The Low-Pressure Ground Sprayer

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More agricultural chemicals are applied with low-pressure, self propelled or towed boom type ground sprayers than with any other kind of equipment. These sprayers are used to apply chemicals to control weeds, insects, and diseases in field crops, ornamentals, turf, fruits and vegetables, right-of ways, etc. They are available in tractor-mounted, pull-type, and self-propelled or truck mounted units and are capable of developing spray pressures ranging from 10 to 100 psi and application rates from l to 75 gallons per acre.

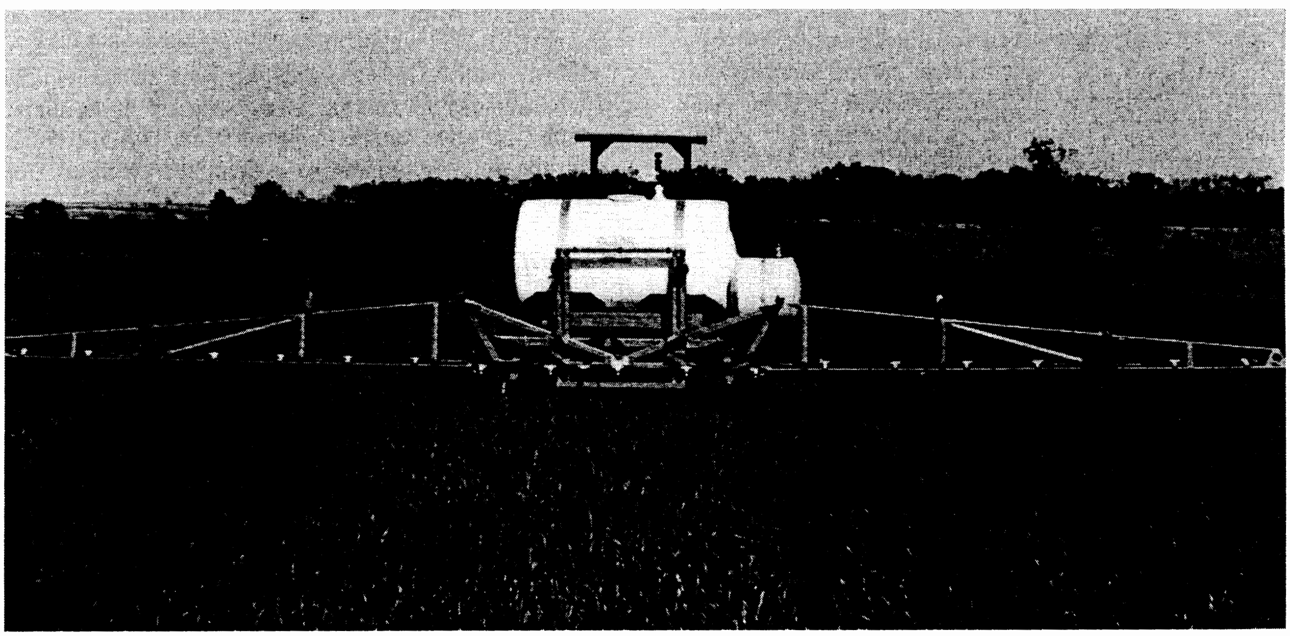
This Fact Sheet is devoted to a discussion of the basic components of low-pressure sprayers, which are the tank, agitation system, flow control system, strainers, distribution system and pump, and information on maintenance and cleaning. Discussions of special types of low pressure ground sprayers such as: (1) air assisted hydraulic boom sprayers, (2) air curtain sprayers, (3) orchard mist sprayers, and (4) multiple nozzle cluster boomless right-of-way or pasture nozzle sprayers are beyond the scope of this fact sheet.

Tanks

When considering sprayer tanks give attention to size, resistance to corrosion, chemicals, and ease of filling and cleaning. The most desirable tank will be one that:

1) Is easy to fill and clean.
2) Is shaped suitably for mounting and effective agitation.
3) Is corrosion-resistant.
4) Has adequate openings for pump and hydraulic or mechanical agitation connections.

