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EXPERIMENTAL USE OF SILVEX AND OTHER AQUATIC HERBICIDES IN GEORGIA FARM PONDS[1]

By W. W. THOMASTON, PHILLIP C. PIERCE and HERBERT N. WYATT

ABSTRACT

The results of two years experimental weed control in Georgia Farm Ponds using silvex,[2] propylene glycol butyl ether ester, dalapon, sodium salt of 2,2-dichloropropionic acid; 2, 4-D granules of iso-octyl ester of 2, 4-dichlorophenoxy acetic acid. Residual control and overall effectiveness is evaluated over a two-year period on acquatic weeds in approximately 100 ponds. Preliminary screening of Inverton, an invert emulsion of 2, 4, 5-trichlorophenoxy acetic acid; Garlon, a solution of dalapon and silvex; and simazine, 2-chloro-4, 6 bis-(ethylamino)-S-trizaine are presented.

Different concentrations were used and observations made during 1958 and 1959. Results are presented for different herbicides and evaluation made for their effectiveness on specific aquatic weeds.

Silvex appears to have the widest range of control for underwater and emergent aquatic weeds. Preliminary results indicate this chemical is as effective as sodium arsenite in many situations. Dalapon has given some degree of control for grasses and satisfactory control for cattails. Granular 2, 4-D has given satisfactory control for water lilies and parrots feather (*Myriophyllum brasiliense*). Garlon and Inverton look promising for the control of some aquatic weeds. Simazine has not been generally effective for control or eradication of higher aquatic plants in the concentrations listed.

INTRODUCTION

One of the major problems in Georgia Farm Pond Management is aquatic weeds. Their detriment to fish production has long been recognized by fishery

1 This work was undertaken with Federal Aid to Fish Restoration funds under Dingell-Johnson Project F-6-R-5, "Evaluation of Pond Management Practices".

2 Common name for 2(2, 4-5 trichlorphenoxy) propionic acid.

workers. An intensive research program has been initiated in Georgia to find methods of prevention, control, and eradication. The most effective means of prevention is proper pond construction and a good fertilization program. This is not always effective for some weeds such as *Lemna sp.* Proper fertilization will eradicate underwater weeds in some situations. Mechanical weed control would be effective but is laborious and time consuming. The use of chemicals has proven to be the most effective method up to date to cope with aquatic weed problems.

Herbicides used in farm ponds must meet several requirements other than satisfactory herbicidal properties. These chemicals must not interfere with the normal use of the pond over a prolonged period. This includes fishing, swimming, irrigation, and the watering of livestock. It is desirable to obtain a complete kill because growth in Georgia ponds is rapid and reinfestation would occur. The cost should be reasonable, the herbicide available locally, application technique simple, and preferably non-toxic to aquatic organisms and livestock. Few, if any, chemicals meet these exact requirements. Some of the newer herbicides such as silvex, dalapon, and granular 2, 4-D approach some of these specifications. However, the continued use of sodium arsenite is necessary in Georgia for certain species of weeds such as *Elodea canadensis.* The toxicity of sodium arsenite to bottom organisms, livestock, and dangers in prolonged handling of this material has been instrumental in current research for new herbicides.

METHODS

All experiments were carried out in typical Georgia Farm Ponds. The experiments carried out during 1958 were rechecked during the spring and early summer of 1959 for regrowth.

Spraying was the most common method of application and was used for all experiments in this report unless otherwise indicated. A John Bean piston-type pump was used from a boat in most of the chemical applications. Spraying pressure up to 300 pounds per square inch with nozzle disc between 4 to 8 were used, depending on coverage and type of application required. Complete and thorough coverage usually required 60-70 gallons of spray per acre on all weeds except marginal varieties and cattails, which require 100 gallons per acre. The spray carrier was water unless otherwise indicated. The solution was concentrated on the weed beds for underwater weeds when parts per million concentration was used. When a definite concentration of p.p.m., based on acid equivalent was used, the chemicals were mixed with enough water to insure adequate distribution. The gravity flow method when used, consisted of drum mounted on a rack in the boat. A hose was attached to the shear gate valve in the drum and extended into the water. The flow was concentrated on the weed beds and a sufficient number of trips were made over the area to get uniform distribution. Granular herbicides were usually broadcast by hand. A cyclone seeder was tried but a satisfactory technique was not worked out.

