



# Weed Spraying Equipment

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## Foreword

The use of herbicides to control weeds is now a common practice on a large percentage of Oregon farms. With the continued advances in herbicide chemistry, this practice will increase.

The selection of suitable equipment for the application of herbicides is important if full benefits from their use are to be enjoyed. The equipment needs for different sections of the state, specialty crops, and farming enterprise varies considerably.

This bulletin is to aid the farmer in proper selection, care, operation, and management of his weed spraying equipment.

A handwritten signature in cursive script that reads "J. E. Price". The signature is fluid and elegant, with the first letters of each name being capitalized and prominent.

Dean and Director



The author acknowledges the assistance of Professors J. B. Rodgers and V. H. Freed for helpful suggestions in the preparation of the manuscript.

# Weed Spraying Equipment

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The use of chemicals to control weeds in the state of Oregon is common practice on large areas of range land and by many growers of small grains, flax, legumes, small fruits, and truck crops. Chemicals are also used on fence rows, ditch banks, dikes, and roadsides for control of weeds and brush.

Equipment for applying these chemicals includes hand sprayers and dusters, motorized ground rigs, airplanes and helicopters. The chemical application equipment should fit into the management plan for the farm on which it is to be used. This bulletin has been prepared to help the farmer in selecting or building a weed sprayer that will best meet his needs. Consider first what the weed spraying needs are going to be in the near future. The farmer having a brush problem and attempting to control it with Ammonium Sulfamate (Ammate) and similar sprays, will need a sprayer that is made of corrosion-resistant material. The strictly grain farmer may need only a steel rig to handle 2,4-D. The width of the sprayer will be

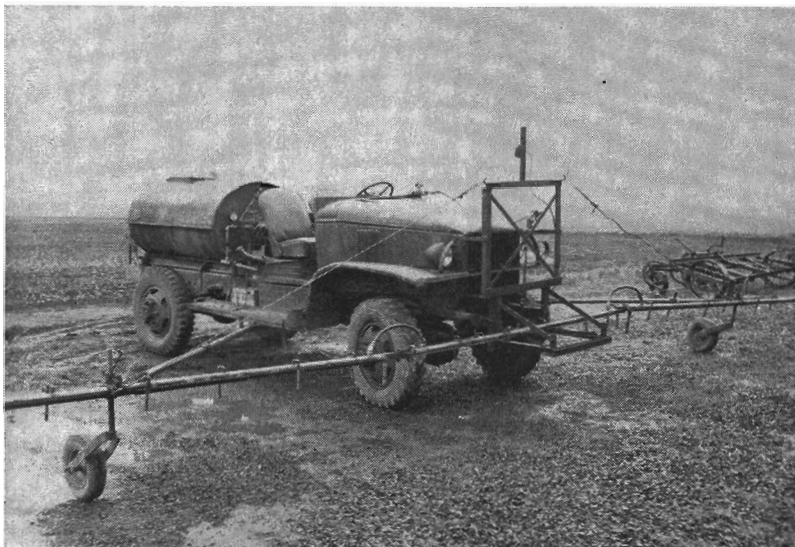


Figure 1. A sprayer of the type popular in Umatilla County.

determined by the total acreage and the size, shape, and topography of the fields to be sprayed. The size of the tank and the type of agitation will be governed largely by the spray material to be used. Controls should be easy to operate from the seat of the tractor.

When feasible, it is best to use one sprayer for herbicides and another for insecticides. On a small acreage, however, it may be economically desirable to use the same unit for both jobs. The related jobs that the equipment may be required to perform in many cases will determine the type of pump needed.

Each part of the sprayer will be discussed separately starting with the pump.

### Types of Pumps

The type of pump used for weed spraying equipment is not important so long as it is capable of supplying the required volume at the necessary pressure.

The plunger or piston pump is a positive displacement pump; the discharge in gallons per minute at maximum pressure setting is about the same as at zero pressure. Systems using a positive displacement pump require the use of pressure regulator valve with

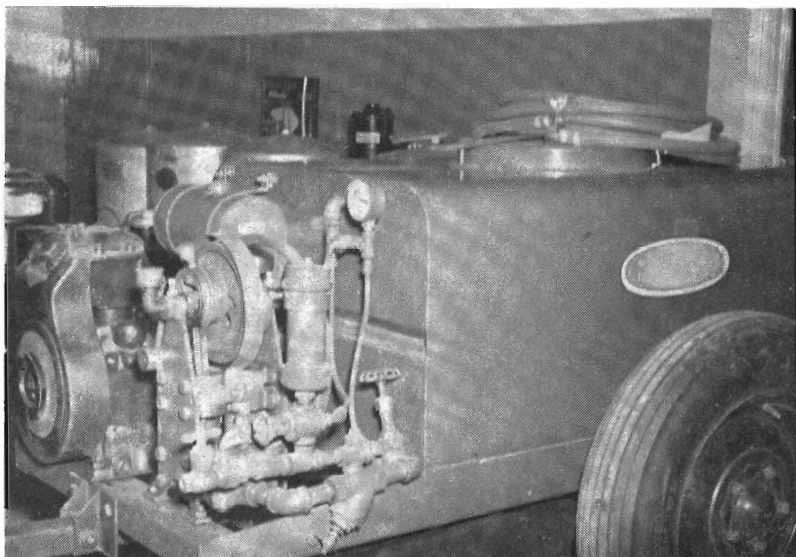


Figure 2. High pressure, piston spray pumps are used for weed sprayers when the same sprayer is to be used for cattle grub or orchard spraying.

bypass to protect the pump and system from damage when the flow of liquid to the nozzles is shut off. Piston pumps are used where high pressures are required, as when the equipment is used as an orchard sprayer or by ranchers for spraying cattle or for stand-by fire equipment. This type of pump is usually long lived, fairly expensive, and because of size, is difficult to mount in a limited space. At a given pump speed the power required to drive the pump is directly proportional to the pressure at the pump. Due to the high discharge pressure developed in the plunger and piston pumps they usually require greater driving power than other pumps.

A rotary pump is a relatively low first cost, compact, positive, displacement pump. The common types used for weed spraying include the gear pumps (Figure 3) and the vane pumps (Figure 4). The rotary pumps require the protection of a pressure regulator valve with bypass. The nonpulsating pump discharge does not require the surge chamber required with the piston pumps. The compact design and ability to operate at low speeds makes it ideally suited to tractor power takeoff drive for tractor mounted sprayers. Rotary pumps are not well suited for the handling of liquids containing grit or abrasive.

