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AQUATIC PLANT CONTROL WITH 2,4-D

By Eugene W. Surber
Aquatic Biologist, Division of Fishery Biology

INTRODUCTION

During the war, a number of new compounds called "hormones" or plant growth-regulators have been developed, particularly in the laboratories of the Chemical Corps, United States Army, at Camp Detrick, Maryland. Several hundreds of new compounds were synthesized and their effect on plants tested. Results of many tests made at Camp Detrick are reported chiefly in Botanical Gazette, Vol. 107, June 1946. Some of these plant growth-regulators have been tested as herbicides on obnoxious aquatic plants at the Fisheries Experimental Station, Leetown, West Virginia, during the 1946 season, with the advice and collaboration of the Chemical Corps.

It has been found possible to control such highly obnoxious emergent plants about hatcheries as the cattail, spike rush, round stem bulrush, bur reed, willow, and such submerged weeds as Potamogeton crispus, nodosus, foliosus, filiformis, and Anacharis canadensis, with these compounds. The results with the water lily are not yet clear. It seems certain, at present, that more than a single treatment will be required effectively to control it.

In treatment of emergent plants, aqueous sprays have been found to be less effective than oil sprays. In the preparation of oil sprays, tributyl phosphate is employed as a cosolvent in order to introduce 2,4-D into the oil. Any low-viscosity oil that is light enough to be sprayed can be employed, but care must be exercised in the use of such oil sprays because of the high toxicity of tributylphosphate to fish. Concentrations of this compound in excess of 15 p.p.m. were toxic to bluegill sunfish. Action frequently is very rapid. Esters of 2,4-D that are directly miscible with oil can be employed, but these are not so readily available as 2,4-D itself. Since 2,4-D, according to our present knowledge, is most valuable for the treatment of emergent aquatic plants, treatment of these will be dealt with in some detail.

Cattail (Typha latifolia)

The cattail is probably the most common obnoxious emergent aquatic plant about pond stations. Ditches invariably become clogged with it and once this weed becomes established in a pond it quickly reduces the area of the pond capable of producing fish.

When only a few plants are present in a pond they may easily be pulled up by hand. This plant has an underground stem or rhizome from which new shoots arise at the joints (nodes). These rhizomes are rather brittle and often break off when efforts are made to pull them up by hand. The broken-off sections are capable of producing new shoots so that even though one superficially removes all plants, new shoots almost invariably arise the next season.

At the Moorefield Substation, West Virginia, it is estimated that cattails in two of the four ponds have reduced the productive pond surface area by 25 to 30 percent per pond within a period of three years.

Controlled cutting of the cattails has been practiced particularly in Europe for many years, but this method is laborious, especially where the cattails have become well-established.

In the experiments at Leetown and Moorefield, 2,4-D with tributylphosphate as a cosolvent and kerosene as carrier proved the most effective treatment.

This spray material can be applied very effectively with a knapsack sprayer which will deliver a fine spray at about 40 pounds pressure per square inch. An important advantage of this spray solution is the glistening oil-soaked appearance it imparts to treated plants, which enables the operator to see exactly where he has sprayed. This oil-soaked appearance is caused by rapid penetration of the carrier. Within two days after treatment, plants become bleached and sprayed portions of plants appear to be dead. About 20 gallons of the spray per acre are required where cattails have already become well established.

At the Moorefield substation, one-tenth of an acre of cattails was sprayed within a fifteen-minute period with a knapsack sprayer and a five percent 2,4-D solution in kerosene and tributylphosphate as described below.

Another effective formula for treatment of cattails used at the Moorefield substation during the 1946 season was a 7.5 percent solution of 2,4-D in trienthanolamine, the latter being miscible in water. In large scale applications of this formula, as well as all other aqueous solutions, one has difficulty in determining just where one has sprayed

in passing through a dense growth of weeds. The aqueous solutions do not glisten upon the leaves of the cattails as do the oil sprays.

This disadvantage can be overcome in part by adding a water-soluble dye to the aqueous solution. Suitable dyes are anthraquinone blue and ceresine and should be used at a concentration of approximately one percent. 1/

Failure to cover the cattails adequately during the first spraying necessitates further spraying and subsequent loss of time. The wetting of cattails followed by immediate dusting with 2,4-D powder containing 50 percent 2,4-dichlorophenoxyacetic acid proved ineffective.

Spike Rush (Eleocharis sp.)

This plant of which there are a large variety of species forms a lush green mat on the bottom of ponds where it seldom exceeds a height of more than six inches. In the ponds at Leetown it usually begins its growth in the fall after the ponds have been drained. It thrives best in ponds which do not become thoroughly dried out. Efforts to control it by spraying with sodium arsenite and copper sulfate when the plants were submerged had proven ineffective.

It is very difficult to remove fish from a pond which has a growth of this type of weed on the bottom. It cannot be raked, and the growth is not tall enough to cut. Small fish such as bluegill sunfish and bass find excellent shelter in it and refuse to leave it when the water reaches a low stage.

At the New Jersey State Fish Hatchery at Hackettstown, this plant is removed manually with the aid of a fire hose and high pressure nozzle.

At the Tresselt Fisheries, Thurmont, Maryland, where it became established in some ponds, the only effective way of eliminating it was by plowing the turf under. Efforts there to control it by heavy fertilization proved a failure.

In experiments at Leetown this weed has proven quite sensitive to the 2,4-D formulae used.

