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Application Equipment and Techniques [1]

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Herbicides are applied with both sprayers and applicators for applying dry materials, primarily granular materials. Since the majority of the herbicides are applied by sprayers, this type of equipment will be emphasized below.

Sprayers used in agriculture are often classified as either low pressure (up to 80 psi -- pounds per square inch of pressure) or high pressure (up to 500 psi) types. The primary difference in the two types of sprayers is the type of pump used. A low-pressure sprayer is usually equipped with a roller or centrifugal pump, while the high-pressure unit would have a positive displacement pump such as a piston or diaphragm pump.

CHOOSING A SPRAYER

The choice between a cheaper, low-pressure sprayer and a more expensive, high-pressure sprayer would depend largely on whether the unit is to be used for applying herbicides exclusively, which requires relatively low pressures, or whether the unit would be a multi-purpose sprayer, which could require pressures up to 500 psi.

However, sprayers that are used exclusively for applying herbicides may often be high pressure sprayers, because these more expensive sprayers are usually the only units with an agitation system capable of keeping wettable powders in a uniform suspension. If most of the herbicides to be used are formulated as wettable powders, good agitation is a primary concern when choosing a herbicide sprayer. The competively priced, low-pressure sprayer with a marginal agitation system is generally useful for low-pressure spraying of liquid formulations.

A high-pressure sprayer used to spray herbicides must be capable of operating in the 20 to 50 psi pressure range. Manufacturers of some high-pressure sprayers have recognized that their equipment is being used for low as well as high pressure applications, and have provided their sprayers with adequate by-pass capacity so that low pressures can be reached. A high-pressure sprayer can be modified so low pressure levels can be used by adding an additional by-pass line equipped with a valve to vary the amount being bypassed back to the tank.

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SPRAYER PARTS AND THEIR FUNCTION

The **Pump** is the heart of the sprayer. The typical boom sprayer consists of a power take-off (PTO) driven pump which has a chain that is secured to keep the pump from turning. As the PTO turns, a partial vacuum is created in the suction line which fills with spray from the tank. The spray is forced through the pressure side of the system by the pump. Three factors to consider in selecting a pump for a sprayer are:

1. **Capacity** - The pump must have enough capacity to supply the boom output and to provide for adequate agitation when hydraulic agitation is used. The amount of flow needed for good agitation depends on the size and shape of the sprayer tank and it is difficult to give general guidelines for determining the flow needed for agitation. Pump capacities are given in gallons per minute or per hour.

2. **Pressure** - The pump must be able to operate at the pressure needed for properly applying the spray applications. Pressure is measured in pounds per square inch (psi).

3. **Resistance to Corrosion and Wear** - The pump must be able to handle the chemical spray materials without excessive corrosion or wear.

The **Sprayer Tank** should be of corrosion-resistant metal or fiberglass. The tank should have a large opening to allow for easy filling plus a drain to facilitate cleaning.

Agitation of spray mixtures is normally achieved by a hydraulic jet agitator, or by a mechanical agitator which usually consists of paddles mounted on a rotating shaft. Generally, a mechanical agitator is the best type of agitation, but it is expensive. Jet agitators can keep pesticide materials in suspension if they are properly designed. The line supplying the agitator must be connected into the pressure side of the spray system. The pump must have enough capacity to provide the flow to both the nozzles applying the spray and the orifices of the hydraulic agitator.

Some inexpensive sprayers rely on the by-pass flow from the pressure regulator to provide agitation. This arrangement might be sufficient when using liquid and soluble powder formulations which require little or no agitation to maintain a uniform mixture, but by-pass agitation is not recommended for applying wettable powder formulations because they might settle out.

Careful calibration of the sprayer is of questionable value if the spray is not uniformly mixed. Just because a sprayer is delivering a uniform rate per acre of spray mixture does not mean that the pesticide is being applied uniformly. Uniform application of pesticides can only be achieved when each volume of spray has a uniform amount of pesticide mixed with it. Achieving this uniform mixture is the function of the agitator, so its importance cannot be overemphasized.

The **Pressure Regulator** has two functions. One is to regulate the system pressure by allowing some of the pump output to escape back to the tank through its variable opening. The other is to relieve excess pressure when the shut-off valves are closed.

The **Pressure Gauge** should be located where the sprayer operator can easily check the system pressure. A gauge should be easy to read, and the pressure range should be appropriate for the pressures being used. A gauge with a maximum reading of 100 psi is adequate for herbicide sprayers equipped with roller pumps. A sprayer that has a high-pressure pump, but is often used for low pressure work, should have two gauges, one reading up to 100 psi and the other up to approximately 500 psi. The low-pressure gauge would be isolated from the system when high pressures were being used.

The **Flow Cut-off Valve** is a quick-acting valve that should be placed between the pressure regulator and the boom to control the flow of spray materials. One valve may be used to cut off the entire flow, or a combination of two or three valves may be used to control the flow in two or more sections of the boom. Also available is a special selector valve which will control the flow of spray to any section or combination of sections of the boom.

All **Hoses and Fittings** should be of the quality and strength required to handle the chemicals and operating pressures. A good hose is flexible, durable, and resistant to sunlight, oil, chemicals, and the general abuse given a hose during sprayer use.

