PRELIMINARY RESULTS OF SEVERAL HERBICIDES ON AQUATIC VEGETATION IN FLORIDA

By J. B. COPELAND and J. W. WOODS
Hyacinth Control Division
Lakeland, Florida

ABSTRACT

The 1957 Legislature expanded The Florida Hyacinth Control Program to a Noxious Vegetation Control Program. This made testing of herbicides for the control of other noxious plants necessary. A convenient field test of herbicides was developed. These herbicides were tested using disel oil and/or water as a carrier.

The herbicides tested were Atlas "A" (sodium arsenite), Amino Triazole (3 amino-1,2,4-triazol), Aquaherb (orthodichlobezene and aromatic salt), Aqua San (trichlorobenzene and aromatic petroleum distillate), Ammate (ammonium sulfomate), Atlacide-2,4-D (sodium chlorate-2,3-dichoroxyacetic acid), Granulated Chlorea (sodium chlorate, sodium metaborate and 3-(P-chlorophenyl)-1,1-dimethylurea), Dowpon or Radapon sodium salt of 2,2 dichloropropionic acid), Esteron (2,4,5-trichlorophenoxyacetic acid, propylene gycol buytol ether ester), HCA (hexachloroacetone), Kuron, propylene glycol butyl ether ester of 2(2-4,5 trichlorophenoxy) propionic acid, M-502 (invert immulsion butoxy ethanol, ester of 2,4-D), Simazin-10G (2-chloro-4,6-bis-(ethylamino)-S-triazine), TCA (sodium salt of trichloroacetate), Veon-100 (dimethylamine salt of 2-4 dichlorophenoxyacetic acid-dimethylamine salt-2,4,5-trichlorophenoxyacetic acid), 2,4-D Pellets (iso-octylhexyl) (ester 2,4-D attaclay granules), 2,4-5T Pellets (iso-octyl ester of 2,4-5T), 2,4-D Ester (isopropyl, 2,4-5T (iso-octyl ester).

Several herbicides were used on separate plots of alligator weed, cattails, maiden cane, Najas, pickerel weed, spatterdock and water lettuce.

Preliminary results of these tests indicate an aquaherb and 2,4-D combination, 2,4-5T pellets or M-502 gave some control when used on alligator weed. Kuron, 2,4-D Ester or HCA gave good results on pickerel weed. Dowpon, Radapon or 2,4-D Ester gave excellent results on cattails. M-502 gave good results on water lettuce. None of the herbicides used on Najas or maiden cane gave the desired results, although Dowpon, Radapon and Amino Triazole showed some promise of control on maiden cane. Kuron gave a good indication of control of spatterdock.

INTRODUCTION

The Florida Game and Fresh Water Fish Commission has engaged in noxious vegetation control work for the past six years. All General Appropriation funds, until July 1, 1957 were earmarked for the control of the water hyacinth, *Eichornia crasippes*. This program has been described (Luethy 1954). The 1957-59 appropriation made possible large scale spraying operations on other noxious vegetation. After reviewing the literature available, we found several recommendations for each type aquatic vegetation. Various chemical companies furnished new material and experimental recommendations for some types of vegetation. This study was established to evaluate some of these recommendations on plots of aquatic vegetation in Florida.

PROCEDURE AND MATERIALS

Prior to beginning field operations, lakes and other bodies of water were surveyed to locate areas with the type of vegetation to be treated.

Areas of alligator weed, *Althernanthera philoxeroides*, were found in Lake Gibson, 2,500-acre lake near Lakeland. The areas extended from the shore line into water 6 feet deep. Two other areas were located in a small stream flowing from Lake Gibson into Lake Parker. Alligator weed in these areas extended from the moist stream bed into water 18 inches deep.

A pure stand of cattails, *Typha latifolia*, was located in a large barrow pit near Leesburg growing in water approximately 2 feet deep. Other stands of

cattails were located in Lake Parker near Lakeland; these plants were growing in water about 2 feet deep.

Suitable plots of maiden cane, *Panicum hemitomum,* were found growing in 3 to 6 feet of water in Lake Harris near Leesburg. Some maiden cane was found in spatterdock plots in Williams Lake.

