KEEP GRASS GREEN WITH

V-C 13®

KILLS NEMATODES AND CHINCH BUGS

V-C 13 is the ideal liquid product to use to protect turf from nematodes and chinch bugs. Nematodes are tiny, thread-like worms that attack grass roots and stunt or ruin growth. Fertilizer, water and good care are wasted when nematodes wreck grass roots. Chinch bugs are death on green grass. They actually suck the life out of grass stems. The grass turns yellow and then brown, as it dies. V-C 13 is a practical, easy way to destroy nematodes and chinch bugs. It provides powerful, long-lasting control of these destructive pests. And V-C 13 is safer to use, lower in toxicity than chlorinated hydrocarbon preparations. It's easy to keep grass green with V-C 13. Get it from your supplier or write to the address below for full information.

VIRGINIA-CAROLINA CHEMICAL CORPORATION
401 East Main Street
Richmond 8, Virginia

V-C®

WEEDS and TURF
PEST CONTROL
A SECTION OF PEST CONTROL MAGAZINE

November, 1963

Features

Departments

Published Monthly by
TRADE MAGAZINES, INC.
1900 Euclid Avenue
Cleveland, Ohio 44115

JAMES A. NELSON
Publisher

CHARLES D. WEBB
Editor

DAVID E. SCHNEIDER
Staff Biologist

R. J. HOFFER
Circulation Manager

Advertising Representatives
National Headquarters
1900 Euclid Avenue
Cleveland, Ohio 44115
Phone: Area Code: 216 + 771-4169

New York City
Billingslea & Ficke
420 Lexington Avenue
Phone: Area Code: 212 + LExington 2-3667

Single Copies: 35 cents

Annual Rate for
12 Monthly Issues: $3.00

Check those dates!

When we first learned that the Weed Society of America and the Aquatic Weed Control Society were holding their annual meetings during the same week next year, we were dismayed, because there are so many industrymen who wish to attend both sessions.

It is heartening that the two groups have agreed to hold joint sessions for people who have a stake in both fields (W&T, Oct., pg. W-34). Material presented at conferences such as these, which go on all over the country, all year long, is invaluable to applicators who want to keep up with what's new in the industry . . . it's a shame when conflicting dates make it necessary to choose between one important seminar and another.

We suggest that the heads of the various regional weed conferences, turf associations, applicator organizations, and similar groups get together when they draw up plans for future meetings, so that duplication of dates can be avoided. Perhaps this is already done to a certain degree by some of the long-established societies; it should be done by all.

Readers have written us that they appreciate *Weeds and Turf* because it is a clearinghouse of news about such conferences and because we try to report in detail what goes on, so that those who have to miss the session will still get some of the benefit. While we rejoice in this reader appreciation, we must nevertheless insist that there's nothing so valuable as actual attendance.

We will continue (and expand) our policy of detailed reporting of as many meetings as we can, and we will continue to urge our readers to attend these industry confabs. We hope the associations will help themselves by making sure a scheduled get-together does not have to vie with another conference slated for the same dates.

Chemicals for the Control of Aquatic Weeds

Results of another *Weeds and Turf* field research project

APPLICATORS generally agree that an inexpensive, fast, dependable mechanical method of aquatic weed control is highly desirable.

Mechanical methods would eliminate many of the variables encountered in chemical control, and concern over water temperature, fish kill, water pH, etc., would be unnecessary if weeds were simply removed from water mechanically.

No such method, meeting all of these requirements, has been found, however.

Some attempts have been made, and some degree of success achieved, with nonchemical weed elimination, but the factor of economy in time, labor, and equipment has not been overcome. Mechanical methods are slow and cost operators and customers a great deal.

Chemical Curbs Most Economical

To date, the most economical methods for aquatic weed control are chemical ones. Chemicals are applied onto vegetation or introduced into water in amounts sufficient to kill unwanted growths.

