CHAPTER 8

AQUATIC HERBICIDE APPLICATION EQUIPMENT AND TECHNIQUES

When a management plan has been established for a body of water, efforts can begin to obtain and maintain the aquatic qualities outlined in the plan. Fulfilling a management plan is an ongoing process involving several pest management techniques.

This chapter focuses on the various pesticide application methods used for managing aquatic weeds.

Application Methods

After identifying the pest and selecting the correct pesticide for treating aquatic plants, choosing the appropriate application technique is the next important step influencing a chemical's effectiveness in controlling the aquatic weed population. Choice of application techniques should be based on the type of aquatic weed problem that exists and the herbicide to be used.

Aquatic herbicides are formulated as liquids, powders and granules. The liquids and powders are usually applied in a water carrier; granules are applied directly to the water. Invert emulsion systems for control of submersed weeds are used to improve herbicide placement in other states but are not permitted in Michigan. Large bodies of water may require aerial spraying. Some swimmer's itch treatments are done this way in Michigan.

Bottom Treatments

Herbicides can be injected into bottom water by connecting weighted brass pipes to 15- to 30-foot hoses that extend from a boom on the spray boat. The herbicide is released into the water through small holes bored about 6 inches from the end of the pipe. For best results, pipes should be no more than 3 feet apart. Application rates are based on the volume of the lower 2 feet of water. This technique is particularly effective early in the growing season when submersed plants are still short. It works best in lakes or static waters that have firm, sandy bottoms; it is not recommended for flowing water or muddy bottoms.

Bottom treatments using weighted invert emulsions or polymers are not currently permitted in Michigan.

Granular Treatments

Granular herbicides should be applied with a granule spreader, not by hand. These products sink to the bottom and release the herbicide into the water. The inert ingredient, or the carrier of the active ingredients in granular formulations, is typically clay. Deposition of this clay on the lake bottom which may not be desirable.

Spray Treatments

Plants with most of their leaf area above the water surface (emergent, free-floating and rooted floating plants) are usually sprayed with aqueous solutions of herbicides. A wetting agent enhances the chemical's penetration of the cuticle, the thin, waxy layer on leaf surfaces. The dosage of foliar applications is calculated on the basis of the surface area to be covered.

Treatment of Water Conveyance Systems

Making applications to flowing water systems requires permission from every riparian along the entire system to be treated. Flowing water in ditches and canals requires control techniques different from those used in lakes, ponds or other static systems. Herbicide solutions are usually injected or allowed to drip into the water, and the water disperses the herbicide. In drip systems, constant-flow metering devices slowly drip the chemical into the water. The dosage rate on the herbicide label is usually given as the amount of herbicide per hour per cubic feet per second (CFS). CFS can be determined using the following formula:

CFS = average width (ft) x average depth (ft) x velocity (ft/sec) x 0.9

The number 0.9 is a correction factor for the velocity measurement. The velocity measurement is taken at the surface, and this factor helps average the measurement throughout the depth of the water.

A dry concentrate applied in large volumes can be used to "slug" or introduce high concentrations of a chemical into the water. The concentration gradually decreases downstream, providing control and permitting the safe use of the water. This procedure is commonly used with copper for algae control.

Re-treatment

Most aquatic herbicides are contact materials. Contact herbicides often control aquatic plants for three to six weeks depending on the growing season. Most aquatic contact herbicides are not persistent (ability of a pesticide to remain in an active form at the site of application or in the environment). This characteristic can be desirable because it means that restriction periods on the use of water can be fairly short. Limited persistence can also be undesirable because vegetation can regrow in an area soon after treatment, either from vegetation not killed by the treatment or vegetation that comes back from seeds, spores, root crowns, turions or tubers. This problem is particularly true of algae.

Algae must often be re-treated several times per season, whereas flowering plants usually require only a follow-up treatment to kill missed or late-sprouting plants. A common weed "shift" is the appearance of Chara after submersed flowering plants are controlled. Another is the bloom of microscopic algae after submersed plants are killed. This requires the area to be re-treated, targeting a different plant. Although weed shifting is common, it is not the rule.

Re-treatment of a given site is typical during a single growing season. However, the species targeted with subsequent applications are not necessarily the same as those targeted by the initial treatment. Rather, subsequent or sequential applications are targeted at plant species that have emerged since the initial treatment. Applications may continue during the growing season as different weed species emerge.

Re-treatment in subsequent years is usually required because new species appear or weeds return from seeds, spores or vegetative propagules. A successful herbicide weed control program should be considered a long-term program requiring continued but varying treatments.