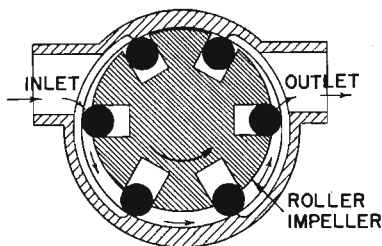


Figure 4. The vane pump may have either circular or rectangular vanes.

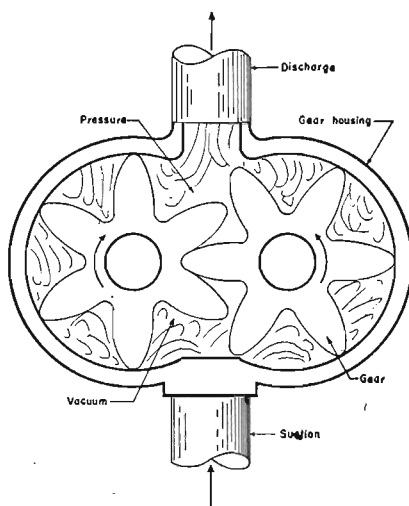


Figure 3. The rotary gear pump is a compact, positive displacement machine.

Small pieces of grit may cause pump breakage. A small change in clearances due to wear will change the performance characteristics of the pump. There is no means of compensating for wear other than replacement of worn parts. The rotary pumps are usually self priming, but may lose this ability when worn. The power requirements at constant speed varies directly as pressure varies.

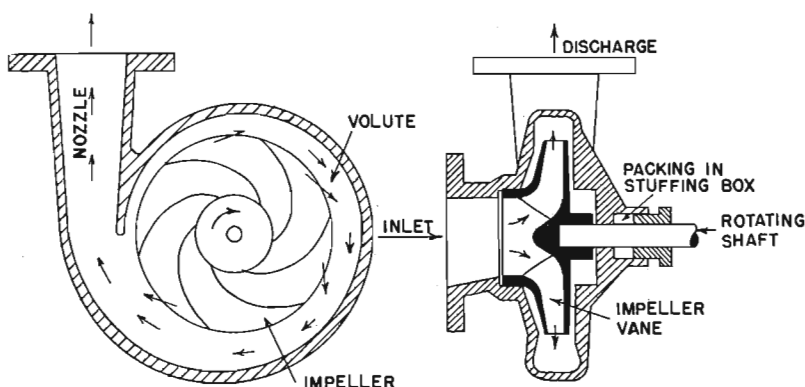


Figure 5. The rotating impeller of the centrifugal pump imparts a velocity to the liquid passing through the pump.

The centrifugal and turbine pumps, Figure 5, are not positive displacement pumps. The rotating impeller imparts a velocity and pressure to the fluid in the pump. The maximum pressure at pump discharge occurs at no flow through the pump and is dependent upon the speed of the rotor, increasing with the square of the rotor speed. The maximum flow occurs at zero discharge pressure. For a given pump speed there is a combination of pressure and flow which will require the maximum power. The power source should be sized to handle the maximum power requirement at operating speed. The normal operation speed for a centrifugal pump is greater than tractor power take-off speeds. A diaphragm pressure-reducing valve is used to maintain uniform pressure to spray nozzles on centrifugal pump systems.

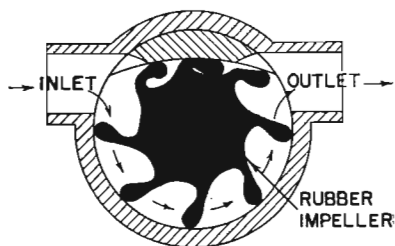


Figure 6. At low pressures the flexible impeller pump acts as a positive displacement machine. As pressure builds up the impeller is forced away from the pump body.

Flexible impeller pumps have performance characteristics between those of positive displacement and of centrifugal pumps. At low pressures, around 20 pounds per square inch, they will give good service and may be operated at power take-off speeds. The rubber impeller will be damaged if run dry.

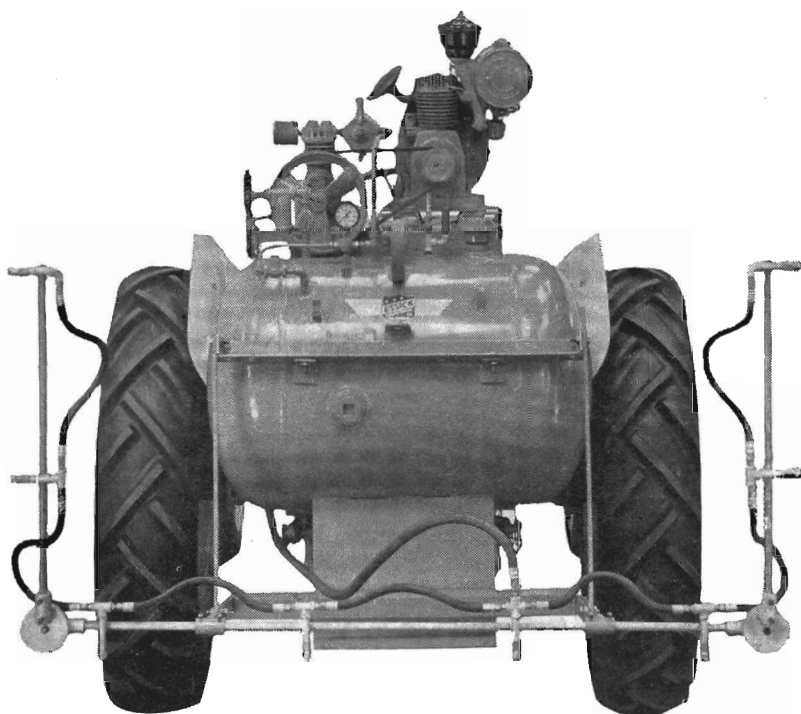


Figure 7. This type of sprayer uses an air compressor to force air into the pressure tight tank containing the spray liquid. The air in turn forces the liquid to the spray nozzles.

Compressed air units can handle any spray material without damage to the pump because the spray material does not go through the pump. Compressed air units are useful the year round for tire inflation, paint spraying, and operation of pneumatic tools. Since they require a strong pressure-tight tank, the supply tank size is limited. The supply tank size is not an important factor where only low gallonage sprays are required. The compressor cannot be used for refilling the supply tank.

### Pump Capacity

The first step in the selection of a pump is to determine the required capacity. The required capacity depends upon (1) the rate of application per acre, (2) width of swath it is desired for the machine to cover, and (3) rate of travel.