Two general methods of control are followed. Chemicals may, first of all, be applied as liquids in one of several ways. They may be applied, in the same manner as terrestrial herbicides, to exposed vegetation and soil during a drawdown (lowering of the water level). Diluted liquids may be sprayed over the surface of the water or onto emersed vegetation as contact herbicides. Or concentrated herbicides may be poured into water so that toxicants will yield a predetermined final concentration upon dilution. In other cases it is necessary to inject chemicals through tubes or nozzles under water to give the desired distribution and concentration.

Granular application is the second method. Granules may also be applied to bare soil during a drawdown. They may be broadcast onto water by hand or by machine so they sink into water and dissolve and/or disintegrate to form the desired herbicidal concentration. In some cases where it is desirable to attack roots, granular methods work best. Granules may not be useful on thick matted vegetation because these particles do not readily penetrate the mat. Sometimes granules are evenly distributed on ice (maximum thickness suggested 8 inches) in late winter so that when the ice melts in spring (the time delay does not harm chemical effectiveness), the granules sink to the bottom. This technique works best as a complete treatment of a small water body rather than partial treatment of a large lake. On lakes there is the possibility that the ice pack may shift and misplace the granules.

Three Things to Watch For

After the contracted area has been surveyed, weeds accurately identified, and chemical chosen to do the job, there are three very important points to be considered for successful control: timing, dosage, and application method.

Timing. When should the chemical be applied for best results? Optimum control periods when plants are most susceptible differ with each species. Generally recommendations say to apply chemicals before weeds flower, while they are actively growing. All species do not flower at the same time, so this must be considered when surveying a job where several species are involved. For nonflowering species, the rule is usually to apply controls while active growth is taking place. Submersed species are best controlled before they become too plentiful. Best time, then, will be in the spring, although it is true that some exceptional species are more prominent later in the season.

With certain species of bluegreen algae, according to Bennett (1963), toxic substances are produced when the organisms become plentiful and die. Domestic animals and fish are killed during "blooms" of species such as *Anabena* and *Glaeotrichia*. Thus treating early can be economically important to a client considering factors other than amounts of chemical and time required to do a job.

A second point in favor of treating weeds before they become plentiful is that if a heavy stand of weeds is killed at once, there may be excessive decay of the plants. Decay requires oxygen and water may become deficient in oxygen if too many weeds are decaying at the same time. Lessened oxygen in the water may result in fish suffocation. This occurrence is said to be a greater hazard in aquatic weed work than toxicity of the herbicides. Oddly enough, fish suffocation will occur naturally in late summer in infested lakes when water levels lower, and weeds begin to die. This occurrence indicates that the particular water body had too many weeds for the fish population. In fishing water, weeds should be kept at a level sufficient to provide oxygen in summer, but insufficient to cause oxygen depletion when weeds die in the fall.

If one suspects that treatment of a large stand of weeds may result in oxygen depletion, because

Mechanical control of aquatic weeds is too costly for wide use, and is frequently unsatisfactory to applicator and customer alike. But while chemical methods are effective, great care must be exercised in handling and application. This article, second in a series of three which began last month, outlines the types of compounds now available for water weed work. The third and final installment, on equipment and techniques, appears next month.

of decomposition, a waiting period is advised between partial or band treatments. Or spot treatments may be made. These are equally safe to fish and just as practical and effective.

Second point to be considered is *dosage*. How much should be applied to get the desired control and keep fish kill at zero? To obtain proper dosage figures, the area to be treated and the volume of the water body, must be calculated to determine chemical concentrations necessary to give the accepted recommendations.

Dosages for aquatic weed control are often stated in parts per million (ppm) of active ingredient which may be by weight, in pounds, or by volume, in gallons.

One part (pound) per million (pounds of water) in an acre of water one foot deep is 2.7 pounds (there are approximately 2,700,000 pounds of water in one acre-foot of water).

One part (gallon) per million (gallons of water) is 0.3 or ⅓ gallons, since there are approximately 300,000 gallons of water in an acre-foot (43,000 cubic feet of water).

Volume measurements are written "ppmv"; weight measures, "ppmw" (formerly simply ppm).

Tables or charts of dosage recommendations for various weeds will always be found on product labels. Sometimes in research bulletins recommendations are expressed in terms of active chemical and not by product. Often a single chemical can be found in various formulations under many trade names; researchers will usually use the chemical common name to avoid reference to registered trademarks. Operators who get the best buys and best results are those who read the label for the information about the chemical active ingredient.