Equipment Selection

Most equipment used for aquatic herbicide applications is similar to that used in agricultural applications. Modifications are made to adapt equipment to special situations, such as applying from boats and injecting herbicides into deep water. The remainder of this chapter discusses the use of conventional herbicide application equipment and adaptations for use with aquatic herbicides.

Liquid Formulations

The majority of aquatic herbicides are formulated as liquids. The equipment needed for applying liquids depends on which of the two methods below is used:

a. Spray tank. The herbicide and the diluent — usually water — are mixed in a tank and the mixture is applied to the weeds.

b. Direct metering into pump suction. The herbicide is metered into the suction side of the pump at the rate needed to apply the correct amount per acre. The diluent needed to ensure adequate coverage is drawn directly from the body of water being treated.

The spray tank method is suitable for treating relatively small areas or when mixing several herbicides. When large areas are treated, it may be more efficient to use the direct metering method to reduce the time spent refilling the tank.

Aquatic plants are treated from boats with out- or inboard engines, airboats, fixed-wing aircraft and helicopters. The type of application equipment used is dictated to some degree by which vehicle is used.

Spray Tank Applications

Figure 8-1 shows a typical sprayer used to apply herbicides from a boat. Features of the sprayer components are described below.

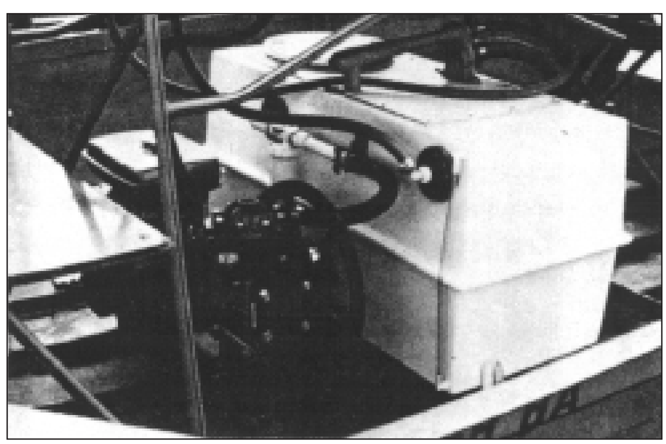

Figure 8-1. Boat mounted sprayer used to apply aquatic herbicides.

Tank. The boat-mounted tank, usually made of fiberglass, holds 50 to 100 gallons. Usually the tank will have graduations on the side that indicate volume. The tank should have a large opening for easy filling and cleaning.

Agitation system. Most spray tanks are equipped with some type of agitation system. **Good agitation is important for maintaining a uniform spray mixture and for mixing adjuvants such as inverting oil or polymers**. Figure 8-2 shows hydraulic and mechanical agitators. Some tanks are equipped with both types of agitators.

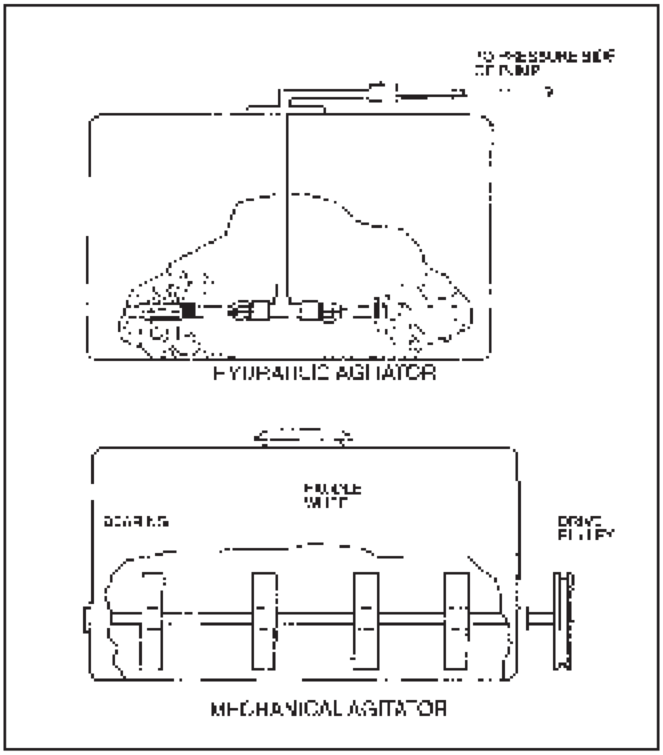

Figure 8-2. Agitation systems for liquid application equipment.