The application rate is dependent on the herbicide used: for 2,4-D the application rate may be as low as 10 gallons per acre in the Willamette Valley or 5 gallons per acre in the wheat regions. Dinitro sprays may require 120 gallons per acre, and other contact sprays may run as high as 400 gallons per acre. For exact recommendations of application see Extension Bulletin 687 "2,4-D a Weed Killer in Oregon;" Circular of Information No. 445, "A Preliminary Report on Experiments to Control Quack Grass;" and Experiment Station Bulletin 483, "I.P.C. a New Weed Killer." The capacity of the pump to be used should be determined by the highest rate of application. The width of swath or length of spray boom will be determined largely by the acreage to be covered by the machine in a given time, and by the size, shape, and topography of the fields. The pump capacity in gallons per minute can be figured by the following formula:

$$\text{Gallons per minute} = (0.002)(\text{rate gal. per acre})(\text{swath width feet})(\text{speed m.p.h.})$$

*Example:* Find the pump capacity necessary when using a sprayer for an application of 25 gallons per acre, with a 20-foot boom and traveling 4 miles per hour.

$$\text{Gallons per minute} = (0.002)(25)(20)(4) = 4 \text{ gal. per minute.}$$

Allowing at least a 25 per cent margin of safety would mean that a pump with a capacity of 5 gallons per minute at a pressure of 60 to 100 pounds per square inch would be required.

The pump desired can be selected from commercial literature which usually tabulates pump capacities, gallons per minute, and horsepower required at various pump pressures and speeds.

## Pump Drive

Pumps should be driven at the speeds recommended by the manufacturer. Pumps recommended for operation at 535 RPM may be driven by direct connection to the tractor power take-off. Other pumps may have a belt drive from power take-off or belt pulley of the tractor, or by belt or direct connection to an auxiliary power unit. High pressure piston pumps may be roller chain driven. Many pumps are not designed for belt drive. Unless a special bearing is provided caution should be taken to guard against excessive belt tension, or improper alignment of direct drive. When a belt is used it should be kept just tight enough to drive the pump.



## Spray Booms

The length of boom wanted will depend upon the topography, size and shape of fields, and total acreage to be sprayed by a given machine. In small irregular fields, a boom 20 feet or less will probably be wanted because of ease of handling and to keep skip and overlap to a minimum. For large areas a boom length 20 feet or greater will be wanted to reduce application time and crop losses.

The over-all width of the spray rig with outer sections folded or removed should be less than 8 feet for safe road travel.

End sections should fold readily and be well supported by guy chains or caster wheels. All nozzles should be at a uniform height and spacing and of uniform capacity. It is desirable to have removable caps on boom ends to aid in cleaning the equipment. The flow of herbicide to each section of the boom should be controlled separately. This degree of control is especially desirable if the machine is to be used for roadside and fence row spraying.

Pipes  $\frac{3}{4}$  to 2 inches in diameter may be used for spray booms. They may be galvanized or black iron or an alloy. The type of material used in the boom is dependent upon corrosive properties of the herbicide used. The 1-inch pipe is sufficient for a 15-foot boom and  $1\frac{1}{4}$  to  $1\frac{1}{2}$  is recommended for longer booms. Pipes smaller than 1 inch are not practical for high rate of application because the resistance to liquid flow causes a difference in pressure at the nozzles. For example, in 10 feet of 1-inch pipe, a 25 gallon per minute flow will cause a 3-pound drop in pressure. It is easier to cut and tap holes for the nozzles in the larger pipe which is stronger and more rigid and the amount of whipping and possible buckling is reduced.

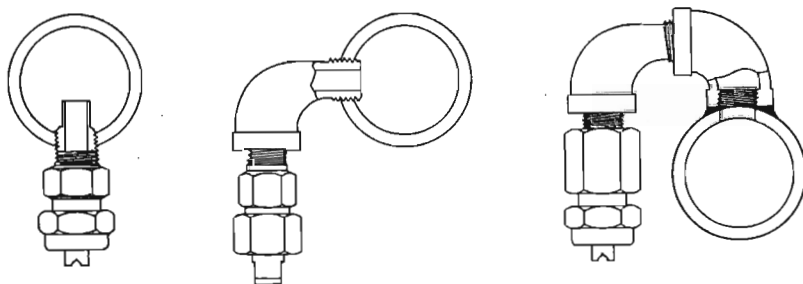


Figure 8. These diagrams indicate a few of the methods by which nozzles may be attached to the boom allowing space for dirt particles that may be present in the spray solution. *Left and center*, the boom was drilled and tapped for the nozzle and street elbow. The boom is thereby weakened. *Right*, the boom was drilled and the elbow welded in place to retain boom strength.

Booms made of large pipes, however, have the disadvantage of giving the spray material more time to settle out in the boom.

Booms should be reinforced at nozzle attachment when needed to give adequate threads. For low volume 2,4-D spraying smaller pipes or copper tubing may be used but should have some additional support.

### Boom Hinges

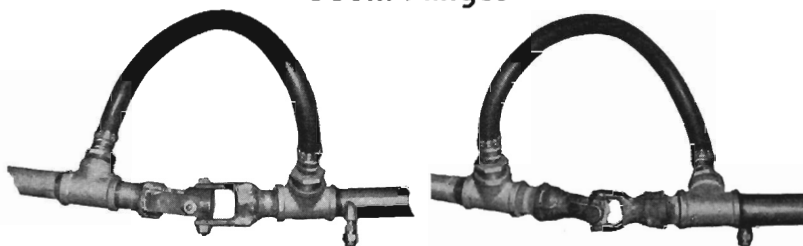


Figure 9. Boom hinge made by welding strap iron to pipe caps, *left*. Boom hinge made by welding universal joint to pipe caps, *right*.

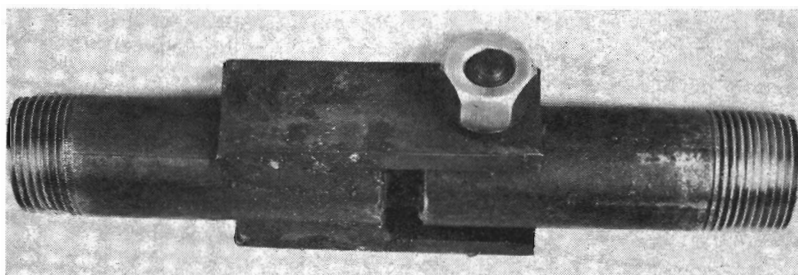


Figure 10. Simple welded hinge for boom.

A hinged boom makes a sprayer more versatile by being able to follow the contour of fields, roadside ditches, irrigation or drainage channels, levee banks, field borders and fence rows. In many cases it is also desirable for the boom to be able to swing clear on striking an obstruction. A hinge also allows for quick folding of boom for transit. It is often desirable to have the outer ends of long booms supported by a wheel or wheels, to aid in maintaining proper nozzle heights when they are to be used on uneven ground.

