(8) Aquathol Plus Granules (3.6% Endothol acid plus 5.0% Silvex acid)
(9) Aqua Kleen 2, 4-D Granules (2, 4-dichlorophenoxyaretic acid, Butoxy Ethanol Ester)
(10) Diquat (1:1-ethylene-2:2'-dipyridylium dibromide)
(11) Karmex (Diuron(3-(3,4-dichlorophenyl)-1, 1 dimethylurea)
(12) Lorox (Linuron(3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea)

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DIURON AS AN AQUATIC HERBICIDE

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INTRODUCTION

Pondowners and fish culturists are continually searching for a herbicide that will kill aquatic weeds at a reasonable price. Field trials using diuron were conducted on farms of cooperators with Soil and Water Conservation Districts in Arkansas. Results indicate that powdered 3-(3,4-dichlorophenoxy)-1, 1-dimethyl urea (diuron)[1] is an effective aquatic herbicide. Results are reported in this paper.

The wettable powder form of the commercial product contains 80 per cent diuron. It has been marketed in huge amounts in Arkansas as a premerge for selective control of weeds in cotton fields. The U. S. Department of Agriculture has registered diuron for use in cotton. The Department has not, however, registered diuron for use as an aquatic herbicide.

Siles (1964) reported on results obtained from applications of diuron to control filamentous algae. His data showed that diuron was effective against several forms of filamentous algae at rates above one-half pound per surface acre.

METHODS

Rate of Application. Diuron was used at the rate of one pound per surface acre, and one-half pound per surface acre. One application was made at the rate of one pound of diuron for 35 surface acres.

Method of Application. The chemical was applied as a dry powder and as a spray. The powder was allowed to drift over the water surface with the wind spreading it. Spray material was also applied. Applications were made by walking along the edge of the water or broadcasting from a boat. Broadcasting of the dry powder was the most practical when the plants were in the water. Spraying was more practical when the plants were on moist or dry land.

[1] Marketed by E. I. du Pont Co. under the trademark "Karmex."

RESULTS

Table 1 gives results of treatments using diuron in Arkansas during 1964-1965.

No fish kills were noted that could be attributed to diuron. One fish kill did occur, however, but it was attributed to an oxygen deficiency approximately two weeks after application of the herbicide.

In one trial involving liquid diuron numerous channel catfish were killed. Further trials using this formulation were cancelled.

Aquatic plants having food storage root systems, such as waterlily and watershield, showed regrowth several weeks after application of the herbicide. This regrowth died in about one week. Good results on cattail were obtained in two cases and poor results in another. Further trials are needed on cattail. *Chara* was blackened by the herbicide but in two or three weeks regrowth occurred and persisted. It was concluded from these observations that powdered diuron is not an effective herbicide for killing Chara.

Aquatic plants that are apparently not adversely affected by diuron are common ducksmeat, *Spriodela polyrhiza* are common lizardtail, *Saururus cernuus*. There are undoubtedly others.

It was noted that after diuron had been applied to fertile water the phytoplankton bloom was reduced. Several fish farmers have used diuron to reduce build-up of phytoplankton at the rate of one-fourth to one-half pound per surface acre. The chance of an oxygen deficiency is reduced by this procedure. Further trials are necessary to establish the exact rate of application that is needed.

These field trials in Arkansas were carried out in water that was mildly acid to alkaline with a range in pH from 6.0 to 8.2 and a range in methyl orange alkalinity from 21 ppm to 190 ppm. Anyone who has worked with copper sulphate knows that it works best in alkaline waters. Perhaps the same is true with diuron. Dr. John M. Lawrence, of the Auburn Agriclutural Experiment Station, informs me by personal communication that the Station's experiments with diuron indicate it is not effective in controlling waterweeds in most Alabama ponds at rates of one or two pounds per acre. I know of no one who has tried buffering acid water with hydrated lime and then applying diuron. It would be worth a try.

DISCUSSION AND SUMMARY

Diuron has proved both effective and economical. Cost of application has averaged $3.00 per surface acre. Use of diuron at rates of one-half to one pound per surface acre has given good results on bladderwort, naias, *Potamogeton*, watershield, white waterlily, parrotfeather, spikerush, and pickerelweed. Results on cattail were varied, indicating need of further field trials. It was not effective against muskgrass, duckweed, and lizardtail.

Follow-up investigations showed that where the shoreline is deepened and a good fertilization program followed one treatment of diuron was sufficient. The Lakeview pond was treated with diuron on May 14, 1965 and fertilized only one time thereafter. A check on September 20, 1965 showed that naias and *Pithophora* were again beginning to infest the pond.

Caution would need to be used in the application of diuron. Crops should not be irrigated where diuron has been used the season of application. Adjacent crops could also be adversely affected. Du Pont reports, in a personal communication, that valuable trees were killed after diuron was applied nearby. So far in Arkansas, trees growing on levees were not affected by the amounts applied in these trials.

This paper reports results of field trials. Diuron has not been registered by the U. S. Department of Agriculture for use as an aquatic herbicide at this time. Application of this chemical should not be tried on other than a field trial basis until it is registered by the Department.