The capacity at various 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. External sight gauges, such as clear polyethylene plastic tubing, should be protected with safety guards on either side, and have a manual shutoff valve at the base of the sight gauge for shutoff in case of a leak in the sight gauge. The top opening



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should be fitted with a cover that can be secured to avoid spills or splashes and should be large enough to allow easy cleaning. An easily accessible drain should be available in the bottom of the tank so that it may be emptied completely. Sprayer tanks may be made from fiberglass, polyethylene, stainless steel, or galvanized steel.

Fiberglass tanks are widely used on all types of sprayers and applicators and as nurse tanks. Fiberglass is strong and durable, but it will break or crack under impact, especially in cold weather. One advantage of fiberglass over polyethylene is that breaks or cracks can be easily repaired. Fiberglass tanks are moderate in cost and offer excellent corrosion resistance to most chemicals.

Polyethylene tanks are less expensive than fiberglass tanks (about $^1/_2$ to $^2/_3$ the cost) and are available in many sizes and shapes. They offer excellent corrosion resistance to most chemicals and have good durability. However, unlike a fiberglass tank, if a polyethylene tank is cracked or punctured, it is much more difficult to repair. High density "crosslinked" polyethylene tank materials should be specified for toughness, strength, and fracture resistance. Both polyethylene and fiberglass tanks must be properly mounted on a "saddle" which supports the tank over a large area. Without proper support, the weight of the liquid could break the tank as the sprayer bounces over rough terrain.

Stainless steels are strong, durable, and highly resistant to corrosion by most agricultural chemicals. However, because stainless steel is the most expensive material used for pesticide and fertilizer applicator tanks, only sprayers with high annual use can justify stainless steel tanks.

Galvanized steel tanks, although inexpensive, are also extremely susceptible to corrosion. Even with protective coatings, chemicals can cause rapid rusting of the inside surface of the tank where internal coatings crack or flake off. When rust flakes off, it can damage pumps and result in clogged strainers and nozzles and operator frustration. Galvanized sprayer tanks are not recommended except for sprayers with very low annual use.

Agitation Systems

Agitation requirements depend on the applied chemical formulation. Soluble liquids and powders that remain in solution after mixing generally do not require special agitation. Wettable powders, emulsions, and liquid and dry flowables, however, will generally separate if not continuously agitated. Separation causes the concentration of the pesticide spray to vary greatly as the tank empties resulting in uneven application. For this reason, thorough agitation is essential. Either mechanical paddles or hydraulic jets can be used to agitate the sprayer solution.

Mechanical agitators are propellers or paddles mounted on a shaft near the bottom of the tank and rotated at 100 to 200 RPM. Because of its cost, mechanical agitation is generally not used except in larger tanks, when the primary material sprayed is a wettable powder formulation, or on sprayers equipped with piston pumps. Tanks of over 500 gallon capacity will usually require mechanical agitation for effective mixing of wettable powders and similar formulations.

Hydraulic agitation is commonly used on low pressure ground sprayers. Hydraulic agitation consists of returning a portion of the pump output back to the tank and discharging it under pressure through holes drilled in a pipe running the entire length of the bottom of the tank or through special venturi injector (jet) type agitator nozzles. To be effective, the agitator should receive fluid from a separate line on the pressure side of the pump and not merely from a pressure or flow relief by-pass line.

The amount of flow needed for agitation depends upon the chemical used, as well as the size and shape of the tank. For a simple orifice jet agitator, a flow of 5 or 6 gallons per minute (GPM) for every 100 gallons of tank capacity is usually adequate. With special jet agitator nozzles which use a venturi to help stir the liquid in the tank using induced flow with less flow from the pump, the output requirement from the pump can be reduced to 2 to 3 GPM for every 100 gallons of tank capacity.

Regardless of the type of hydraulic agitator used, it should be rigidly fastened inside the tank to prevent movement. As the tank empties, foaming can occur if the agitation flow remains constant. This condition can be prevented by using a control valve in the agitator line to gradually reduce flow as the tank empties.

Although hydraulic agitation will keep a suspension from settling, it is not intended to mix the chemical and form the suspension initially. It is usually best to make a slurry in a separate container by adding the desired amount of chemical to a small amount of water. This slurry is then added to a partially filled tank with the agitator running. After the chemical has been added, finish filling the tank to the desired level with water. Once a tank of chemicals has been mixed, try to use the entire tankful before stopping. If the sprayer must be moved to another field before the tank is emptied, keep the agitator running to prevent the chemical from settling out.