The boom hinge must be flexible and liquid tight where spray liquid is to pass through the joint. For boom construction where liquid does not pass through the hinge either a jumper hose across the joint or separate feeder hoses for each boom section must be provided.

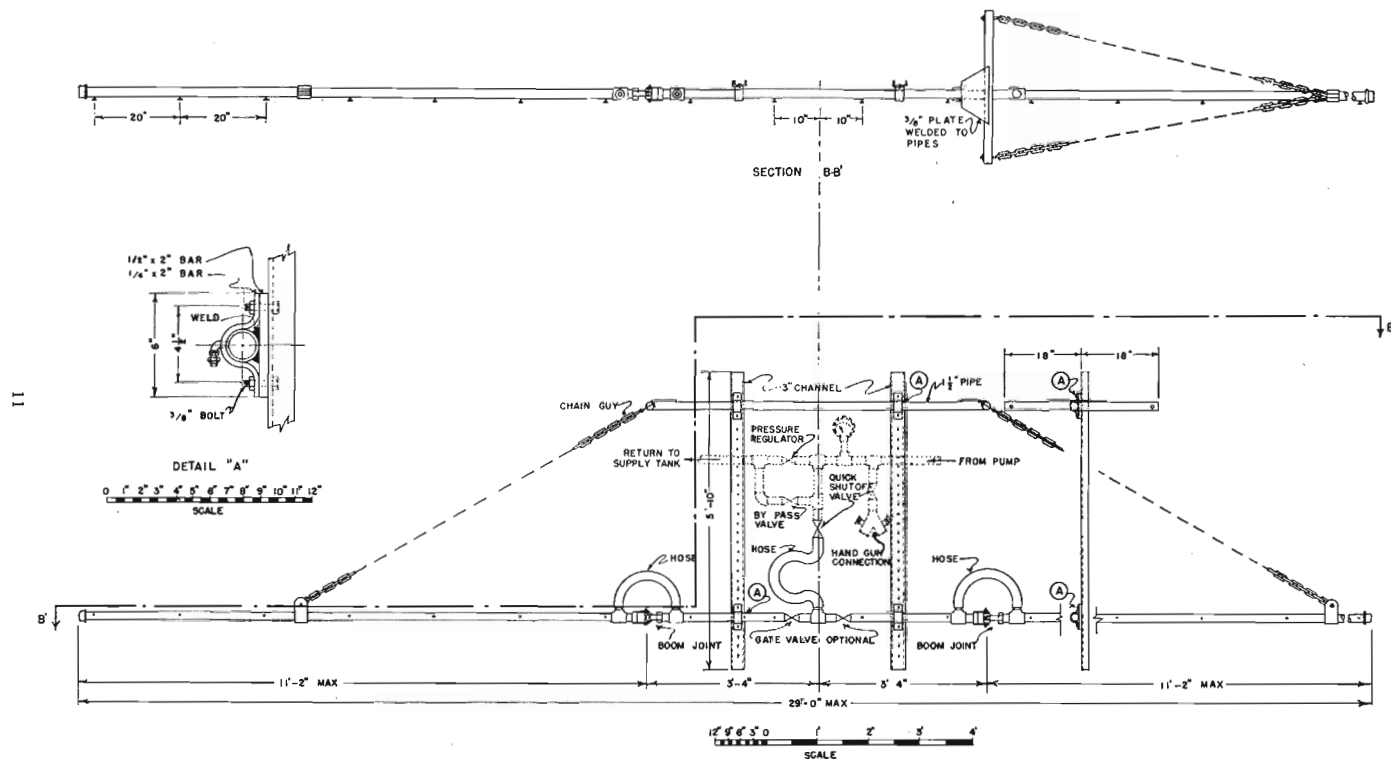


Figure 11. A design for booms 20 to 30 feet long for use on relatively even ground.

## Boom Mounting

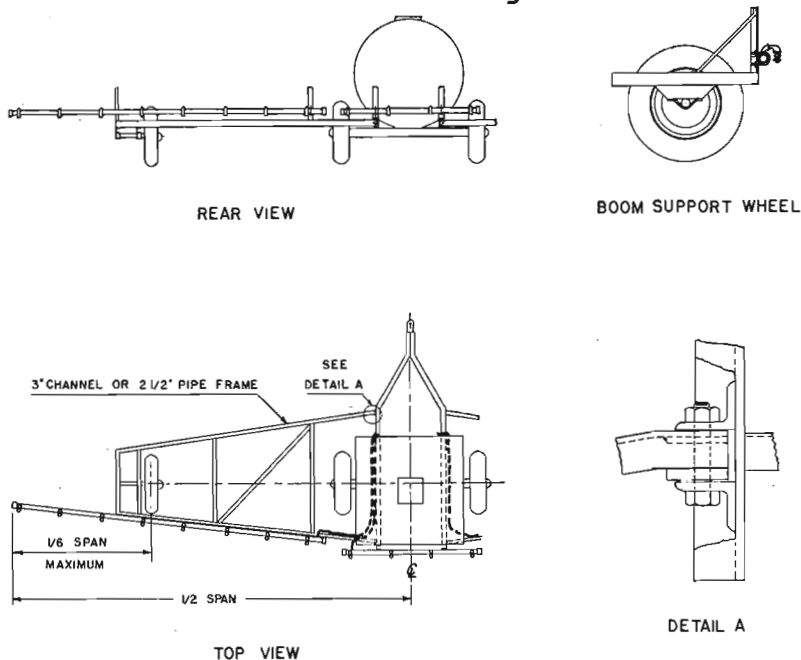


Figure 12. A suggested design for booms 35 feet or over for uneven ground.

Mount the boom on the front of the tractor, truck, or trailer. The best place for a boom is in front of the operator where he can watch for field obstructions and nozzle clogging. Boom mountings should be rugged to withstand rough field conditions. Provision should be made for adjustment of boom height in increments not to exceed 4 inches to assure proper height of nozzles above weed growth.

## Hose

Suction hose should be reinforced with wire and not subject to collapse. Inside diameter should be  $\frac{3}{4}$  inches or greater and long enough that the hose can be used in refilling the supply tank if desired. Hose should be resistant to oils.

Thread-type hose connections are preferred.

Hose leading to the boom should not be less than  $\frac{3}{4}$  inches in diameter.