Silvex has been used as an aquatic herbicide in Georgia Farm Ponds in approximately 60 situations. When any degree of control was achieved the herbicidal effects were apparent within 2 to 3 days but it often took as long as four weeks for the kill to be complete and the weeds to decay. A slow kill is desirable because there is less chance of a fish kill due to an oxygen depletion as the results of weed decomposition. No detrimental effects on fish production have been noted after using silvex. Several pond owners have expressed opinions that fish had an unpalatable taste for a period after using silvex in the fish ponds. Table I lists experimental results with silvex during 1958 and 1959.

TABLE I

THE RESULTS OF WEED CONTROL ACTIVITIES IN GEORGIA FARM PONDS USING *SILVEX* AS AN AQUATIC HERBICIDE

Date of Application	*Concentration or Mixture*	*Lbs. Acid Per Acre or p.p.m.§*	*Weed Treated*	*Estimated % Kill Year of Application*	*Est. % Regrowth 1959*
4- 2-58	1-10*	1.0 p.p.m.	*Myriophyllum brasiliense*	100	0
5-15-58	1-10	0.25 p.p.m.	*Myriophyllum brasiliense*	100	0
5-23-58	1-80	3.0 lbs.	*Myriophyllum brasiliense*	100	0
4- 7-59	1-160	1.5 lbs.	*Myriophyllum brasiliense*	100	–
4-29-59	1-160	1.5 lbs.	*Myriophyllum brasiliense*	100	–
5- 6-59	1-160	1.5 lbs.	*Myriophyllum brasiliense*	100	–
4-29-58	1-20	1.0 p.p.m.	*Myriophyllum heterophyllum*	100	0
4-29-58	1-20	0.5 p.p.m.	*Myriophyllum heterophyllum*	100	0
6-19-58	1-10	2.0 p.p.m.	*Myriophyllum heterophyllum*	100	0
6-20-58	1-10	2.0 p.p.m.	*Myriophyllum heterophyllum*	100	0
			Brasenia schreberi	100	0
			Juncus repens	100	0
			Najas sp.	100	0
4- 9-59	1-10	0.25 p.p.m.	*Myriophyllum heterophyllum*	100	–
5-21-59	1-10	1.0 p.p.m.	*Myriophyllum heterophyllum*	100	–
			Utricularia sp.	50	–
			Juncus repens	100	–
7-16-59	1-10	0.2 p.p.m.	*Myriophyllum heterophyllum*	99	–
			Nympheae sp.	100	–
			Juncus repens	75	–
4-21-58	1-20	0.5 p.p.m.	*Lemna sp.*	0	–
6-11-59	1-80	0.3 p.p.m.	*Lemna sp.*	0	–
5-28-59	1-10	2.0 p.p.m.†	*Lemna sp.*	0	–
5-29-58	1-10	2.0 p.p.m.†	*Elodea canadensis*	0	–
4-29-58	1-20	6.0 lbs.	*Nympheae sp.*	100	0
5-13-58	1-20	6.0 lbs.	*Nympheae sp.* *Nuphar sp.*	100	0
5-13-58	1-80	3.0 lbs.	*Nympheae sp.*	100	–
			Nuphar sp.	75	50
6-11-58	1-80	3.0 lbs.	*Nyhpheae sp.*	90	25
8-14-58	1-80	2.0 lbs.	*Nympheae sp.* *Nuphar sp.*	100	0
4-16-59	1-160	1.5 lbs.	*Nympheae sp.*	100	–
			Brasenia schreberi	75	–
4-23-59	1-160	1.5 lbs.	*Nympheae sp.*	100	–
			Nuphar sp.	50	–
5-20-59	1-160‡	1.5 lbs.	*Nuphar sp.*	100	–
5-16-59	1-160	1.5 lbs.	*Brasenia schreberi*	100	–
5-23-59	1-160	1.5 lbs.	*Nuphar sp.*	80	–
6-16-59	1-80	3.0 lbs.	*Nelumbo sp.*	100	–
7-17-59	1-160	1.5 lbs.	*Nympheae sp.*	90	50
7-27-59	1-160	1.5 lbs.	*Nympheae sp.*	90	75
4-29-59	1-80	3.0 lbs.	*Brasenia schreberi*	100	–
5- 6-59	1-80	3.0 lbs.	*Eichornia crassipes*	100	–