Flow-Control Assembly

A roller pump or other positive displacement pump will usually have a flow control assembly consisting of a by-passtype pressure regulator or relief valve, a control valve, a pressure gauge, and a boom shut-off valve (Figure 1). Bypass pressure relief valves usually have a spring-loaded ball, disc, or diaphragm that opens with increasing pressure so that excess flow is by-passed back to the tank, preventing damage to the pump and other components due to "hydraulic hammer" and high pressure spikes when the boom valve is shut off.

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 for centrifugal pump systems (Figure 2). The spray pressure can be controlled with a simple gate 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. These valves are especially useful for enclosed cabs.

A pressure gauge must be included on every sprayer because nozzles are designed to operate within certain pressure limits and without a gauge it is impossible to know whether the correct pressure is being maintained. The pressure gauge is also necessary for accurate calibration of the sprayer. Pressure loss between the gauge and boom nozzles must be determined during calibration for accurate operation. To establish line pressure loss, install the same pressure gauge in place of a boom nozzle near the center of the boom and check using the same pressure regulator setting. Use a gauge designed for the pressure range normally used. A range of 0 to100 psi or 0 to 60 psi are generally adequate for most agricultural chemicals. When a 150 or 200 psi gauge is used for operating at 20 psi, accurate pressure adjustment is difficult, if not impossible.

Boom shut-off valves allow sprayer booms to be shut off while the pumps and agitation systems continue to operate. This is important so that chemicals may be kept in solution during travel.

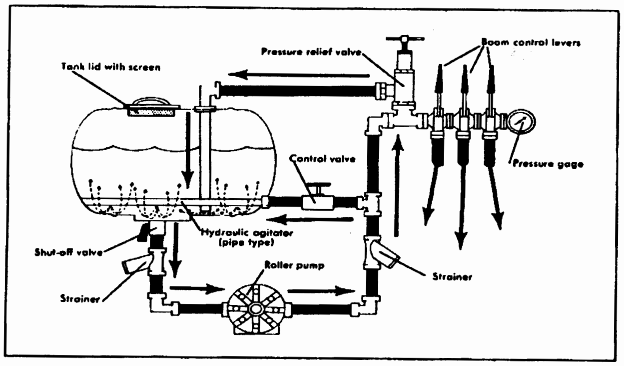

Figure 1. Roller Pump Spraying Service

Strainers

Strainers are designed to catch foreign material which may be in the spray solution before it can cause damage or plugging. The three types of strainers commonly used on low-pressure sprayers are tank filler strainers, line strainers, and nozzle strainers. Strainers are classified by mesh numbers (20-mesh, 50-mesh, etc.) which indicate the number of openings per inch. Strainers with high mesh numbers have smaller openings than strainers with low mesh numbers, i.e. a 50-mesh strainer will catch smaller particles than will a 20-mesh strainer.

Tank filler strainers should be used to prevent twigs, leaves, label booklets, plastic lids, and other debris from entering the tank during filling. A 16- to 20-mesh strainer is generally recommended here.

Sprayers equipped with a roller pump should have a 40 to 50-mesh suction line strainer between the tank and pump to prevent rust, scale or other material from damaging the pump.

If the sprayer has a centrifugal pump, a suction line strainer is generally not recommended because the inlet of a centrifugal pump should not be restricted. If the suction line of a centrifugal pump is restricted, the result can be loss of pressure control and possible damage to the pump. With a centrifugal pump, in place of the suction line strainer, a line strainer (usually 50-mesh) should be located on the pressure side of the pump to protect the spray nozzles and agitation nozzles. If a suction line strainer is used, it should have an effective straining area several times larger than the area of the suction line, be no smaller than 20-mesh, and should be cleaned frequently.

Nozzle strainers usually are necessary for nozzles with flow rates of less than I 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 GPM. For nozzles with flow rates above 1 GPM, nozzle strainers are usually not needed if a good line strainer is used. However, some labels require nozzle strainers.