Results were best when treatment was applied when plants were

Table 1. Results of Field Trials Using Diuron for Control of Aquatic Weeds.

Pond	Species Treated	Date Treated	Rate of Application	pH	Methyl Orange Alkalinity	Percent Kill in Two Weeks
Robert Winters	Cattail, *Typha latifolia*	April 10, 1964	1 pound per surface ac.	7.8	125 ppm	100% in water
	Bladderwort, *Utricularia* spp.					100%
	Muskgrass, *Chara* spp.					80%
	Naias, *Najas flexilis*					100%
	Waterweed, *Potamogeton pectinatus*					100%
	Watershield, *Brasenia schreberi*					100%
	Waterlily, *Nyphaea oderata*					100%
	Duckweed, *Spirodela polyrhiza*					None
J. F. Jacobs	**Parrotfeather, *Myriophyllum*** spp.	June 1, 1965	1 pound per surface ac.	6.8	21 ppm	100% in water
	Cattail, *Typha latifolia*					100% in water
	Spikerush, *Eleocharis obtusa*					100%
	Lizardtail, *Saururus cernuus*					None
Bill Dodgens	Watershield, *Brasenia schreberi*	June 5, 1965	1 pound per surface ac.	7.1	43 ppm	100%
	Spikerush, *Eleocharis obtusa*					100%
Garland Hicks	Watershield, *Brasenia schreberi*	June 10, 1965	1 pound per surface ac.	6.0	31 ppm	100%
	Waterweed, *Potamogeton pectinatus*					100%
V. H. Williams	Pickerelweed, *Pontedaria lanceolata*	April 20, 1964	1 pound per surface ac.	7.7	92 ppm	20%
		July 30, 1964				80%
		April 15, 1965				100%
J. H. Royston	Naias, *Najas flexilis*	May 28, 1965	½ pound per surface ac.	8.2	190 ppm	100%
	Muskgrass, *Chara* spp.					65%
Edgar Farmer	Branched filamentous algae, *Pithophora* spp.	Aug. 28, 1964	1 pound per surface ac.			100%
	Waterweed, *Potamogeton pectinatus*	April 13, 1965	1 pound per 35 surface acres			95%
	Muskgrass, *Chara* spp.					10%
Troy Wood	Naias, *Najas flexilis*	June 29, 1965	1 pound per surface ac.	6.9	40 ppm	100%
Shelby Floyd	Naias, *Najas flexilis*	June 30, 1965	1 pound per surface ac.	7.0	44 ppm	100%
	Duckweed, *Spirodela polyrhiza*					10%
Lindel McCollough	Cattail, *Typha latifolia*	July 2, 1965	1 pound per surface ac.	6.9	38 ppm	15%
Lakeview	Naias, *Najas flexilis*	May 14, 1965	1 pound per surface ac.	7.7	105 ppm	99%
	Pithophora					

actively growing—in May, June, and July. Apparently diuron remains toxic to aquatic plants for more than three weeks after application.

No fish kills attributed to diuron were noted. Concentrations used in the field trials were well below the mortality levels to fish reported by Siles (1964). Users of aquatic herbicides must always be on guard against oxygen depletions caused by decaying organic materials. Where heavy concentration of weeds occur in a pond only part of the pond should be treated to prevent oxygen depletion.

Under no circumstances should water that has been treated with diuron be used for irrigation during the season of application. Rice was successfully grown on a field that was treated with diuron to control aquatic weeds the previous year.

Diuron is in the category of compounds with very low toxicity to warm blooded animals. We have used diuron where livestock had access to the pond and have not heard of any complications.

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OBSERVATIONS ON CONTROL OF VEGETATION IN LAKE CATHERINE USING ISRAELI CARP AND A FALL AND WINTER DRAWDOWN[1]

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1965

ABSTRACT

Due to a combination of factors, Lake Catherine, a 3,000-acre reservoir which had never known a vegetation problem, suddenly became congested with rooted aquatic vegetation in 1960. The vegetation, mostly coontail, *Ceratophyllum demersum*, and *Elodea* sp., could be controlled with chemicals and consequently various chemicals were used by the riparian property owners on small localized areas. However, for the larger, main body of the lake, chemical herbicides were considered too expensive to be practical.

In October 1960 the Arkansas Game and Fish Commission was petitioned both by the sportsmen in the area, the riparian property owners, and the Arkansas Power and Light Company (owners of the dam and reservoir), to advance a plan for the control of the vegetation.

The formulation and the carrying out of that plan is discussed, with emphasis on the combination of two biological methods of control.

DESCRIPTION AND HISTORY OF LAKE CATHERINE

Lake Catherine is the oldest of three lakes located in series on the Ouachita River near Malvern and Hot Springs, Arkansas (Plate 1). The dam was completed in 1923 by the Arkansas Power and Light Company, and the 3,000-acre reservoir filled the same year. The reservoir was impounded for hydroelectric power and recreational purposes. The installed hydroelectric capacity is approximately 10,000 kilowatts.

Lake Catherine is not as well developed commercially as is Lake

[1] Paper presented at the 19th Annual Meeting of the Southeastern Association of Game and Fish Commissioners, Tulsa, Oklahoma. 1965.