1992, ANR-570

Visit our Web site at: **www.aces.edu/department/crd/pubs.html**