Areas of Najas, *Najas guadalupensis,* were located in two small ponds at a fish hatchery near Leesburg. The water in these ponds varied from 6 inches to 2 feet in depth. Other areas of Najas were located in Lake Wire, a 25-acre lake in Lakeland. Najas extended from the edge of the lake into water about 8 feet deep in a strip about 35 feet wide completely around the lake.

Some pickerel weed, *Pontederia cordata,* was mixed in plots of spatterdock in Williams Lake near Leesburg.

Williams Lake, a 7-acre lake near Leesburg, contained about 6.5 acres of spatterdock. Williams Lake varied in depth from 2 to 10 feet deep. Two areas of spatterdock were located in Rock Springs Run near Leesburg. Rock Springs Run is a cool sluggish stream varing in depth from 3 feet to 6 feet.

Areas of water lettuce, *Pistia stratiotes,* were located in a barrow pit near Leesburg. Two areas in a large phosphate pit near Lakeland were also treated.

Plants were identified from keys in Faccett (1940) and Eyles and Robertson (1944).

Convenient areas were measured and stakes placed to mark 2,000 square foot plots. The water lettuce plots were enclosed with ½ inch mesh chicken wire to prevent the lettuce from drifting.

Specific recommendations for the control of alligator weed were taken from Stephens (1954) and personal correspondence with representatives of Dow and American Chemical and Paint Companies.

Specific recommendations for the control of cattails were taken from Stephen (1954), Lawrence, Snow (1957), Heath and Ruch (1957), and personal correspondence with representatives of General Chemical and Dow Chemical Companies.

Specific recommendations for the control of Najas were received from Chipman Chemical, Dow Chemical and Resor Hill Chemical Companies.

Specific recommendations for the control of spatterdock were taken from Lawrence and personal correspondence with Chipman, Dow and American Chemical and Paint Companies.

Specific recommendations for the control of water lettuce were received from AmChem Company, Chipman Chemical Company, Collins Chemical and Dow Chemical.

Measured amounts of chemicals were applied with the John Bean Model K-33 spray pumping unit from the shore or a 14-foot plywood boat powered with a 3 h.p. Johnson outboard motor. Weekly observations were made and recorded for a six-week period. If treatment looked promising, continued observations were made. Only on one occasion was an area re-sprayed.

The herbicides tested were Atlas "A" (sodium arsenite), Amino Triazole (3 amino-1,2,4-triazol), Aquaherb (orthodichlobezene and aromatic salt), Aqua San (trichlorobenzene and aromatic petroleum distillate), Ammate (ammonium sulfomate), Atlacide-2,4-D (sodium chlorate-2,4-dichoroxyacetic acid), Granulated Chlorea (sodium chlorate, sodium metaborate and 3-(P-chlorophenyl)-1,1-dimethylurea), Dowpon or Radapon (sodium salt of 2,2 dichloropropionic acid), Esteron (2,4,5-trichlorophenoxyacetic acid, propylene gycol buytol ether ester), HCA (hexachloroacetone), Kuron, propylene glycol butyl ether ester of 2(2-4,5 trichlorophenoxy) propionic acid, M-502 (invert immulsion butoxy ethanol, ester of 2,4-D), Simazin-10G (2-chloro-4,6-bis-(ethylamino)-S-triazine), TCA (sodium salt of trichloroacetate), Veon-100 (dimethylamine salt of 2-4 dichlorophenoxyacetic acid-dimethylamine salt-2,4,5-trichlorophenoxyacetic acid), 2,4-D Pellets (iso-octylhexyl) (ester 2,4-D attaclay granules), 2,4-5T Pellets (iso-octyl ester of 2,4-5T), 2,4-D Ester (isopropyl, 2,4-5T (iso-octyl ester).

RESULTS

All rates are expressed in pounds of active ingredient.

Details of alligator weed plots sprayed are found in Table I. Areas treated at the following rates with 2,4-D, 2,4-5T combination at 5.0 lbs. per acre, 2,4-D Ester and Aquaherb at 4.2 lbs. per acre, Ammate X at 76 lbs. per acre, 2,4-D-2,4-5T-TCA combination at 19.2 lbs. per acre, 2,4-5T at 5.0 lbs. per acre, 2,4-D Ester at 4.2 lbs. per acre, Granular Simizen at 10 lbs. per acre, gave very poor results. Alligator weed plots treated with Granular Chlorea at the rate of 393 lbs. per acre, 2,4-5T Pellets at 20 lbs. per acre, M-502 at 10 lbs. per acre gave good results on moist ground and very shallow water. Some regrowth occurred in one plot where M-502 was used and this area was re-sprayed 8 weeks after initial application. Eight weeks later additional regrowth appeared.