A well designed hydraulic agitation system that uses a venturi device for stirring is adequate for keeping wettable powders in suspension. However, this type of agitator will not stir the mixture enough to form invert emulsions or mix polymers. To function properly, the hydraulic agitation line must be tapped into the high-pressure side of the pump (Figure 8-2). When you're using a hydraulic agitator, the pump must have the capacity to deliver the required flow simultaneously to the boom or handgun and to the agitator. If the maximum pressure that can be achieved after completely closing off the pressure regulator is lower than the pressure needed, the agitator orifice size must be reduced. Mechanical or paddle wheel agitators are probably the best type of agitator. Well designed mechanical agitators stir the mixture vigorously and allow the use of both polymers and invert emulsions in states that permit these applications. Sometimes a clutch is added to the agitator drive, and the operator can keep the mixture at the desired consistency by agitating only when needed.

Hoses. The inner and outer layers of all hoses should be resistant to the chemicals used. Check with the chemical and hose supplier if there is any doubt — a hose weakened by chemicals might leak or burst unexpectedly. Two materials widely used for hoses are ethylene vinyl acetate (EVA) and ethylene propylene dione monomer (EPDM). A pressure hose must be strong enough to withstand the maximum pressure within its length without bursting. Pressure varies along the hose, with the greatest pressure occurring at the pump. Hose size is important because the pressure loss in the hose depends on the hose inside diameter (ID), length and flow rate (Figure 8-3). For example, a 1/2-inch ID hose loses 1 pound per square inch (psi) per foot at a flow rate of 10 gallons per minute.

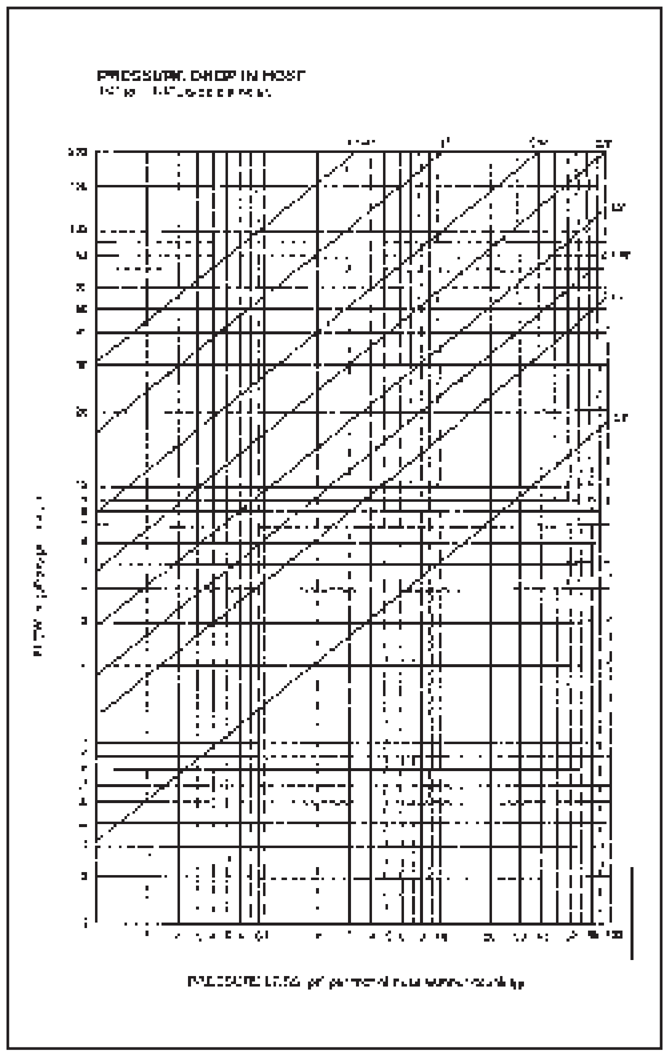

Figure 8-3. Pressure drop in hoses.

Pressure loss in relatively short hoses is not very important, but it is important to choose the proper hose size when extremely long hoses are used, such as in some handgun spraying work. Recommendations for hose sizes are presented in Table 8-1.

Suction hoses are under a partial vacuum — they will not burst but they can collapse. Choose a suction hose that is reinforced to prevent collapsing. A collapsed suction hose can restrict the flow of liquid and starve a pump. This will cause decreased outflow and greatly accelerated wear. As a rule of thumb, suction hose diameters should be at least as large as the pump inlet port.