The following descriptions of the major chemicals used and their phytotoxicity to aquatic weeds will help applicators decide which may be best suited to their jobs, and give novices a basis for further study of aquatic weed control. *Application methods* is the subject of the concluding installment of this series.

Specific Herbicides for Specific Weeds

An applicator may try to get results by using only one chemical for all jobs, but both his and his customers' satisfaction may not be as great as if he had chosen the particular herbicide suited to each job, and each customers' needs.

Sodium Arsenite

Sodium arsenite is an inorganic arsenical that has been used extensively for aquatic weed control. It is more effective on submersed weeds which do not have a waxy covering (Klingman 1961). It is usually applied as a spray and at times is injected under water for better distribution and to reduce the exposure hazard to operators.

For best control, sodium arsenite should be applied early in the growth season, when plants are actively growing.

Rates of 3 to 7 ppmw, depending upon the weed species (rarely more than 10 ppmw) of arsenic trioxide (the active ingredient) are required against most aquatic weeds. Waterlilies, cattail, bulrushes, sago pondweed, chara, and nitella are not susceptible to sodium arsenite at the usual rates of application (10 ppmw arsenic trioxide). Rates greater than 10 ppmw are not recommended because of hazard to fish and warm-blooded animals.

Considerable care is required

when using sodium arsenite because it is very toxic to man and animals. Contact with undiluted sodium arsenite or even drift from spray applications can harm unprotected skin. This is due to the sodium hydroxide (caustic soda) used to suspend the sodium arsenite in solution. Exposed skin of operators should be protected with gloves, salves, or lotions. Goggles or masks should be worn to protect the eyes. Water with more than 0.05 mg per liter should not be used for drinking, bathing, or irrigation. All treated waters should be restricted from all uses for at least three days. Domestic animals should not be permitted access to treated areas for at least this period and until heavy rain has washed the chemical residue from shoreline vegetation. Sodium arsenite should never be used in potable (drinkable) water supplies or lakes or streams which supply potable water.

Sodium arsenite does not remain in water indefinitely. In larger lakes treated marginally concentrations are usually reduced to safe levels after 3 days (Reed, 1963). In smaller lakes and ponds that are treated completely, a wait of 7 to 14 days is advised before using the water for recreational purposes.

Researchers have shown that arsenic can be found in significant amounts in bottom muds after treatment periods (Barkeley 1962). This residual concentration may have some temporary effect on microscopic organism populations and has been shown to have a direct effect on fish spawning. Barkeley (1962) showed that the most critical period for fish susceptibility to small arsenic concentrations is soon after egg deposition. Even 5 ppmw of arsenic limited the number of fish which hatched. Later the same 5 ppmw did not affect small fingerlings. Dupree (1958) determined that muscle tissue of adult goldfish and bluegills was not affected by arsenic concentrations in mud; that is, arsenic was not stored in edible muscle.

Manufacturers of sodium arsenite for aquatic work, such as Chipman Chemical Company, producers of Atlas "A", recommend dosage rates of 4 ppmw of arsenic trioxide for small lakes (less than 2 acres), and 5 ppmw for lakes larger than 2 acres but less than 10 acres. For very large lakes, treatments in the range of 10 ppmw are said to be successful against vulnerable weeds. Treatments for some filamentous algae species of the surface scum type can be accomplished with 4 ppmw. Sodium arsenite is not generally effective on submersed algae. Shoreline treatments of large lakes require 7½ ppmw if the shores are protected from heavy wave action and 10 ppmw if there is no protection and hence likely to be a lot of dilution.

Copper Sulfate

Copper sulfate has been a widely used algicide since 1904. The copper portion (Cu ion) of this inorganic metal compound kills algae at low concentrations.

Copper sulfate may be broadcast on water in dry crystal form. It is available in several particle sizes; the size partially determines the rate at which the solid chemical will dissolve. Heavy copper sulfate crystals are used for treatment of chara and nitella algae because the crystals sink to the bottom before completely dissolving. This builds up a higher concentration on the bottom where it will do the most good.