## Controls

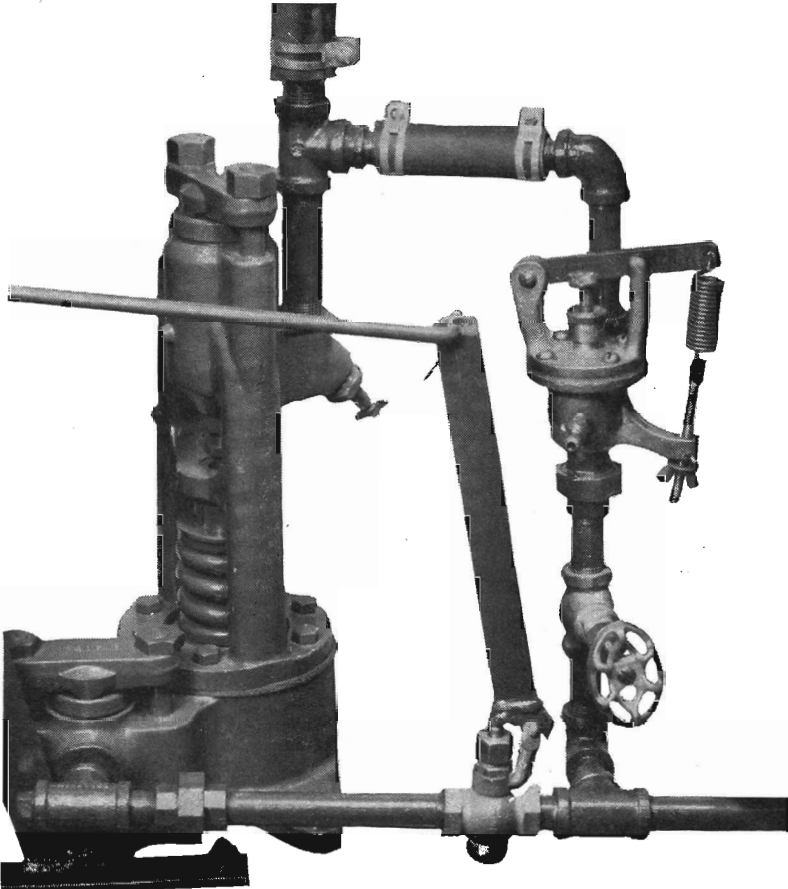


Figure 13. Control system for a spraying system to be used for high pressure spraying and for weed spraying. With the globe valve closed the heavy pressure regulator at the left controls the line pressure; when the globe valve is open the small pressure regulator on the right controls pressure for weed spraying.

A pressure gauge with a minimum pressure range equal to the maximum pressure of the pump should be used. The gauge should be so located that it can be easily read from the operator's seat and when adjusting the pressure control.

For positive displacement pumps, an adjustable bypass valve with a return line going to the supply tank is necessary to control

pressure. The bypass valve should be of the spring-loaded type, made of brass or other corrosion-resistant material and adjustable from 10 to 100 pounds. When using a high pressure pump, two pressure regulators are desirable (see Figure 13), one set at weed spraying pressures and one set for the high pressure application of the pump. For centrifugal pumps, a pressure regulator or a pressure reducing valve may be used to control pressure.

A quick acting boom shut-off valve or valves should be easily controlled from the operator's seat.

There are two methods of controlling nozzle drip when the boom valve is closed. One method uses reverse suction to empty the boom. The suction is provided by discharging the flow from the pump through a venturi whenever the boom valve is closed. The patented four-way valve makes possible the control of both the liquid and suction with one valve. The second method uses a valve at each nozzle. The valves used for this purpose are either a spring-loaded ball check or a rubber diaphragm backed by a coil spring. These check valves close when the boom pressure falls below the pressure required to keep them open. For airplane spraying some operators use standard petcock valves at each nozzle. All valves are connected in parallel and operated manually.

### Tank Refill

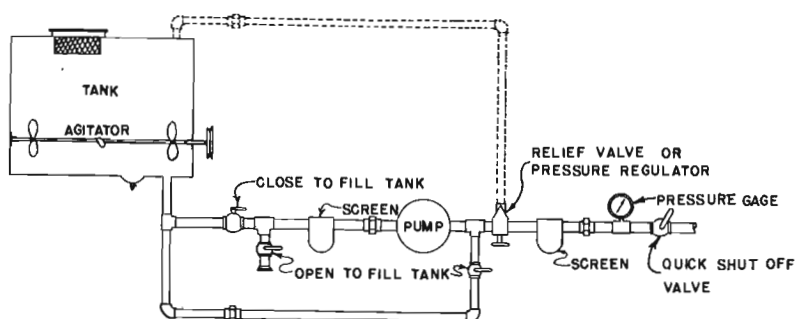


Figure 14. A suggested piping arrangement for the use of the sprayer pump for filling the tank. A bypass regulator must always be used in the line of a positive displacement pump. When a centrifugal pump is used a diaphragm type reducing valve may replace the bypass regulator.

A valve which will permit refill of supply tank through use of the spray pump is desirable. This is preferably a valve other than the bypass valve so as not to disturb the bypass-valve setting.

## Nozzles

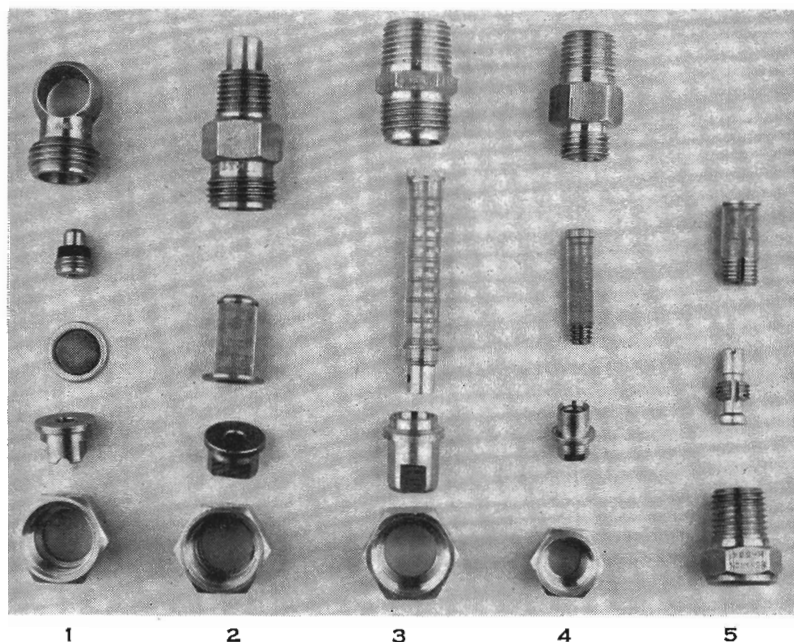


Figure 15. Break-down showing parts of five types of flat-fan-discharge nozzles. Parts, from top to bottom, are: 1. Body to slip over drilled  $\frac{1}{2}$ " O.D. tubing; packing and lock screw; screen;  $\frac{1}{2}$ " tip; holding nut. 2.  $\frac{1}{4}$ " male body with extension tube; screen;  $\frac{1}{2}$ " tip; holding nut. 3.  $\frac{3}{8}$ " male body; screen;  $\frac{1}{2}$ " tip; holding nut. 4.  $\frac{1}{4}$ " male body; screen;  $\frac{1}{4}$ " tip; holding nut. 5. Strainer; insert;  $\frac{1}{4}$ " male body with nonremovable tip.