Polyvinyl chloride (PVC) pipe works well for rigid plumbing, but you need to use caution in selecting valves. For example, a 1 inch valve can be plumbed to a 1 inch pipe, but the inside diameter of the valve may be restricted to 1/2 inch.

Pumps. Most pumps used for applying liquid herbicide formulations are of five general types: roller, piston, centrifugal, diaphragm and gear. Each type has certain capabilities and limitations that determine when it should be chosen. Characteristics of the various pumps are listed in Table 8-2.

Roller pumps have the advantage of being relatively inexpensive. They are widely used in agriculture on general-purpose crop sprayers. Roller pumps are not often used for aquatic weed control work, however, because they do not produce the high pressures needed for handgun spraying. Though a pressure capability of 300 psi is stated for a roller pump (see Table 8-2) which is adequate for handgun spraying, the pump would not be able to sustain high pressure very long because the rollers wear and fluid leaks back past the rollers. Figure 8-4 shows how to plumb a liquid application system using a roller pump. The system has a hydraulic agitator that would be suitable only for systems not used to apply invert emulsions or sprays containing polymers.

Piston pumps are often used in aquatic weed control because they can deliver high pressure for handgun spraying. These pumps are dependable, long-lived and highly adaptable to most types of service. Their primary disadvantages are that they are expensive and they deliver relatively low volumes, though the volume is usually sufficient for aquatic applications.

A piston pump is a positive displacement pump. This means that the output depends on the displacement of the piston in the cylinder. Output is proportional to speed and virtually independent of the pressure needed to force the flow through the orifice area on the system.

Output from a piston pump is not steady. It comes in spurts because the distance that the piston travels in the pump cylinder varies with time.

Table 8-1. Recommendations for hose sizes.

	Hose size (inches)	
Pump output (gpm)	Suction side	Pressure side
< 12	3/4	5/8
12-25	1	3/4
26-50	1 1/4	1

Table 8-2. Characteristics of various pumps.

Pump type	**Capacity (gpm)**	**Speed** (rpm)	**Maximum pressure** (psi)	**Material that can be sprayed**
Roller	0-35	600-2600	300	Nonabrasive
Piston	0-60	500-1800	1000	Abrasive
Centrifugal	0-150	600-6000	70	Abrasive
Diaphragm	1-60	200-1200	850	Abrasive

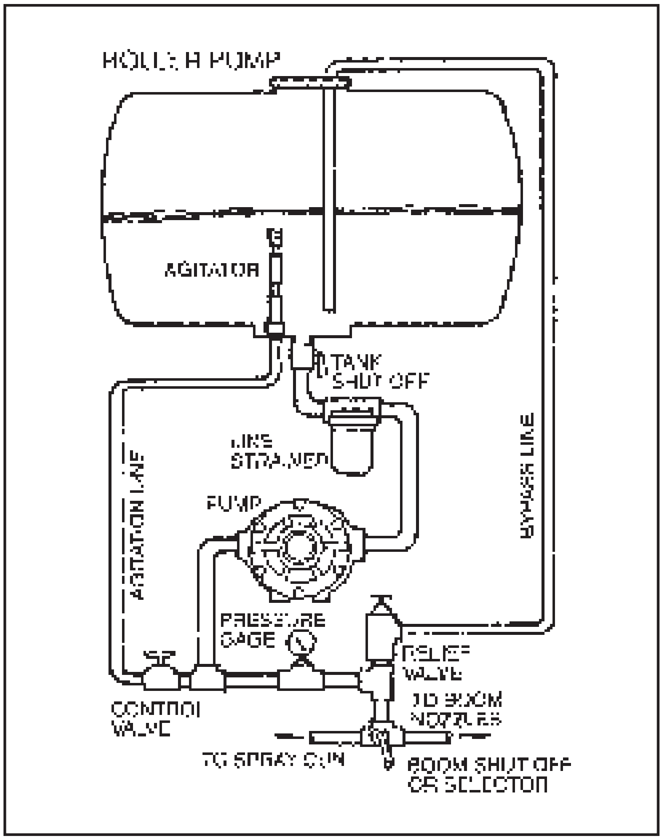

Figure 8-4. Roller pump system.

This problem can be eliminated through the use of a surge dampener. Pulsation is especially noticeable for pumps with a small number of pistons (small pumps often have two pistons). The pulsing nature of the flow makes a surge tank desirable. The system should also be equipped with a glycerine-filled pressure gauge (glycerine dampens movement of the gauge needle). These gauges last longer and can be read more easily than non-dampened gauges on piston pump-equipped systems.