Filamentous algae are usually treated with a fine granular form of copper sulfate, which dissolves as it sinks in relatively shallow water.

Planktonic algae are treated with a fine dust or "snow" form so that copper is concentrated just under the surface.

With regard to rates, MacKenthun (1960) states; "Solubility of copper in water is influenced by pH and alkalinity, as well as temperature, and the dosage required for control depends not only on these factors, but also upon the species or genus variation of the organisms, and their resistance to copper sulfate." Dosage should be carefully calculated to include all of these factors so all troublesome species are controlled. If dosage is not figured properly, there may be an outbreak of an uncontrolled species after removal of a dominant species eliminates competition.

Although fish are killed at low rates in soft water, higher rates may be necessary in hard waters because the copper unites with negatively charged mineral ions and settles out. That copper which settles out will not kill weeds nor harm fish significantly.

Liquid spray systems may also be used to apply copper sulfate solution. This solution is corrosive and will damage galvanized tanks. Stainless steel, copper-lined, or other specially treated tanks are advised.

A less efficient application method which eliminates danger to sprayers is the burlap sack method. After the proper dosage rate has been determined, the required quantity of copper sulfate can be put in a gunny sack and towed across the water by a boat until the chemical is dissolved. This method also eliminates expensive equipment, although it is no less exacting.

In potable water supplies, copper sulfate concentration cannot exceed 3 ppmw of the copper ion, which is equal to 7.5 ppmw of copper sulfate, according to the standards of the U. S. Public Health Service (1946).

Best application time is in early spring before algae become plentiful enough to cause trouble. For hard-to-kill species, some researchers suggest multiple applications of lower rates rather than one heavy dose. Algae samples can be taken and observed under a microscope. From these samples, applicators can determine when populations reach the stage where they can be efficiently controlled. Copper sulfate is not a preventive treatment; that is, applications will do no good if there are no algae present to kill. Copper does not remain in water over a period of time to serve as a "pre-emergent" herbicide. Application of controls at a time when algae are just beginning to be abundant will stem outbreaks or "blooms" later in the season. This early application also reduces possibility that later sudden kill of heavy algae growth may deplete water oxygen content and pose a hazard to fish. Mackenthun (1958) states: "Summer fish mortalities occurring in many lakes throughout the country are a rather common occurrence and some are caused by this type of [algal decomposition] phenomenon."

2,4-D

The growth regulator 2,4-D has been used widely and successfully in its many forms against many aquatic weed species. Knowledge of the various forms is useful, because each form requires special applications and may work better against one species than another, or better in one situation than another.

Before going into the different forms of 2,4-D, differentiation between volatility and drift may be helpful.

Volatility is the ability of a

ORTHO® is Proud to Announce A New Aquatic Weed Control that Really Works!

ORTHO DIQUAT

Public officials, ranchers and crop growers have long felt the need for a potent weed-killer practical enough for large-scale control of aquatic weeds. A weed-killer that was not toxic to wildlife and livestock when used according to directions. One that wouldn't contaminate the soil or cause contamination when treated water was used for irrigation. One that was economical, and easy to apply. New DIQUAT, *recommended by many agricultural agencies, represents a successful solution to these problems.*

Fast kill on a wide variety of weeds. DIQUAT is highly soluble, and moves in quickly for the kill. (Much faster, for instance, than 2,4-D.) Weeds absorb it rapidly, then wilt, collapse and die. And the kill covers a wide range of aquatic weed pests: waterlettuce, waterfern, water hyacinth, elodea, southern naiades, pondweed —in fact, preliminary tests show DIQUAT to be effective against at least 22 of the more common aquatic weeds.

Low hazard, and non-contaminating. (Used as directed.) DIQUAT greatly reduces hazards to applicators, wildlife, etc., when properly used as recommended. Residue contamination is not a factor, as DIQUAT does not build up in water, and is inactivated immediately on contact with soil.