Details of cattail plots sprayed are found in Table II. Plots treated at the following rates with 2,4-D-2,4-5T at 10 lbs. per acre, Dowpon at 51 lbs. per acre, Ammate X at 120 lbs. per acre, and Dowpon at 16 lbs. per acre gave very good results.

Details of maiden cane plots sprayed are found in Table III. Areas sprayed with Amino Triazol at the rate of 10 lbs. per acre, Dowpon at 17 lbs. per acre, 2,4-D and TCA at 90 lbs. per acre, HCA at 80 lbs. per acre did not give desired results where maiden cane was growing in water, however, all the above mentioned herbicides did give good results on moist ground.

Details of Najas plots sprayed are found in Table IV. Areas treated with 2,4-D Pellets at the rate of 80 lbs. per acre, Atlas "A" at the rate of 50.3 p.p.m., 18.6 p.p.m., 17.6 p.p.m, 11.7 p.p.m., Granular Chlorea at 393 lbs. per acre, Kuron at 20 lbs. per acre, 2,4-D Pellets at 24 lbs. per acre, 2,4-5T Pellets at 24 lbs. per acre, did not give good control. Application of 80 lbs. 2,4-D Pellets per acre resulted in a total fish kill.

Details of pickerel weed sprayed are found in Table V. The pickerel weed tested was scattered in the spatterdock plots. Application of 2,4-D Ester at the rate of 4.2 lbs. per acre, HCA at 80 lbs. per acre, 2,4-5T at 6.4 lbs. per acre, gave good results.

Details of spatterdock plots treated are found in Table VI. Areas treated at the following rates with 2,4-D and 2,4-5T combination at 10 lbs. per acre, 2,4-D Ester at 4.2 lbs. per acre, 2,4-D and 2,4-5T combination at 5 lbs. per acre, HCA at 160 lbs. per acre, 2,4-D Ester at 8.4 lbs. per acre, 2,4-D Pellets at 21.8 lbs. per acre, Aqua San and 2,4-D combination at 45 lbs. per acre, Altacide at 10 lbs. per acre, 2,4-D Pellets at 21.8 lbs. per acre, Granular Chlorea at 450 lbs. per acre, Granular Chlorea at 499 lbs. per acre, Kuron at 20 lbs. per acre, Veon 100 at 10 lbs. per acre and M-502 at 10 lbs. per acre gave poor results. Kuron applied at the rate of 0.38 p.p.m. to the total volume of a three-acre lake, appeared to give good results. Large root stocks appeared at the surface of the water and approximately 70% of the lake was open water 8 weeks after treatment.

Details of water lettuce plots sprayed are found in Table VII. Poor results were obtained on areas sprayed with Aqua San and 2,4-D combination at the rate of 20 lbs. per acre and Aqua San at the rate of 32 lbs. per acre. M-502 at used rate of 10 lbs. per acre resulted in a 80% kill when used as a boat spray. Aerial application at the rate of 4.8 lbs. per acre gave poor results.

TABLE I

RESULTS OF HERBICIDES USED ON ALLIGATOR WEED

Location	*Chemical*	*Date*	*Concentration*	*Carrier*	**Rate lbs./Acre*	*% Killed*
Lake Gibson	2,4-D/2,4-5T	7/15/57	8 oz./5 gal.	Water, Spreader Sticker	5.0	1–2
Lake Gibson	Ammate X	7/15/57	4 lbs./5 gal.	Water, Spreader Sticker	76.0	1
Lake Gibson	2,4-5T	7/15/57	8 oz./5 gal.	Water, Spreader Sticker	5.0	1–2
Lake Gibson	2,4-D Ester	7/15/57	8 oz./5 gal.	Kerosene	4.2	2
Lake Gibson	2,4-D Ester/ Aquaherb	8/12/57	16 oz./5 gal.	Water, Spreader Sticker	14.2	1–2
Lake Gibson	2,4-D/2,4-5T+ TCA	8/12/57	16 oz.+.5 lb. TCA /5 gal.	Water, Spreader Sticker	19.2	1–2
Lake Gibson	Granular Chlorea	4/23/58	20 lbs.	None	393.0	30
Lake Gibson	Granular Simizen	4/23/58	5 lbs.	None	10.0	0
Gibson Creek	2,4-5T Pellets	5/29/58	5 lbs.	None	20.0	95
Gibson Creek	M-502	6/16/58	16 oz./12.4 gal.	Kerosene, Water	10.0	90
Gibson Creek*	M-502	8/25/58	16 oz./12.4 gal.	Kerosene, Water	10.0	85
Gibson Creek	M-502	8/25/58	16 oz./12.4 gal.	Kerosene, Water	10.0	90