Figure 8-5 shows how to plumb a system equipped with a piston pump. The system includes an unloader valve that is especially useful when spraying with a handgun. When the gun is shut off, the system pressure rises until it is sufficient to overcome the spring force on the unloader valve. The valve will crack open and bypass fluid back to the tank. Without the unloader valve, the pressure would continue to rise until a hose burst. The plumbing system shown in Figure 8-5 is appropriate for all of the positive displacement pumps, including diaphragm and gear pumps, as well as the piston type.

Centrifugal pumps deliver high flow rates when working against a low pressure. These pumps are especially useful for transferring fluids from one tank to another or from the body of water into the tank when refilling.

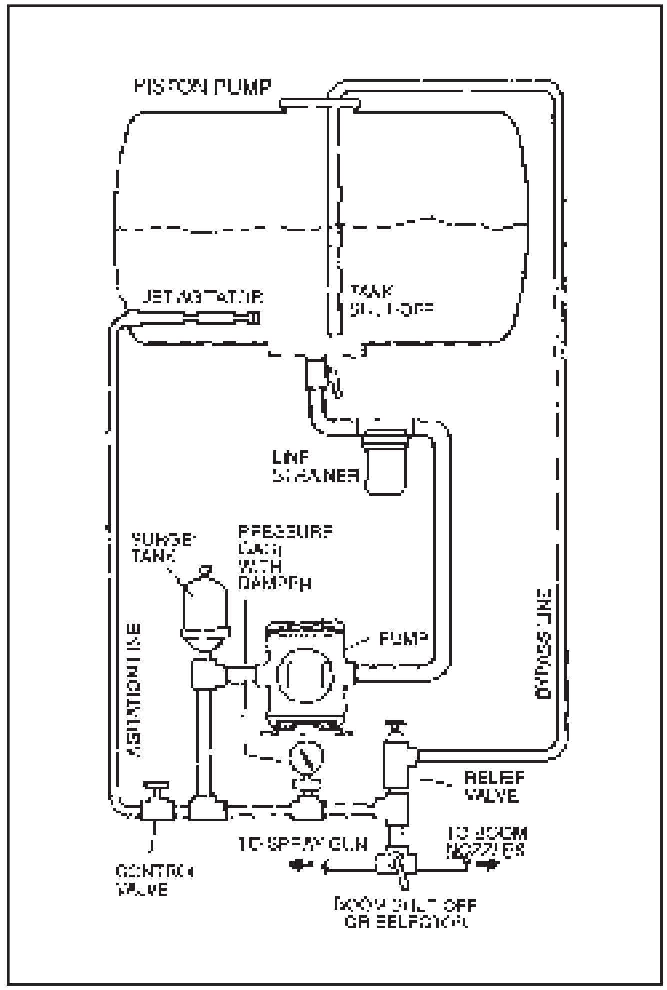

Figure 8-5. Piston pump system.

Diaphragm pumps are now used in many applications instead of piston pumps. Benefits of diaphragm pumps include relatively low cost, low maintenance and small size compared with other pumps with similar flow and pressure ratings. Like piston pumps, diaphragm pumps are positive displacement pumps, so the pump output depends on pump speed and remains constant regardless of the pressure it is working against.

Gear pumps are used in a number of applications and are positive displacement pumps capable of high pressure. The corrosive chemical comes in contact with the pumping gears, so maintenance can be a problem. Gear pumps are becoming less popular and are being replaced by diaphragm and piston pumps in many installations.

Nozzles. The spray nozzle forms the spray pattern, determines the droplet size and meters the flow rate. Nozzle selection is based on a balance of these three functions. Many types of nozzles are used in terrestrial weed control. Because of the nature of aquatic weed control, the variety of nozzles used in aquatic spraying is much narrower.

The method of application (submersed or surface) determines the nozzle type selected. The four primary application methods and nozzle considerations in aquatic weed control are:

1. Handgun spraying of surface, emersed and ditch bank species. Handguns are equipped with nozzles that provide a high flow rate (3 to 6 gallons/minute), a straight stream and a large droplet size. This arrangement ensures thorough wetting of the target vegetation with minimum spray drift.