TABLE I—*Continued*

THE RESULTS OF WEED CONTROL ACTIVITIES IN GEORGIA FARM PONDS USING *SILVEX* AS AN AQUATIC HERBICIDE

Date of Application	*Concentration or Mixture*	*Lbs. Acid Per Acre or p.p.m.*§	*Weed Treated*	*Estimated % Kill Year of Application*	*Est. % Regrowth 1959*
5- 6-59	1-120	2.0 lbs.	*Eichornia crassipes*	90	–
5- 6-59	1-160	1.5 lbs.	*Eichornia crassipes*	80	–
5-23-58	1-5†	2.0 p.p.m.	*Utricularia sp.*	10	–
			Eleocharis acicularis	10	–
6-22-59	1-10‡	1.0 p.p.m.	*Utricularia sp.*	100	0
			Eleocharis acicularis	100	0
6-24-59	1-5	1.0 p.p.m.	*Utricularia sp.*	99	–
3-30-59	1-5	2.0 p.p.m.	*Eleocharis acicularis*	100	–
4- 6-59	1-10	0.25 p.p.m.	*Eleocharis acicularis*	100	–
5-28-59	1-5†	2.0 p.p.m.	*Eleocharis acicularis*	100	–
6-23-59	1-10	0.5 p.p.m.	*Eleocharis acicularis*	100	–
7-22-59	1-10	3.0 p.p.m.	*Eleocharis acicularis*	100	–
4-24-58	1-20	12 lbs.	*Juncus effusus*	100	0
6-24-58	1-80	3 lbs.	*Juncus effusus*	100	–
5-22-58	1-20	12 lbs.	*Glyceria sp.*	0	100
7- 7-58	1-80	3 lbs.	*Hydrochloa caroliniensis*	0	100

* 1-10 is 1 gallon herbicide mixed with 10 gallons water as a carrier.

† Gravity flow.

‡ Repeat application and refers to preceding application.

§ Experimental plot treatment only; p.p.m. refers to total treatment and pounds refer to acid equivalent.

The results of two years experimentation on control of aquatic weeds in farm ponds using silvex indicate that this herbicide has a far wider range of satisfactory control than any other herbicide used in Georgia. If silvex at a low enough concentration to be economically feasible will prove effective for control of *Najas sp., Potamogeton sp., Myriophyllum heterophyllum, Utricularia sp.*, and few other submerged species, it will virtually replace sodium arsenite as a herbicide in Georgia. Indications are favorable that this will be accomplished. Silvex has given no indication of control for *Lemna sp.*, or *Elodea canadensis, Glyceria sp., Hydrochloa caroliniensis, Leersia sp.*, or *Paspalum sp.* Evidently silvex will control or eradicate all weeds that 2, 4-D will control plus others such as *Juncus effusus*. This is a very promising herbicide and further research is warranted using this and other hormonal type herbicides such as 2, 4-D and 2, 4, 5-T for comparative results.

Dalapon has been used primarily to control marginal grasses and cattails. It has not been used on broadleaf or submerged weeds in Georgia. Good results have been achieved and this chemical is recommended for marginal grasses and cattails. Dalapon contains 85% active ingredient and in this report the pounds of material used refers to the total dalapon used and not the active ingredients.

TABLE II

RESULTS OF WEED CONTROL ACTIVITIES IN GEORGIA FARM PONDS USING *DALAPON* AND DALAPON MIXTURES AS AQUATIC HERBICIDES

Date of Application	*Concentration or Mixture*	*Lbs. Dalapon Per Acre*	*Weed Treated*	*Estimated % Kill Year of Applicatilon*	*Est. % Regrowth 1959*
6- 2-58	1-10*	10 lbs.	*Glyceria sp.*	75	100
7-21-58	1-10	10 lbs.	*Glyceria sp.*	100	100
5-15-59	1-5†	20 lbs.	*Glyceria sp.*	95	–
6-22-59	5 lbs. dalapon 5 pts. silvex 25 gals. water	20 lbs. 10 lbs.	*Glyceria sp.*	50	–