Round Stem Bulrush (Scirpus validus)

The round stem or soft stem bulrush is another common nuisance plant at hatcheries. It becomes much more solidly rooted in a pond bottom than

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1/ These dyes are obtainable from E. I. DuPont Company, Wilmington 99, Delaware.

the cattails. The underground stems are thickly matted and almost impossible to pull by hand.

Fifteen percent 2,4-D in triethanolamine and water proved very effective in killing this weed which apparently is about as sensitive to 2,4-D as is the spike rush.

Although the tributylphosphate-kerosene formula was not tried on this species, it is felt certain that, as in the case of cattails, one can tell better in spraying just where one has sprayed if the oil carrier is used.

Bur Reed (Sparganium americanum)

The bur reed is a common plant in ditches where water flows continuously. It will establish itself about the borders of small lakes and large ponds which have a fairly constant water level. Although it is common about the station grounds at Leetown it has not become established in any pond which is drained annually.

Fifteen percent 2,4-D in triethanolamine and water was very effective in controlling it. The tributylphosphate-kerosene formula probably would be even more effective. In an experiment where the plants were wetted first and dusted immediately afterwards with 2,4-D powder containing 50 percent 2,4-D, the plants were not seriously affected.

Willow (Salix sp.)

The willow is notorious for its destructiveness to pipe lines. In spite of efforts to control it by removal of the entire tree or shrub with power equipment at Leetown it has persisted and obtained a foothold in numerous ponds at the station. The spraying of the trees or shrubs with 2,4-D in tributylphosphate and kerosene will provide a quick and easy means of getting rid of them. One spraying in which the leaves and branches are well wetted will kill.

Submerged Plants

Water Lily

The experiments on the water lily (Nuphar advena and Nymphaea sp.) are still in progress. Spraying of the leaves on the surface of filled ponds with 2,4-D in tributylphosphate and in triethanolamine has proven ineffective. The addition of these sprays to surface leaves caused them to curl. The petioles became spirally twisted or otherwise contorted, but only a few were killed by the surface spray.

Ammonium sulphamate at the 10 pound per acre level also proved ineffective in ponds at normal stages, although it did kill a few leaves.

In the most recent experiment at Leetown, the leaves and petioles were sprayed with 2,4-D in tributylphosphate and kerosene after water was drained from the pond, with the result that the leaves and petioles were destroyed. But, new sprouts with highly-curled leaves and convoluted petioles have developed from the root stalk. At the present time the effect on the water lily is uncertain, but it seems certain that a single spraying will not destroy it. Apparently a series of sprayings will be necessary at times when the pond levels are low enough to expose both surfaces of the leaves as well as the petiole.

The use of 2,4-D and related compounds in the treatment of submerged vegetation requires additional study. Treatments as low as 5 p.p.m. have been effective in aquarium experiments. However, the cost at this level is prohibitive when compared with sodium arsenite.

Preparation of Spray Solutions

A five percent solution of 2,4-D has been found to be very satisfactory for most plants, but higher concentrations may be necessary on the more resistant species. Although both tributylphosphate and triethanolamine may be used as solvents in the preparation of spray materials for emergent plants, tributylphosphate should not be used for control of submerged aquatic plants in waters containing fish.

Triethanolamine is not toxic to fish and may be used as a cosolvent in sprays for submerged plants. Cattails, bur reeds, and other emergent plants can be sprayed, even though they stand in water, with a tributylphosphate-kerosene solution without getting a great deal of the spray solution into the water.

Solutions may be prepared as indicated in the table below:

Composition of spray solutions

Solution Number	2,4-D		Cosolvent		Carrier to make five gallons
	Percent	Weight	Name	Volume	
		Pounds		Quarts	
1	5	2	TBP*	2	Kerosene
2	5	2	TEA**	2	Water

* TBP represents Tributylphosphate.
** TEA represents Triethanolamine.

The 2,4-D should first be dissolved in the cosolvent and then diluted with the carrier and thoroughly mixed prior to use. 2,4-D is soluble in water to the extent of about three percent if small quantities of ammonia (ammonium hydroxide) or washing soda (sodium carbonate) are used to aid solution. 2,4-D may be obtained from most chemical supply houses such as J. T. Baker Chemical Company, Phillipsburg, New Jersey; Dow Chemical Company, Midland, Michigan; E. I. DuPont Company, Wilmington, Delware; Sherwin-Williams, Chicago, Illinois; and sells at approximately one dollar per pound. The ammonium or sodium salts generally are slightly higher but may be dissolved directly in water to produce a three percent solution. Tributylphosphate may be obtained from Commercial Solvents Corporation, Terre Haute, Indiana, or the Barrett Division, Allied Chemicals, 40 Rector Street, New York City. The cost of the latter is about $0.50 per pound in bulk or approximately half that of 2,4-D.

Triethanolamine may be obtained from Carbon and Carbide Chemicals, 30 East 42nd Street, New York City; the Mallinckrodt Chemical Works, St. Louis 7, Missouri; Sharples Chemicals, Incorporated, Philadelphia; and Amend Drug and Chemical Company, 117 East 24th Street, New York City. The current price in small lots is $1.50 per quart or $4.75 per gallon.

The sprays may be applied with garden or orchard spray equipment, but such equipment must be thoroughly cleansed prior to use on desirable vegetation. If oil sprays are used the equipment should be rinsed with kerosene; if aqueous sprays are used a diluted solution of washing sode is an effective rinse.