Nozzles that give a flat spray with a spray angle of  $65^{\circ}$  to  $80^{\circ}$  are usually preferred for weed spraying. Any nozzle that will give a uniform spray pattern without heavy edges may be used. It is important that the nozzles be accurately machined so that when uniformly spaced the resulting spray pattern will be uniform.

Nozzles should be fitted with screen having openings slightly smaller than the nozzle orifice. Particles too small to clog the nozzle pass through the screen but materials that might clog the nozzle are stopped at the screen. An old tooth brush is handy for cleaning clogged nozzles.

Nozzles with interchangeable tips and screens are more expensive in first cost but enable the sprayer to be quickly adapted to different rates of application.

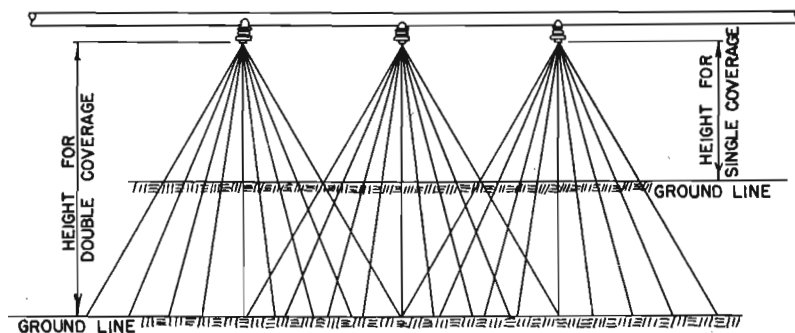


Figure 16. The nozzle fan width and the spacing on the boom determine how high the boom must be above weed growth to have the fans meet. Double coverage gives more uniform application because ground is covered by spray from two nozzles and tends to counteract any nonuniformity in nozzle characteristics.

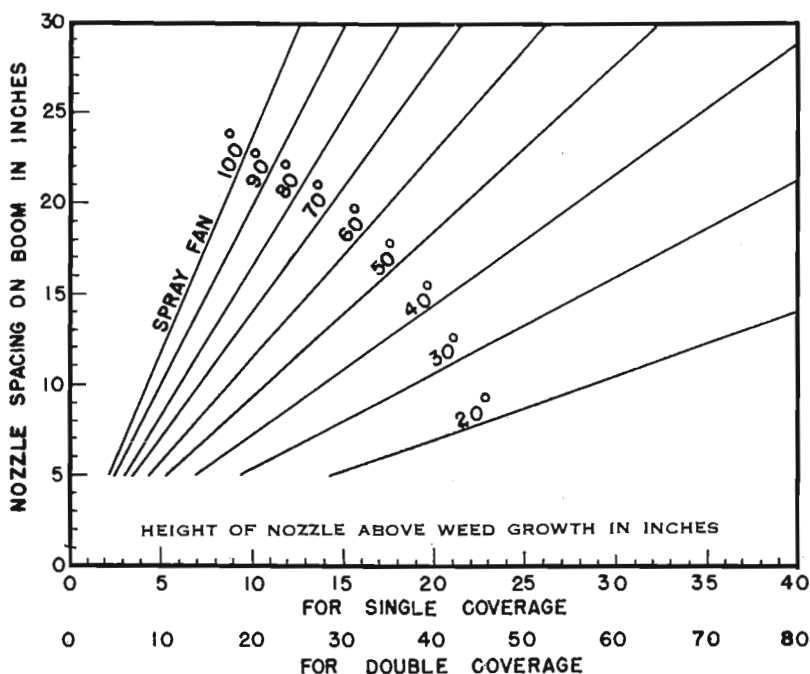


Figure 17. Nozzle heights above weed growth to give either single or double coverage.



Nozzle drop pipes are used for spraying weeds in tall row crops to enable the weeds to receive a proper application of spray while the leaves of the crop plant receive a minimum.

The height of the nozzle above the weed growth should be such as to give either single or double coverage. Figures 16 and 17 give the proper nozzle heights for nozzle spacing up to 30 inches when using nozzles that give a uniform fan-spray pattern with sharp edges. Most manufacturers will supply similar information for their nozzles. Remember the higher the nozzle the more chance there is for drift so keep the nozzle spacing close.

### Screening or Filtering

Mesh or screen should be less than the size of nozzle orifice.

Each machine should be provided with both a screen on the suction line and a line filter. Each should have a large screen area. The total area of screen opening should be 10 times as great as the area of the intake opening of the pump. In fine screens approximately two thirds of the total surface area is filled by the wires themselves, leaving approximately one third of the area open. The total screen area, therefore, should be at least 30 times the area of the pump intake.

### Agitation

Straight oil sprays are the only sprays that do not require some agitation.

The 2,4-D sprays require only slight agitation. A return line carrying a few gallons of liquid per minute from the bypass valve to the bottom of the supply tank will supply sufficient agitation to keep the 2,4-D in suspension.

Oil emulsions and heavy suspensions require constant and vigorous agitation. Most manufacturers of orchard spraying equipment have developed suitable agitators for these sprays. The two common types used are the mechanical and the hydraulic agitators.

The mechanical agitator consists of a series of paddles mounted on a shaft running through the spray tank. The design of the paddle blade and the speed of the shaft depend upon the size and shape of the tank. Blades should sweep within  $\frac{1}{2}$  inch of the bottom and have a peripheral speed of about 350 feet per minute.

The hydraulic agitator usually requires more power to operate but is simple to build, requiring no moving parts in the tank. Ten to fifteen gallons of spray material for each 100 gallons of tank capacity is forced at boom pressure through many small openings or

replaceable jets in a pipe laid in the bottom of the tank. Most spray liquids are more or less abrasive. To keep tank wear at a minimum, the discharge from the jets should not impinge against the side or bottom of the tank through less than one foot of liquid. A centrifugal pump is generally used when employing hydraulic agitation because of the large volume needed.

## Hand Booms

The hand boom is an essential part of every weed spraying outfit. Two hand booms are desirable. Each should be provided with at least 50 feet of  $\frac{3}{8}$ -inch inside diameter hose, a shut-off valve at the spray rig, and a quick-acting valve at the boom handle.