TABLE II—*Continued*

RESULTS OF WEED CONTROL ACTIVITIES IN GEORGIA FARM PONDS USING *DALAPON* AND DALAPON MIXTURES AS AQUATIC HERBICIDES

Date of Application	*Concentration or Mixture*	*Lbs. Dalapon Per Acre*	*Weed Treated*	*Estimated % Kill Year of Applicatilon*	*Est. % Regrowth 1959*
7-16-59	5 lbs. dalapon‡	20 lbs.			
	1 qt. invert 2,4,5-T	10 lbs.	*Glyceria sp.*	95	–
	5 gals. No. 2 fuel				
	25 gals. water				
6-18-58	1-10	10 lbs.	*Hydrochloa caroliniensis*	0	100
6-21-58	10-25†	20 lbs.	*Hydrochloa caroliniensis*	0	100
6-21-58	1-5†	40 lbs.	*Hydrochloa caroliniensis*	0	100
6-10-58	1-5	20 lbs.	*Typha latifolia*	100	5
6-20-58	1-7.5	15 lbs.	*Typha latifolia*	100	0
7-21-58	1-10	10 lbs.	*Typha latifolia*	90	–
			Leersia sp.	100	–
			Paspalum sp.	50	–
8-20-58	1-10‡	10 lbs.	*Typha latifolia*	100	5
			Leersia sp.	100	10
			Paspalum sp.	100	100
8-14-58	1-5	20 lbs.	*Typha latifolia*	100	5
10-29-58	2.5 lbs. dalapon	10 lbs.	*Typha*		
	1 pt. ester	20 lbs.	*latifolia*	100	10
	2, 4-D/2, 4, 5-T		*Leersia sp.*	100	5
	25 gals. water		*Alnus rugosa*	100	5
5-14-59	1-10	20 lbs.	*Typha latifolia*	100	–
5-18-59	1-20	10 lbs.	*Typha latifolia*	80	–
			Typha latifolia	100	–
5-26-59	1-7.5	15 lbs.	*Typha latifolia*	100	–
			Juncus effusus	100	–
			Eleocharis obtusa	100	–
5- 3-59	1 lb. dalapon	10 lbs.	*Typha latifolia*	90	–
	1 pt. silvex	5 lbs.	*Sagittaria sp.*	50	–
	10 gals. water		*Scirpus rubricosus*	90	–
7- 9-59	1 lb. dalapon‡	10 lbs.	*Typha latifolia*	100	–
		=			
	1 qt. silvex	10 lbs.	*Sagittaria sp.*	90	–
	10 gals. water		*Scirpus rubricosus*	100	–
7-10-59	1-7.5	15 lbs.	*Typha latifolia*	100	–
8-26-59	4 gals. silvex§	0.33 p.p.m.	*Chara sp.*	100	–
	16 lbs. dalapon	0.33 p.p.m.	*Najas sp.*	100	–
	25 gals. water				

* 1-10 is 1 pound dalapon mixed with 10 gallons water.

† Wetting agent such as Tide used in spray mixture.

‡ Repeat application and refers to preceding application.

§ Gravity flow.

From the results of these experiments indications are dalapon will successfully control or eradicate cattails sprayed at the rate of 1 lb. to 5 gal. of water or 20 lbs. per acre. Although 1 lb. to 10 gal. of water (10 lbs. per acre) has usually been satisfactory the results have not been consistant and repeat applications were sometimes necessary. Indications are 1 lb. to 7.5 gal. (15 lbs. per acre) will prove satisfactory. It is virtually impossible to prevent a small amount of regrowth on cattails, probably because of its root system. Cut grass has been controlled with 1 lb. to 10 gal. of water (10 lbs. per acre). Dalapon has given erratic results on *Glyceria sp.* and *Paspalum sp.* but is the best herbicide available for control in Georgia.

Granular 2, 4-D has also been used experimentally on a wide range of aquatic plants. Table III lists the completed experiments with pelletized material and observational results.

TABLE III

RESULTS OF WEED CONTROL ACTIVITIES USING *GRANULAR 2,4-D* IN GEORGIA FARM PONDS

Date of Application	*Pounds Per Acre*	*Pounds Acid Per Acre*	*Weed Treated*	*Estimated % Kill Year of Application*	*Est. % Regrowth 1959*
2-20-58	480 lbs.	96 lbs.	*Elodea canadensis*	0	100
3-11-58	430 lbs.	86 lbs.	*Elodea canadensis*	0	100
11-13-58	430 lbs.	86 lbs.	*Elodea canadensis*	0	100
4-23-59	860 lbs.	172 lbs.	*Elodea canadensis*	0	–
4-12-58	430 lbs.	86 lbs.	*Chara sp.*	0	100
6- 2-58	430 lbs.	86 lbs.	*Glyceria sp.*	0	100
8-25-58	430 lbs.	86 lbs.	*Hydrochloa caroliniensis*	0	100
12-17-58	800 lbs.	160 lbs.	*Eleocharis acicularis*	0	100
7- 9-58	430 lbs.	86 lbs.	*Myriophyllum heterophyllum*	100	0
4-22-58	600 lbs.	120 lbs.	*Myriophyllum brasiliense*	100	0
12- 4-58	100 lbs.	20 lbs.	*Myriophyllum brasiliense*	100	0
6- 9-58	430 lbs.	86 lbs.	*Utricularia sp.*	100	0
4-12-59	100 lbs.	20 lbs.	*Utricularia sp.*	75	–
7- 9-59	100 lbs.	20 lbs.	*Brasenia schreberi*	90	–
4- 7-59	100 lbs.	20 lbs.	*Brasenia schreberi*	90	90
4-13-59	100 lbs.	20 lbs.	*Nympheae sp.*	100	–
4-21-59	100 lbs.	20 lbs.	*Nympheae sp.*	100	–