Hundreds of practical applications. Because of its proven effectiveness and inherent safety, DIQUAT has a wide variety of possible applications. It can be used to control weeds in canals, lakes, drains, and ponds. In parks, or on farms or ranches, it can be used for drainage and irrigation ditches, ponds, marshes, and swamps.* DIQUAT is also an excellent non-selective control for weeds and grasses around buildings and along fences, ditch banks and roadways.

***Note:** As with many chemicals, water treated with DIQUAT should not be used for swimming or drinking purposes until ten days after application. And since it is a herbicide, allow ten days before spraying, irrigating or other uses of treated water.

A special word to Municipal Officials: It goes without saying that you can't make an important policy decision on the basis of one advertisement. But we believe that the technical data available will convince you that DIQUAT can provide safer, more effective and more economical weed control. Why not get the full story, by writing: C. E. Cody, National Sales Manager, Agriculture, California Chemical Company, Ortho Division, 200 Bush St., San Francisco, Calif.

ORTHO®

"Helping the World Grow Better"

chemical to vaporize. Vapors may be carried on air currents to damage desirable crops or other plants.

True spray mist drift occurs when improperly applied chemicals are atomized by too high spray pressures. The particles or droplets formed by impact with air may float through the air to harm plants.

Low or nonvolatile chemicals may reduce the tendency of a chemical to vaporize and cause damage, but it does not eliminate the possibility of damage through drift. Drift is controlled by proper calibration of spraying pressure and proper choice of nozzle type.

2,4-D is produced in the acid form (2,4-dichlorophenoxyacetic acid). Modification of the acid portion of the molecule imparts to 2,4-D characteristics which make it more useful for purposes of aquatic weed control. Differences are generally in the form of increased or special solubilities or lower volatilities.

Crude 2,4-D has a low solubility in both water and oil. It is wholly unsuitable for use as an herbicide. To facilitate ease of handling and application, the 2,4-D acid is formulated into either an ester or an amine salt.

Salt formulations are obtained by neutralizing the 2,4-D acid with a salt to form a water-soluble amine. Sodium, potassium, and ammonium salts of 2,4-D may be sprayed in a water carrier or injected directly into water. They are not considered hazardous with respect to volatility.

Amine salts of 2,4-D, such as the alkylamines(di- or trimethylamine, di- or triethylamine) and the alkanolamines(di- or trimethanolamine, di- or triethanolamine), have somewhat higher water solubility than the sodium, potassium, and ammonium salts. Amine salts are also nonvolatile and have uses in common with these metallic salts. Amine salts, however, are generally more toxic to fish than the metallic salts (sodium and potassium).

Ester formulations are made by reacting the pure 2,4-D acid with an alcohol in the presence of a catalyst. This process is known as esterification. Depending upon the type of alcohol used in the reaction, the resultant formulation will give the appropriate ester of 2,4-D. For example, if the acid is reacted with isopropyl alcohol (rubbing alcohol), the resulting ester will be the isopropyl ester of 2,4-D.

A series of ester formulations (methyl, ethyl, isopropyl, butyl) are soluble in oil but not in water. These are volatile and hazardous to use near desirable crops or ornamentals. A more complex series of ester formulations having lower volatility includes the isooctyl (2 ethyl hexyl), butoxyethanol, and the propyleneglycolbutyl ether esters of 2,4-D. All ester forms must be emulsified for use in water. The addition of certain emulsifiers makes them especially toxic to fish because emulsifiers are themselves usually toxic.

Formulations of the water-soluble salts, including the amine salts, usually have surfactants added by the manufacturer to enhance penetration and absorption into plants. On especially hard-to-wet plants (those with waxy or hairy leaf surfaces), it is often necessary to add a wetting agent to the spray solution to overcome such penetration barriers. Ester formulations applied in oil penetrate plants very quickly and are more effective at lower rates than are the salts of 2,4-D.

Granular forms of 2,4-D for aquatic work will generally be a low-volatile ester such as the isooctyl. Granular formulations are becoming more widely used in still waters since they kill more completely in less time and often give longer lasting control through residual activity in bottom muds.

Since very small doses of 2,4-D will harm crop plants, treated water must not be used for irrigation.