* Sprayed regrowth on plot treated 6/16/58.

** Active ingredient.

TABLE II

RESULTS OF HERBICIDES USED ON CATTAILS

Location	*Chemical*	*Date*	*Concentration*	*Carrier*	**Rate lbs./Acre*	*% Killed*
Leesburg pit	2,4-D/2,4-5T	9/ 6/57	16 oz./5 gal.	Kerosene	10.0	80
Leesburg pit	Dowpon	9/ 6/57	3 lbs./5 gal.	Water	51.0	95
Lake Parker	Dowpon	9/10/57	48 lbs./300 gal.	Water	16.0	95
Lake Gibson	Ammate X	6/11/58	12 lbs./20 gal.	Water	120.0	80

* Active ingredient.

TABLE III

RESULTS OF HERBICIDES USED ON MAIDEN CANE

Location	*Chemical*	*Date*	*Concentration*	*Carrier*	**Rate lbs./Acre*	*% Killed*
Williams Lake	2,4-D + TCA	6/20/58	32 oz./15 lbs.	Water	90.0	75
Lake Harris	Amino Triazol	6/25/58	1 lb./15 gal.	Water	10.0	5–7
Lake Harris	Dowpon	6/25/58	1 lb./10 gal.	Water	17.0	3–5
Williams Lake	HCA	12/ 1/58	128 oz./10 gal.	Kerosene	80.0	85

* Active ingredient.

TABLE IV

RESULTS OF HERBICIDES USED ON NAJAS

Location	*Chemical*	*Date*	*Concentration*	*Carrier*	**Rate lbs./Acre*	*% Killed*
Bait ponds, Leesburg	2,4-D Pellets	2/12/58	10 lbs.	None	80.0	2
Bait ponds, Leesburg	2,4-D Pellets	3/ 7/58	10 lbs.	None	80.0	2
Wire Lake	Atlas "A"	11/20/57	1,024 oz.	None	50.3 p.p.m.	0
Wire Lake	Atlas "A"	11/20/57	512 oz./4 gal.	Water	10.6 p.p.m.	0
Wire Lake	Atlas "A"	11/20/57	512 oz./8 gal.	Water	17.6 p.p.m.	0
Wire Lake	Atlas "A"	11/20/57	384 oz./8 gal.	Water	11.6 p.p.m.	0
Wire Lake	Granular Chlorea	4/23/58	20 lbs.	None	393.0	0
Wire Lake	Kuron	4/23/58	32 oz./10 gal.	Water	20.0	0
Wire Lake	2,4-D Pellets	4/23/58	6 lbs.	None	24.0	0
Wire Lake	2,4-5T Pellets	4/23/58	6 lbs.	None	24.0	0

* Active ingredient.

TABLE V

RESULTS OF HERBICIDES USED ON PICKEREL WEED

Location	*Chemical*	*Date*	*Concentration*	*Carrier*	**Rate lbs./Acre*	*% Killed*
Williams Lake	2,4-D Ester	9/26/57	8 oz./5 gal.	Kerosene	4.2	85
Williams Lake	HCA	9/26/57	64 oz./5 gal.	Kerosene	80.0	85
Williams Lake	Esteron 2,4-5T	12/17/57	10 oz./10 gal.	Water, Tide	6.4	80

* Active ingredient.