From the data available it is difficult to draw any definite conclusions as to the effects or duration of granular 2, 4-D as a herbicide. However, indications are that granulated 2, 4-D will control *Nympheae sp., Myriophyllum brasiliense, Myriophyllum heterphyllum, Brasenia schreberi* and *Utricularia sp.* at the rate of 100 lbs. per acre (20 lbs. acid).

Inverton 2, 4, 5-T has successfully eradicated parrots feather with two applications. The first application was made at the recommended rate of 1 gal. Inverton, 15 gal. diesel fuel and 84 gal. water. This mixture killed too rapidly and regrowth appeared shortly thereafter. A lighter application, using one quart of Inverton and the same dilution mixture as the first application was made in the same pond and the kill was complete. *Nympheae sp.* was killed at the recommended rate of one gallon Inverton, 15 gallons fuel and 84 gallons water, on three occasions with the kill complete in less than a week. This herbicide appears to have definite possibilities when the desired mixture is worked out.

Simazine has not given any encouraging results as an aquatic herbicide in Georgia. Although *Nympheae sp.* was killed at rate of 50 lbs. per acre, no epinastic effects were noted. The chemical did not translocate and only killed the tops. Other treatments on *Leersia sp., Paspalum sp.,* and *Juncus sp.,* were unsuccessful and gave no encouraging results. Limited use of simazine has not proven it to be a satisfactory aquatic herbicide in Georgia.

Garlon designed as an overall herbicide containing 4 lbs. per gal. dalapon and ½ lb. per gal. silvex acid has given indications of control of several species of weeds, including underwater species such as *Myriophyllum heterophyllum,* and *Utricularia sp.* However, present results are inconclusive and this herbicide warrants further investigation and experimentation.

SUMMARY

Although the bulk of the data presented in this report is from preliminary experiments, the following results have been consistent:

1. Silvex will control *Myriophyllum brasiliense* at the rate of 3 pound acid per acre sprayed.
2. Silvex will control *Myriophyllum heterophyllum* at the rate of 0.5 p.p.m. and indications are lower amounts will be successful.
3. Silvex will control most water lilies at the rate of 3 pounds per acre if application is made early in the year.
4. No degree of control has been achieved using silvex on *Lemna sp.* at rates up to 2 p.p.m.
5. Silvex has eradicated *Eleocharis acicularis* at 0.25 p.p.m. This was in a small shallow pond with a high water temperature. Higher concentrations also have given satisfactory results. At rates of 3 p.p.m. fish were killed but it is not known if oxygen depletion due to weed decomposition or silvex caused the kill.
6. No indications of control has been achieved using silvex for control of grasses.
7. Silvex probably has a wider range of control than other hormonal type herbicides.
8. Dalapon will not consistently control *Glyceria sp., Hydrochloa caroliniensis,* and *Paspalum sp.* Although it is the best herbicide for these grasses, available results are inconsistent and apparently dependent on the degree of plant exposed to the chemical application.
9. Dalapon will successfully control cattails and *Leersia sp.* at rates of 20 pounds per acre and probably lower with indications of control at 10 to 15 pounds per acre.
10. No synergistic effects have been noted using other herbicides mixed with dalapon.
11. Apparently, although sufficient data is not available, Granular 2, 4-D will control water lilies, *Myriophyllum brasiliense, Myriophyllum heterphyllum,* and *Utricularia sp.* at rates of 100 pounds per acre (20 lbs. acid).
12. Comparisons should be made using silvex, dalapon and 2, 4-D and 2, 4, 5-T.

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COMMENTS ON THE NEED FOR CRITICAL FISHERY RESEARCH PLANNING AND ELECTRONIC DATA PROCESSING *

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ABSTRACT

Two great problems facing fishery scientists who must improve and rapidly complete research projects involving large amounts of data are: (a) Improvement in the statistical design of projects; and (b) electronic data processing (EDP) with the aid of punch cards, paper and magnetic tape. Good statistical design of a project is usually achieved by a well-trained fishery scientist work-

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