Dacamine

A new product called Dacamine, produced by Diamond Alkali Company, is a special formulation of 2,4-D. Dacamine is said to be both water emulsifiable and oil soluble and to combine the effective penetration of ester forms of 2,4-D with the lack of volatility (toxic vapors) of normal amines. It is used in the same way as foliage-applied 2,4-D and is available in packages of 2 and 4 pounds of active ingredient per gallon of formulation. Dacamine is more viscous at lower temperatures than normally viscous esters of 2,4-D. The 2-pound material is less viscous than the 4-pound package. Viscosity does not change effectiveness of the herbicide, which is measured by the amount of 2,4-D acid per gallon.

Reports of the success of this new formulation come from Florida and Arkansas. Researchers report good control of alligatorweed in drainage ditches and waterways with 2 pounds of active material per acre. Waterplantain (*Alisma* sp.) was controlled in waters around rice fields with ¼ pound active per acre (Marrese and Sprayberry, 1963).

Silvex

Another growth regulator herbicide is 2,4,5-TP or silvex. Silvex behaves in much the same way as 2,4-D as far as translocation is concerned. Its method of killing is also the same, i.e. physiological imbalance and eventual death.

Application of the potassium salt of silvex, at 2 ppmw and under, gave good control of several higher aquatic plants in tests conducted by Gaylor and Houser (1962).

Results were obtained when silvex was poured into water before plants began to flower, while they were actively growing. Plants controlled were southern naiad, coontail, and American pondweed (*Potamogeton nodosus*). Chara, an alga, was not controlled by silvex since the compound has little effect on algae. Other weeds normally controlled with potassium silvex are: watermilfoil, elodea, cabomba, and waterlilies.

At recommended rates (3 ppmw and less), silvex is not dangerous to fish or warm-blooded animals. Ester forms cause taste problems in fish harvested for food. There is no taste change when the potassium salt of silvex is used. Of course, treated water must not be used for irrigation because of the herbicidal effect on desirable plants.

Esters of silvex can be applied to marginal vegetation in the same manner as to dry land growth, that is, used at the rate of approximately 1 gallon per 100 gallons of water with the vegetation sprayed to wet.

Dalapon

Dalapon is an herbicide effective against grassy weeds. It is generally applied to foliage, so it will be translocated throughout plants, rather than applied directly onto or into water.

For application to plants such as cattail, Timmons et. al. (1963), working in the West and Northwest, found that the sodium salt of dalapon applied at 20 pounds active acid equivalent per acre gave good control.

With the addition of diesel oil and an emulsifier or a wetting agent, the effectiveness increases.

Dalapon action decreases the

production of a waxy covering on leaves of cattail, according to Crafts (1961), and Timmons' research agrees in that wetting agents are not as important when doing a dalapon re-treat.

Timmons also found that mature cattails standing in some water are less resistant to single herbicidal applications of the sodium salt of dalapon. Klingman (1961), working in the East, on the other hand, states that cattail is best controlled with dalapon at 5 pounds per acre plus amitrole at 2 pounds per acre, with the cattail not standing in water. Controls are applied between flowering and seed formation. These variant research results could be due to different cattail species, or different weather conditions, or other conditions which might vary with geography.

At usual application rates, dalapon has no toxic effect on fish. Its toxicity to man compares with that of table salt, still it should be applied with caution and respect.

Diquat

Diquat is a new product being developed by California Chemical Company, Ortho Division, for application to water for control of floating and submersed nuisance weeds. It is a quaternary dipyridyl compound and is formulated to have 2 pounds of active ingredient per gallon.

Diquat is absorbed rapidly by leaves or roots and is distributed through the plant system. Diquat toxicity is triggered by sunlight which controls plant photosynthesis, that is, it will kill faster on a sunny day than on a cloudy day. Diquat may be applied to plants either as a foliage spray or as a concentrate poured into water.

Diquat is relatively nonselective, nonvolatile, has a low toxicity to fish at rates prescribed, and is about as toxic to man as 2,4-D. Treated waters are not to be used for human or animal consumption nor for irrigation for 10 days following treatment.

Diquat should not be applied if infested water is muddy because diquat is deactivated by contact with soil and also by contact with clay particles suspended in water.