The boom should be made of light weight material. A handle about four to five feet long set at a convenient angle with the boom will facilitate operation. The hand boom nozzles should have the same spacing and orifice size as the main boom nozzles.

For nonselective and brush spraying, a hand boom with a single off-center jet-fan-spray nozzle is satisfactory.



Figure 18. An off-center jet nozzle used on a hand boom for fence row or spot spraying.

## Tanks

The tank should be of metal because 2,4-D will be absorbed by wood and if the sprayer is to be used for insecticide on fruit trees or vegetables at some later date, enough herbicide may be released by the wood to damage the crop. The minimum tank capacity should be such that the sprayer can operate continuously for at least 10 minutes.

## Management of the Spray Rig

The life and usefulness of the sprayer will depend largely on its management. Never use dirty water in spraying unless it cannot be avoided. However, if it is necessary to use river or creek water, keep as much of the dirt out of the tank as possible by use of a screen on the filling hose. Dirt clogs strainers and nozzles, wears out the pump, and erodes the nozzle orifice, thus changing the calibration of the unit.

Do not paint or enamel the inside of the spray tank; thinners used in some of the oil sprays loosen the enamel or paint allowing it to flake off and clog the system. Bare iron tanks have a tendency to rust which can be reduced by draining the tank and flushing with a rust preventive oil.

After each use of the machine before putting it away, the machine should be cleaned. All screens and nozzles should be inspected and if partly clogged should be cleaned. An old tooth brush works very well for this purpose. The end caps should be removed from the boom and the boom flushed.

If the machine is used for more than one type of selective weed spray or for other uses than weed spraying, special care should be used in cleaning the rig following the use of 2,4-D.

For oil-soluble 2,4-D rinse first with kerosene, followed by a rinse using 1 to 2 pounds of lye or washing soda to 25 gallons of water. The solution should be allowed to remain in the tank for 4 hours (or overnight) and then rinsed with water.

For water soluble 2,4-D rinse thoroughly with water, then fill tank with water containing 2 pounds of lye per 100 gallons and let stand overnight. If charcoal, either as lamp black or bone black, is available add  $\frac{1}{4}$  pound per 100 gallons and agitate the lye charcoal mixture. Pump out and rinse with water.

After following these precautions, it is still wise to test the equipment by spraying a susceptible plant such as a pea or bean vine with the machine before using the equipment for spraying orchards or vineyards.

## Calibration of the Sprayer

Before you take a sprayer into the field it should be calibrated to make sure that it will apply the desired amount of chemical per acre. Check the sprayer before calibration to make sure it is functioning properly. Make certain that all screens are clean. Remove all nozzles and with plenty of water flush out sprayer and boom. Replace nozzles and run sprayer, check sprayer pressure and adjust pressure regulator if necessary to secure desired pressure. Make sure all nozzles are functioning properly. Check all connections for leaks. (A leak will not only give too high a rate of application at point of drip, but will upset the calibration because the average rate of application will actually be less than what the calibration shows.) Decide on the gear and speed at which you intend to operate and note the throttle setting for future reference.

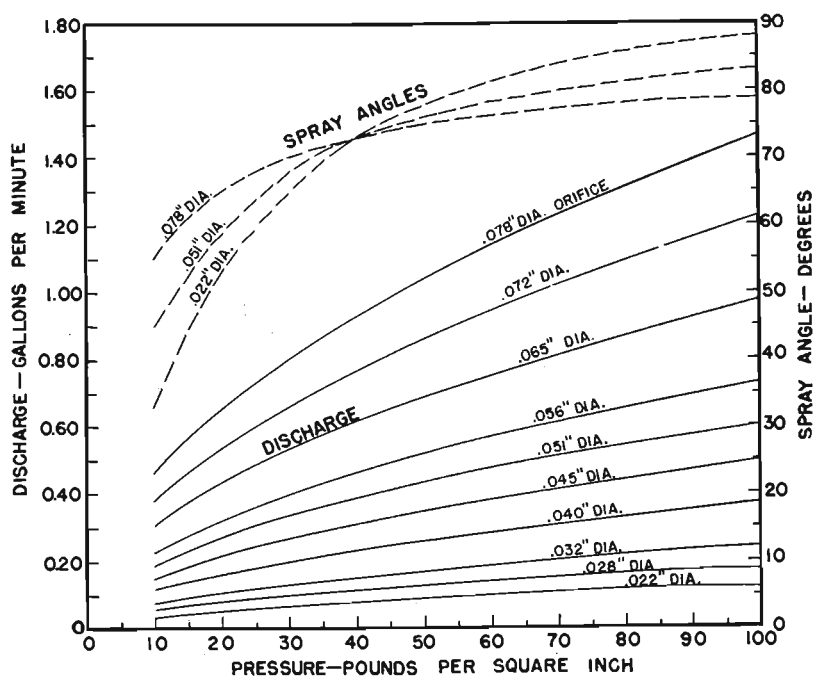


Figure 19. The effect of pressure on the discharge characteristics of a series of nozzles.

Drive the sprayer around at operating speed to be sure everything is operating properly. One acre should be sprayed to determine calibration.

The distance in feet the sprayer will have to travel to spray one acre is equal to the number of square feet in one acre, 43,560, divided by the effective boom length in feet.

*Example:* Find the distance in feet you will have to travel to spray one acre using a boom with 12 nozzles spaced 18 inches apart. The equipment is to be used for spraying 10 to 15 gallons of 2,4-D solution per acre.

The effective boom length in feet is equal to the number of nozzles (12) multiplied by 18/12 the nozzle spacing in feet or an effective length of 18 feet. The distance the sprayer will have to travel to spray one acre will be  $43,560 \div 18$  or 2,420 feet.

Measure off the test course, in the case above this will be 2,420 feet long, and mark each end with a stake or flag.

Fill the supply tank full of water. Then spray the measured course exactly as you intend to spray the field for weed control. While making this test run a check on your speed by counting the number of revolutions the rear wheels make in one minute. Marking the tire or rim with chalk or white-sidewall paint will help in counting revolutions.

This method of counting revolutions can be later used as a periodic check on your rate of travel. At the end of the course shut off the sprayer as you pass the end stake. Refill the supply tank, measuring carefully the number of gallons of water needed to replace the water used in spraying. Assume that it requires  $11\frac{1}{4}$  gallons to refill the supply tank. The sprayer is applying  $11\frac{1}{4}$  gallons per acre, for exactly one acre was sprayed with the  $11\frac{1}{4}$  gallons. For every  $11\frac{1}{4}$  gallons the supply tank holds, add the amount of chemical recommended per acre.