2. Subsurface injection just below the water surface for submersed weed control. Usually short hoses are spaced at approximately 2 foot intervals on a short bow- or stern-mounted boom. Hoses are just long enough to place the nozzle at the water surface or just below it (Figure 8-6). The nozzle body contains a disk that meters the flow into the water.

3. Bottom placement or deep-water injection: Nozzles are located at the ends of long hoses that trail from a boom on the bow of the boat. Hoses are usually weighted to keep the herbicide placement deep within the weed mat or near the bottom (Figure 8-7). A common arrangement involves constructing a nozzle by drilling small holes in a piece of galvanized pipe. The length of the pipe depends on how much weight is needed to lower the hose to the desired depth. Pipe length varies from 9 to 30 inches. The pipe is capped on one end and attached to the hose on the other. Deep-water injection hoses must not have any clamps or protrusions that will catch and hold plants.

4. Aerial applications: Aerial applications normally use hollow cone or flat fan nozzles to improve coverage with the smaller volume of spray solution applied per acre. A specialized aerial boom designed to produce large droplets at low pressure and low volume is the microfoil boom (Figure 8-8).

Direct Metering into Pump

When large areas are treated, it is often more efficient to meter the herbicide into the suction side of the pump and eliminate the time spent filling and mixing tanks. Water is drawn into the pump through "water boxes" built into the bottom of the spray boat (Figure 8-9). Normally, one or more plastic tubes are tapped into the pump suction line. Each tube has a valve for opening and closing the lines. Tubes have an in-line orifice used to meter the correct amount of herbicide into the system. Figure 8-10 shows how a typical herbicide withdrawal hose is constructed.

A number of suction hoses can be used so application can continue without interruption. When the herbicide in the container being used is depleted, the applicator opens a valve in the hose in a second container and closes the valve of the empty one.

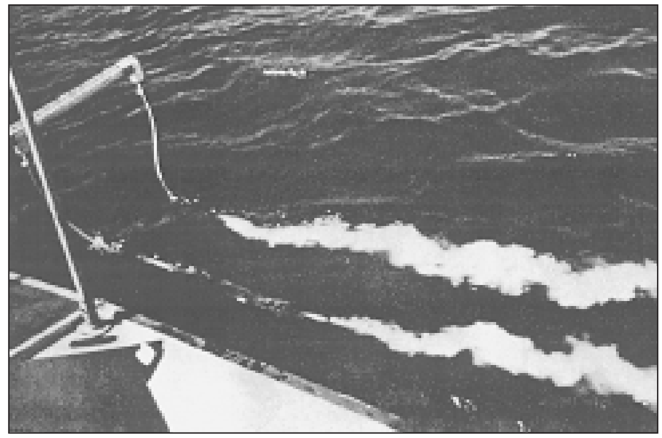

Figure 8-6. Subsurface injection just below the water surface for submersed weed control. If lake water is stratified, reduced control may result with this type of application.

Figure 8-7. Deep water injection with long, weighted hoses can be used to overcome the effects of stratified water.

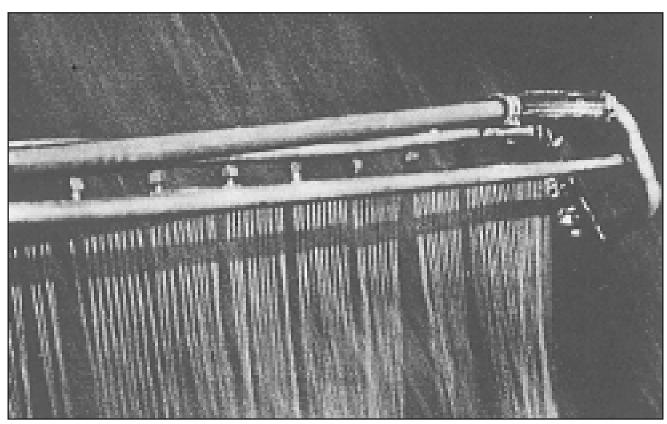

Figure 8-8. Microfoil booms are often used in aerial herbicide applications to reduce drift.

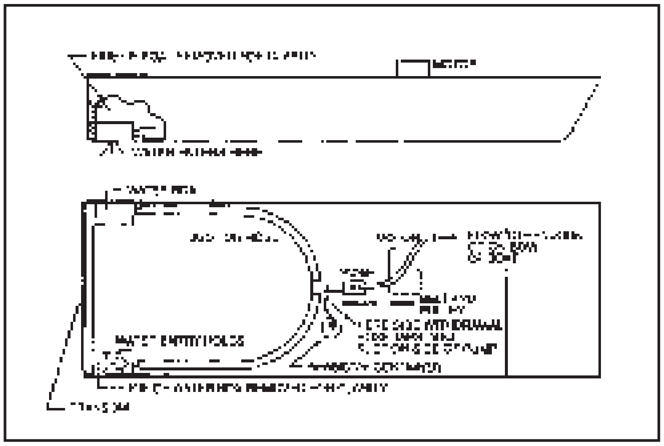

Figure 8-9. System for withdrawing herbicide directly from the container and water from the treated water body.