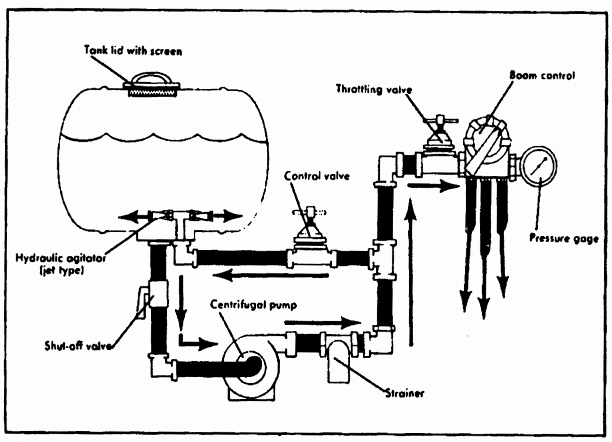

Figure 2. Centrifugal Pump Spraying System

Distribution Systems

All hoses and fittings should be of a suitable quality and strength to handle the spray mixture at the selected operating pressure. They should be chosen on the basis of composition, construction, and size.

A good hose is flexible, durable, and resistant to sunlight, oil, chemicals, and general abuse such as twisting and vibration. Two widely used hose materials that are generally chemically resistant are ethylene vinyl acetate (EVA) and ethylene propylene dione monomer (EPDM). A special reinforced hose must be used for suction lines to prevent collapsing.

Peak pressures which occur as the spray boom is shut off are much higher than average operating pressures. Sprayer hoses and fittings must be maintained in good condition to prevent a hose rupture.

Pressure and suction hoses must be properly sized for each system. The suction hose should be airtight, non-collapsible, as short as possible, and have the same diameter as the pump intake opening. A collapsed suction hose restricts flow and 'starves' the pump, causing decreased flow and damage to the pump or pump seals. When spray pressure cannot be maintained, check the suction line to be sure that it is not restricting flow.

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 varies with the size and capacity of the sprayer. A flow velocity of 5 or 6 feet per second should be maintained throughout the system. If lines are too large, velocities may be so low that pesticides will settle out and clog the system. The suggested hose sizes for various pump flow rates are listed below in Table 1.

Boom stability is important in achieving uniform spray application. The boom should be relatively rigid in all directions. Excessive swinging back and forth or up and down is undesirable. If the boom has a breakaway hinge arrangement, it should be dampened so that the boom is rigid in the fore and aft direction but still able to move if the end of the boom touches the ground or strikes an object such as a tree or fence post. The boom should be constructed to permit folding for transport. Check for interference of the folded booms with pressure lines, tractor or truck cabs, and other parts of the sprayer. The boom height should be adjustable from about I to 4 feet above the ground.

Table 1. Hose and Piping Sizes (I.D.'s).

Pump Output (GPM)		*Suction*	*Pressure*
0 to 6	——	3/4"	1/2"
6 to 12	——	3/4"	5/8"
12 to 25	——	1"	3/4"
26 to 50	——	1 1/4"	1"
50 to 100	——	1 1/2"	1 1/4"

Sprayer Cleaning

Proper cleaning is an extremely important part of an overall chemical application program. Failure to adequately maintain and clean the sprayer after each use can result in clogged nozzles and corrosion damage to the pump and other components. It also can result in injury to crops susceptible to previously applied chemicals.

Check and clean strainers daily. *Use the correct personal protective clothing and equipment when cleaning and servicing sprayers, strainers, and nozzles.* Partially plugged strainers will create pressure drops, reduce nozzle flow rate, and distort the nozzle spray pattern. Most sprayers contain strainers at three locations; the tank fill point, the suction line (to protect the pump or the line between the pump and the boom, depending on the type of pump), and the strainer with the smallest openings in the nozzle body. One way to minimize the problem of clogged strainers is to use clean water. If in doubt about cleanliness of the water, filter it as the tank is filled.

If a nozzle becomes clogged *do not* use a metal object to clean it. The nozzle orifice is precisely machined to close tolerances. *Use of a metal object such as a pocket knife for cleaning, may damage the orifice and drastically affect the nozzle's output and pattern.* To clean clogged nozzle without damaging it, use a special nozzle brush, wooden toothpick, or toothbrush bristles.