If the sprayer had not applied the required amount of spray per acre, the rate of application could have been increased by one or more of the following changes. The ground speed of the sprayer could be reduced, thus taking longer to cover the course and more spray would be applied. The pressure regulator could be changed to increase the boom pressure; or the nozzle tips could be replaced with tips having a larger hole or orifice. The effect of changing nozzle pressure or nozzle-orifice size is shown in Figure 19. The table on page 22 shows the effect of changing ground speed and nozzle spacing.

DISCHARGE PER NOZZLE IN GALLONS PER MINUTE NECESSARY TO GET REQUIRED APPLICATION AT DIFFERENT FIELD SPEEDS.

Required gallons per acre	Speed of travel											
	1 MPH	1.5 MPH	2 MPH	2.5 MPH	3 MPH	3.5 MPH	4 MPH	4.5 MPH	5 MPH	6 MPH	7 MPH	8 MPH
	Gal. per Min.	Gal. per Min.	Gal. per Min.	Gal. per Min.	Gal. per Min.	Gal. per Min.	Gal. per Min.	Gal. per Min.	Gal. per Min.	Gal. per Min.	Gal. per Min.	Gal. per Min.
Nozzles spaced 16 inches apart												
10 .....	.027	.040	.054	.067	.081	.094	.108	.120	.135	.161	.189	.215
15 .....	.040	.060	.081	.100	.121	.142	.161	.181	.202	.242	.283	.323
20 .....	.054	.080	.108	.134	.162	.188	.216	.240	.270	.322	.378	.430
25 .....	.067	.100	.134	.167	.202	.236	.269	.301	.337	.403	.472	.538
30 .....	.080	.120	.162	.200	.242	.284	.322	.362	.404	.484	.566	.646
Nozzles spaced 20 inches apart												
10 .....	.035	.050	.067	.084	.101	.117	.135	.150	.169	.201	.236	.268
15 .....	.050	.075	.101	.125	.151	.177	.202	.226	.252	.302	.353	.404
20 .....	.067	.100	.135	.167	.202	.235	.270	.300	.337	.403	.472	.538
25 .....	.084	.125	.167	.209	.252	.295	.336	.376	.421	.504	.590	.672
30 .....	.100	.150	.202	.250	.302	.354	.404	.452	.504	.604	.706	.808
Nozzles spaced 24 inches apart												
10 .....	.040	.060	.081	.100	.121	.142	.161	.181	.202	.242	.283	.323
15 .....	.060	.090	.121	.150	.181	.213	.242	.272	.302	.363	.424	.485
20 .....	.081	.120	.162	.201	.243	.282	.324	.360	.405	.484	.566	.645
25 .....	.100	.150	.201	.250	.302	.354	.404	.451	.505	.605	.707	.807
30 .....	.120	.180	.242	.300	.362	.426	.484	.544	.604	.726	.848	.970
Nozzles spaced 28 inches apart												
10 .....	.047	.070	.094	.117	.142	.164	.191	.210	.236	.282	.331	.376
15 .....	.070	.105	.142	.175	.212	.248	.282	.317	.353	.424	.495	.565
20 .....	.094	.140	.188	.234	.284	.328	.382	.420	.472	.564	.662	.752
25 .....	.117	.175	.236	.292	.354	.412	.473	.527	.589	.706	.826	.941
30 .....	.140	.210	.284	.350	.424	.496	.564	.634	.706	.848	.990	1.13
Nozzles spaced 32 inches apart												
10 .....	.054	.080	.108	.134	.162	.188	.216	.240	.270	.322	.378	.430
15 .....	.080	.120	.162	.200	.242	.284	.322	.362	.404	.484	.566	.646
20 .....	.108	.160	.216	.268	.324	.376	.432	.480	.540	.644	.756	.860
25 .....	.134	.200	.268	.334	.404	.472	.538	.602	.674	.806	.944	1.076
30 .....	.160	.240	.320	.400	.480	.570	.650	.720	.810	.970	1.13	1.292

## Precautions in the Use of Weed Killers

The drift of such weed killers as 2,4-D is very damaging to susceptible crops. It is very important, therefore, that the operator be extremely careful not to spray with weed killers in a wind when there is a possibility of mist or fumes drifting onto adjoining properties that have susceptible crops, shrubs, or trees.

The distance a spray droplet will drift is dependent on the size of the droplet and the velocity of the air movements. The size of droplet can be increased either by increasing the size of the nozzle orifice used or reducing the liquid pressure or both.

Spray drift may be kept to a minimum by operating only on quiet days using low nozzle heights, low liquid pressures (25 to 40 pounds per square inch), and high volumes of spray per acre. By increasing the number of nozzles, the nozzle height may be lowered, reducing the chance for the air currents to cause drift.

To give some idea of the effect of droplet size on drift—a 150-micron droplet, which corresponds to a coarse spray, will drift about 30 feet while settling 10 feet in a wind of three miles per hour; a 100-micron droplet will drift 50 feet; a 25-micron droplet (1/1,000 of an inch in diameter) will drift over 700 feet; and a 5-micron droplet, which is about the same size as sea fog, will drift close to 4 miles before settling 10 feet in a 3-mile-an-hour wind.

Fast evaporation on hot dry days reduces the size of the droplets and increases the danger of drift.

## Bibliography

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3. Price, F. E.; Lunde, R. N.; Bursik, John; and Freed, Virgil, "Recommendations for Weed Spraying Equipment." Oregon State Agricultural Experiment Station Circular 170, 1946.

## Sprayer Requirements of Common Weed Killers\*

Material	Use	Sprayer requirement
2,4-D	Selective in grain or grass	Low pressure Low volume
2,4-D	Nonselective on such plants as garlic, thistle, and white top	High volume
2,4-D 2,4,5-T 2,4-D and 2,4,5-T	Brush	High volume High pressure
2,4-D 2,4,5-T 2,4-D and 2,4,5-T	Stumps Applied in oil	Low volume Low pressure
Ammate Chlorate (corrosive)	Brush and weed growth	High volume Mechanical agitation
I.P.C. wettable Wettable powders	Selective	Mechanical agitation High volume
I.P.C. emulsifiable	Selective	Mechanical agitation Low volume
Dinitro and oil and I.P.C. and water	Dormant spraying	Mechanical agitation High volume
T.C.A. and oil	Nonselective	Mechanical Agitation High volume
Weed oils	Selective	High volume

\* For recommendation on dosage and time of application see Extension Bulletin No. 687, "2,4-D as a Weed Killer in Oregon" and Station Bulletin No. 483, "I.P.C. a New Weed Killer."