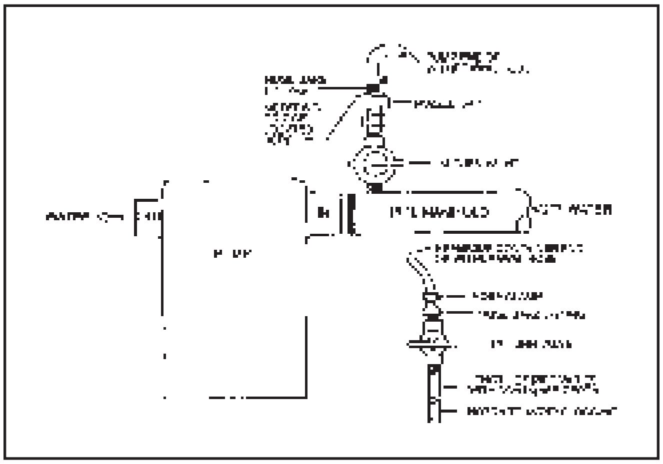

Figure 8-10. Plumbing detail of herbicide withdrawal hose.

Except for not using a tank and having the previously described equipment on the suction side of the pump, equipment used for spraying in this manner is very similar to tank-mix units.

Applying Sprays Containing Polymers

Polymers are long-chain carbon molecules which, when united with water, thicken the solution and increase the number of large droplets. They are often used when spraying surface weeds with a handgun. In Michigan, polymers may be used on emergent plants only.

Applicators may find that the output from their sprayers will diminish greatly when spraying with 1 to 2 percent polymer. The reason often given for the flow reduction is that the water-polymer mixture flows less readily, so the pump is unable to force the material through the nozzles. This is not the reason for the reduced flow, however.

The positive displacement pumps normally used in aquatic weed spraying can force any amount of material that enters the pump out of the pump. If the engine speed (rpm) is set by a governor (as are most small gas engines that power sprayer pumps used in aquatic weed spraying), the output will be the same for a viscous liquid as it would be for water, as long as the same amount entered the pump. The difference is that the pressure required to force the viscous liquid through the discharge hose would have to be greater. More pressure means the engine has to deliver more horsepower.

Output decreases when using these high concentrations (1-2%) of polymer because the amount entering the pump suction is reduced. Flow rates of water and water-polymer mixture through a given nozzle at a given pressure vary little. Most of the flow reduction occurs because the pump is starved on the suction side. A system used to apply water-polymer mixtures should have extra-large suction lines with a minimum of fittings between the tank and the pump inlet.

Granular Formulations

Granular herbicides are normally applied with a bow-mounted centrifugal or blower-type spreader (Figure 8-11). Centrifugal spreaders can treat a wide swath when relatively large granules are used. The ability to treat a wide swath (30 to 40 foot) without requiring any type of structure extending beyond the sides of the boat makes granular application attractive. The disadvantage