New sprayers often contain metal chips, dirt, and grit from the manufacturing process which can damage nozzle diaphragms and orifices, and plug strainers and lines. Flush new sprayers completely before using. Remove all nozzles, strainers, and plugs and flush the sprayer and boom with plenty of clean water. Clean each nozzle thoroughly before reinstalling. After each use, clean the sprayer to remove all chemical residue by thoroughly flushing with water inside and transfer the rinsate into a holding tank marked for the pesticide. Reuse of this rinsate as part of the makeup water for the next spray mix of that pesticide is a common practice.

All sprayers should be filled, cleaned, flushed, and washed externally on concrete wash/containment pads if open mixing and loading systems as used. Use of closed mixing/ loading systems, and suction systems to recover rinsate from spray tanks, booms,and plumbing without external leaks and discharge are good alternative management practices, especially for remote operations.

External wash water is not considered a hazardous waste by EPA, but a facility to recover and reuse internal wash water is needed. **It is illegal to discharge the internal rinse water into streams or onto the ground, water supplies, non-labeled crops, or areas accessible to children, livestock, pets, or wildlife.**

Rinsate or rinse water with chemicals from spray tanks and plumbing must be recovered and contained so that it does not enter surface or ground water. When flushing with clean water, the diluted mixture should be reused as make up water for future applications of the same pesticide or be sprayed over fields or land suitable for the pesticide. Rinsates can be legally stored for only 90 days from the time of recovery and storage according to EPA regulations, **if they are mixed or considered a hazardous waste by the operator.** If an operator segregates pesticide rinsates individually in storage tanks for reuse, they can be stored indefinitely. However, storage of rinsates should be minimized and they should be used as soon as practical.

If possible, use separate sprayers for highly volatile sprays such as 2-4, D and do not mix them with other pesticides where crop damage can occur. If only one sprayer is and must be used for all spray operations, custom application of volatile sprays is an option.

Seasonal Maintenance

To remove residues of oil-based herbicides, such as esters of 2-4,D and similar materials, rinse the sprayer with about one gallon of kerosene or diesel fuel to about 25 gallons of water. *Do not use gasoline as a cleaning solvent!* Spray or flush this rinsate mixture on a driveway or road surface so it will evaporate.

When switching between non-compatible chemicals or other types of chemicals and after flushing with the oil-water mixture, fill the tank about one-fourth full of water and add one pound of household detergent for every 50 gallons of water in the tank. Operate the pump to circulate the detergent solution through the sprayer for a few minutes, and then flush it out through the boom suction rinsate recovery system.

After this solution has been pumped out, fill the tank one-fourth full of a water ammonia solution. This solution should consist of about one quart of household ammonia to 25 gallons of water. Circulate the water ammonia solution through the sprayer for a few minutes, letting a small amount spray out through the nozzles. Allow the remainder of the solution to stand at least 6 hours and then pump it out through the nozzles on ground or fields suitable for the pesticide. At this point remove the nozzles and strainers and clean them, then flush the system twice with clean water.

Rinsate water containing detergents, or cleaning chemicals such as household ammonia, which breakdown or degrade the chemicals should be sprayed on land suitable for the pesticide being cleaned out or taken to a waste disposal facility.

If the sprayer is to be stored for a period of time, add some anti-freeze or rust inhibitor to a small amount of water and pump it through the sprayer. This will help prevent rust and corrosion inside the pump, plumbing, nozzles, and strainers. Make sure the additive is compatible with sprayer gaskets, seals, and shims.

Additional Information

For additional information and fact sheets on other sprayer components, sprayer calibration and on chemical recommendation for various cropping systems, call or visit the OSU Extension Office in county. Contact OSU for wash/containment pad design details and plans.

Companion Fact Sheets

BAE- 1203 "Reducing Drift from Ground Sprayers"

BAE- 1215 "Selecting Nozzles for Low-Pressure Ground Sprayers"

BAE- 1216 "Calibrating A Low-Pressure Ground Sprayer"
BAE- 1218 "Pumps for Low-Pressure Ground Sprayers"

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