Acrolein

Acrolein is a general cell toxicant used for aquatic weed control. Although it is highly flammable, highly reactive chemically, with an odor like tear gas, submersed weeds can be effectively controlled with acrolein. Application equipment which eliminates handling of the chemical reduces discomfort to operators and makes application safer. Acrolein is present at 85% concentration in the product Aqualin, marketed by Shell Chemical Corporation.

Acrolein is a fast-acting plant killer. Plants cease to generate oxygen minutes after acrolein is introduced into warm water (80°F). Cell breakdown and plant collapse follows in a few hours. In cool water, toxic effects may not be evident for 1 or more days.

Acrolein is effective against a wide range of weeds, but the compound must be injected as a solution under water for use against all types of weeds whether floating or submersed. Acrolein has been highly successful against weeds in canals and irrigation ditches in western United States. The chemical is usually applied from a stationary platform or boom in a canal. Rates are judged on volume and velocity of water passing the application point.

Depending upon temperature, water velocity, or species and density of weeds, acrolein is applied at various rates over a period of time from spray nozzles under water. The herbicide is "used up" as the blanket of treated water moves downstream, because of absorption of the chemical by the weed tissue and vapor loss. Therefore, in long canals it may be necessary to "reinforce the wave" at points downstream from the original application. Under certain conditions operators may expect effectiveness of acrolein up to 15 miles from application point, depending upon the species and density of the weeds.

Fish may be killed by acrolein at rates from 1 to 5 ppmv, depending upon the species. Fish will swim away from an acrolein blanket, and band or partial treatments of lakes with acrolein have been successful. Fish are given more of a chance when alternate swaths are treated after a 48-hour wait.

The quick kill and rapid detoxification or degradation of acrolein is an advantage when this chemical is used for complete lake renovation. At high rates, all fish will be killed and the lake can be restocked in a matter of days.

Aromatic Solvents

Some oil companies produce solvents such as naphtha, xylene, and benzene products suitable for control of submersed weeds in ditches and canals. These are chemicals with properties similar to paint thinners and drycleaning solvents. With emulsifiers added, these chemicals make relatively inexpensive aquatic herbicides.

Aromatic products are toxic, in low concentrations, to plant and animal life in streams. These products are also flammable and must be applied with care. Equipment for application is relatively simple: tank, pump, and nozzle boom. Many times it is advised that carbon dioxide be used instead of a pump to reduce fire hazard. If gravity feed can be used to introduce solvents, equipment is simplified even more.

Rates of use with aromatics are high compared with previously discussed herbicides. Weed kill is based on the velocity of water and the time that the blanket of treated water is exposed to the plants.

Endothall

Endothall is a contact herbicide and is the basic ingredient for three aquatic weed control products sold by the Pennsalt Chemicals Corporation.

Disodium endothall is the active ingredient of the product Aquathol. This fast-acting chemical (kills weeds in 3 to 7 days) can be used as a spray, granular, or injected liquid. It is effective against many common weeds found in lakes and ponds. Recommended rate of endothall for treatment of an entire area is 1 to 3 ppmw. Partial treatments where extra dilution must be considered require 2 to 5 ppmw. Endothall leaves a considerable margin of safety for fish; toxicity of endothall to fish is between 100 and 200 ppmw, depending upon species, age, water temperature, etc. Fish from treated areas may be eaten three days after treatment. Lakes or ponds may be used for swimming 24 hours after treatment.

Another inorganic salt, dipotassium endothall is combined with the potassium salt of silvex to produce the herbicide Aquathol Plus, which controls some additional weeds not controlled with endothall alone, such as elodea, cabomba, and waterhyacinth.

Action of Aquathol Plus is both

Changing Your Address?

If so, notify our circulation department right away to be certain the magazine reaches you at your new location. The Post Office won't forward your copies. So when you write us, make it at least three weeks in advance of your moving date, and include your old address, as well as the new one. We'll see you don't miss a single issue. Send this old and new address information to:

Circulation Department
Room 303
1900 Euclid Avenue
Cleveland, Ohio 44115