Strainers are needed to keep foreign matter from plugging the sprayer nozzles. The primary types of strainers are the slit and the wire mesh. Probably the most widely used wire mesh strainer has a 50-mesh screen. The 50-mesh screen will screen out most trouble-making particles while still allowing wettable powders to pass through.

Nozzles are available with male or female connections and may be of metal, nylon, or ceramic materials. They are designed to develop various spray patterns, rates of discharge, and angles of spray.

Manufacturers usually calibrate their nozzles and number them according to the angle of the spray pattern and the flow at 40 psi. All nozzle manufacturers do not use the same system for designating nozzles, but they do have performance charts which give the information needed to choose the correct nozzles. The nozzle tips of most manufacturers are of the same diameter and can be interchanged.

HERBICIDE APPLICATION TECHNIQUES

Broadcast Spraying

When applying a herbicide broadcast, the full width of the sprayer swath is treated with the herbicide. Flat spray, wide angle flat spray, and boomless spray nozzles are all used to apply broadcast applications. These are discussed below.

Flat Spray Nozzles have various pattern angles, and the correct nozzle tip height above the surface to be treated depends on the pattern angle of the nozzle being used. Table 1 indicates the correct height of the boom tip for various angle fan nozzles when located on 20-inch spacing on the boom (a common spacing for boom nozzles).

Flat spray nozzle patterns overlap at the edges, but since the pattern width narrows down in the overlapped zone the application is uniform. The primary reason for overlapping the nozzle patterns at the edge is to avoid skips, due to the boom dipping lower than the ideal height which is unavoidable when spraying in the field.

The distribution of spray from tapered-edge nozzles and even spray nozzles would be uniform as long as the nozzle tip was at the appropriate height. If the boom and the nozzle tips dip down, the application rate between the two tapered fan nozzles would diminish, but there would be an unsprayed skip between the two even spray nozzles.

Wide Angle Flat Spray Nozzles (Flood Nozzles) are designed to produce a pattern in the 115° to 150° range. Since the pattern is so wide, reasonably uniform distribution is obtained when the nozzles are spaced 40 inches apart and the nozzle tip is 13 inches above the surface to be sprayed.

The coarse spray produced by this nozzle type and the low tip height would help minimize drift. However, it is difficult to apply a uniform pattern with this type of nozzle.

Boomless Broadcast Spraying is a cluster of nozzles, or a single special nozzle used to cover a wide swath. These units cost less, have fewer nozzles to maintain, and are well adapted for use on rough terrain. The cluster type is often used to spray fence rows. Usually one side of the unit is closed off with banks so it will spray in one direction when treating fence rows.

Disadvantages of the boomless sprayer are: (1) uniformity of distribution across the swath is not as good as with a boom, (2) spray materials penetrate the crop by gravity alone, while a boom-type sprayer forces the materials into the plant foliage, (3) the pattern is easily distorted by wind.

The best method to obtain even coverage with a boomless sprayer is to double cover the area by overlapping half of the previously sprayed swath. Since the effective swath of the sprayer is only 1/2 of its apparent swath when double covering, the spray mixture would be only 1/2 as concentrated as it would be when single coverage was applied.

Band Spraying

To conserve spray materials and get effective control of weeds in row crops such as cotton and corn, certain herbicides can be applied as a band centered on the row at planting time.

The spray nozzles are usually mounted on a special bracket behind the planter press wheel. Application after the crop is planted means an extra operation, makes it difficult to center the band over the row, and introduces a chance of rain preventing treatment before the crop emerges.

Band spraying is usually done with a special type of nozzle, called an **even spray nozzle**. Even spray nozzles provide uniform coverage across the full band width. Even spray nozzles tips come in at least two pattern angles, 80° and 95°. The band width sprayed depends on the pattern angle and the height of the nozzle tip above the ground. Table 2 indicates the nozzle tip heights needed to apply various band widths.

Postemergence-Directed Spraying

This method of spraying is used to apply herbicides to young weeds in a crop that can withstand the herbicide on its lower, more mature portions, but not on its green tender portions. Usually special skids are used to carry the spray nozzles at a constant height above the ground, to insure against getting the spray on the tender portions of the crop.

Nozzles used to apply directed sprays are sometimes mounted on cultivators in order to get a precisely applied spray without the expense of the skids.

Cone type nozzles are often used for post-emergence directed spray applications. Full cone nozzles produce larger droplets than hollow cone nozzles.

Using nozzle drops to get the nozzle down below the tender portions of the crop is not recommended. The sprayer boom bounces around under even the best of field conditions, and the herbicide damage to the crop will be excessive when using this technique.

Granular Herbicide Applicators

Granular herbicide formulations are applied broadcast across the full width of the field or in bands. The equipment for broadcasting herbicide granules is essentially the same type spreader used to apply granular fertilizers. The two most common designs are the centrifugal spreader and the gravity flow spreader.

Equipment for applying herbicide granules in a band along the crop row is available from several manufacturers. These units usually have a separate granule hopper for each row and are mounted on the planter.

Table 1. Correct height of boom tip.

Pattern Angle (degrees)	Nozzle Tip Height (inches)
65	21 to 23
80	17 to 19
110	15 to 18

Table 2. Nozzle tip heights needed to apply various band widths.

Band Width	Approximate Height (inches) for	
	80 degree nozzles	95 degree nozzles
8 inches	5 inches	4 inches
10 inches	6 inches	5 inches
12 inches	7 inches	6 inches
14 inches	8 inches	7 inches