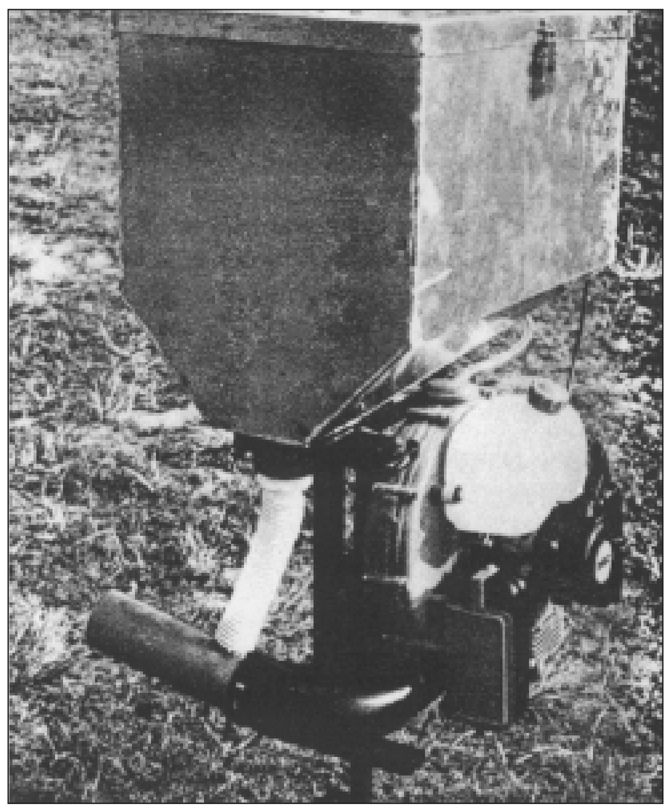

Figure 8-11. Blower type spreader for applying granular or pellet herbicide formulations.

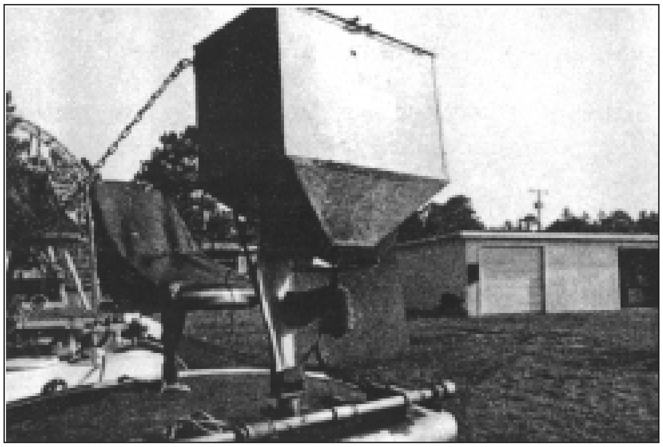

Figure 8-12. Centrifugal type spreader for applying granular or pellet herbicide formulations.

is the large quantity of material (20 to 400 pounds/acre) that must be handled. The rotor that slings the granules is driven by a 12-volt DC motor. Normally, the spreader is purchased as a complete unit except for the mounting system. Because boats used to treat aquatic weeds are normally used to apply both sprays and granular applications from the bow, the spreader is usually mounted so that it can be quickly removed.

Blower-type spreaders use air pressure generated by a low-pressure high-speed two-cycle blower, with a venturi discharge nozzle to propel the granules. An advantage of blower-type spreaders is that they create little dust compared to that created when the mechanical rotor of centrifugal spreaders strikes pellets or granules.

Chapter 8 – Aquatic Herbicide Application Equipment and Techniques Review Questions

Write the answers to the following questions, and then check your answers with those in the back of this manual.

1. After you've identified the pest and selected the correct pesticide for treating aquatic plants, the next important step influencing a chemical's effectiveness in controlling the aquatic weed population is the ________________________.

2. Which of the following application methods statements is incorrect?
   a. Granular herbicides should be applied by hand.
   b. Plants with most of their leaf area above the water surface are sprayed with aqueous solutions of herbicides.
   c. Applications to flowing water systems require control techniques different from those used in lakes, ponds or other static systems.
   d. In a flowing water system, the herbicide concentration gradually decreases downstream.

3. Algae requires only one follow-up treatment to kill missed or late-sprouting plants.
   True or False?

4. When large areas of a lake are treated for weed control, it may be more efficient to use the direct metering method for herbicide dilution.
   True or False?

5. Pressure loss in a hose does not depend on:
   a. Water content.
   b. Hose inside diameter.
   c. Hose length.
   d. Flow rate.

6. Name two materials widely used for hoses.
   1.
   2.

7. As a rule of thumb, suction hose diameters should be at least as large as the ____________ ______________ ______________.

8. A centrifugal pump has a capacity of ____________ gpm and a maximum pressure of _______psi.

9. Which statement concerning the uses of five general pump types is false?
   a. Roller pumps are widely used for aquatic weed control because of their high pressure.
   b. Piston pumps are used in aquatic weed control because they deliver high pressure for handgun spraying.
   c. Centrifugal pumps are useful for transferring fluids from one tank to another.
   d. Diaphragm pumps are positive displacement pumps so the pump output depends on pump speed and remains constant regardless of the pressure it is working against.
   e. In gear pumps, corrosive chemicals come in contact with pumping gears, so maintenance can be a problem.

10. When large water areas are treated, it is often more efficient to meter the herbicide into the suction side of the pump and eliminate the time spent filling and mixing tanks.
    True or False?