TABLE VI

RESULTS OF HERBICIDES USED ON SPATTERDOCK

Location	*Chemical*	*Date*	*Concentration*	*Carrier*	**Rate lbs./Acre*	% *Killed*
Williams Lake	2,4-D/2,4-5T	8/26/57	16 oz./5 gal.	Kerosene	10.0	5
Williams Lake	2, 4-D Ester	8/26/57	8 oz./5 gal.	Kerosene	4.2	3
Williams Lake	2,4-D/2,4-5T	9/ 4/57	8 oz./5 gal.	Kerosene	5.0	3
Williams Lake	HCA	9/ 4/57	128 oz./10 gal.	Water	160.0	0
Williams Lake	2,4-D Ester	12/17/57	16 oz./10 gal.	Water, Tide	8.4	0
Williams Lake	2,4-D Pellets	3/ 5/58	10 lbs./20%	None	43.6	2
Rock Springs	2,4-5T Pellets	3/25/58	5 lbs./20%	None	21.8	3
Williams Lake	Aqua San/2,4-D	2/ 7/58	40 oz./10 gal.	Water	25.0	0
Williams Lake	Altacide/2,4-D	2/ 7/58	32 oz./10 gal.	Water	10.0	2
Rock Springs	2,4-D Pellets	3/25/58	5 lbs.	None	21.8	0
Williams Lake	Granular Chlorea	4/ 7/58	23 lbs.	None	454.0	2
Williams Lake	Granular Chlorea	4/ 7/58	22 lbs.	None	499.0	2
Williams Lake	Kuron	4/25/58	32 oz./90 gal.	Water, Tide	20.0	5–10
Williams Lake	Veon 100	4/25/58	16 oz./10 gal.	Water, Tide	10.0	3
Williams Lake	Kuron	8/ 1/58	640 oz./50 gal.	Water	.38 1 p.p.m.	70
Williams Lake	M-502	6/12/58	16 oz./12.4 gal.	Kerosene, Water	10.0	3

* Active ingredient.

TABLE VII

RESULTS OF HERBICIDES USED ON WATER LETTUCE

Location	*Chemical*	*Date*	*Concentration*	*Carrier*	**Rate lbs./Acre*	% *Killed*
Lake Harris Canal	Aqua San/2,4-D	3/18/58	12.8 oz./10 gal.	Water	20.0	8
Lake Harris Canal	Aqua San/2,4-D	3/26/58	12.8 oz./10 gal.	Water	20.0	5
Lake Harris Canal	Aqua San	4/25/58	32 oz./10 gal.	Water	32.0	2
Kibler Pits	M-502	6/16/58	16 oz./12.4 gal.	Kerosene, Water	10.0	80
Kibler Pits	M-502	7/28/58	1,024 oz./32 gal.	Kerosene, Water	4.8	1–2

* Active ingredient.

DISCUSSION

Based on the results obtained from the 55 plots of six species of vegetation treated in this study, field recommendations were made for the control of cattails. This recommendation of 16 lbs. of Dowpon per acre in 100 gallons of water has proved very successful in Florida.

The recommendation of Kuron at the rate of 0.4 part per million when an entire lake of spatterdock can be treated was adopted.

Limited use of M-502 at the recommended rate of 10.0 lbs. per acre was accepted.

Future studies in Florida should include further work with invert emulsions and pelletized materials on alligator weed, reduced rates of Dowpon on cattails and further tests of 2,4-5T propionic herbicides on spatterdock.

LITERATURE CITED

Eyles, Don E. and Robertson, J. L. 1944. A Guide and Key to the Aquatic Plants of the Southeastern United States. Public Health Bulletin, No. 286. 151 pp.

Faccett, Norman C. 1940. A Manual of Aquatic Plants. McGraw-Hill Book Company, Inc., New York. 382 pp.

Heath, Robert G. and Ruch, Lewis C. 1957. Aerial Control of Cattail with Radapon. Reprint from Down to Earth—Winter—Dow Chemical Company, Midland, Michigan.

Lawrence, J. M. Weed Control in Farm Ponds. A. P. I. Agricultural Experiment Station, Auburn, Alabama.

Luethy, Don R. 1955. Noxious Vegetation Control, Bulletin No. 2, Game and Fresh Water Fish Commission. 26 pp.

Snow, J. R. 1957. A Preliminary Report on the Comparative Testing of some of the newer Herbicides. Proceedings of the Eleventh Annual Conference—Southeastern Association of Game and Fish Commissioners, Mobile, Alabama. 9 pp.

Stephens, John C. 1954. Review of Methods and Formulations for Aquatic Weed Control. Reprint from The Soil Science Society of Florida Proceedings, Volume XIV. 4 pp.