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Effect of Herbicides on Floating Aquatic Plants[1]

DANIEL D. THAYER AND W. T. HALLER[2]

INTRODUCTION

Free-floating plant species are often considered noxious weeds at relatively small populations by virtue of their unique growth characteristics. With the aid of prevailing winds or moving water, floating plants have the ability to readily invade virgin habitats. Additionally, many free-floating plants innately have excessive growth potentials, and coupled with the difficulty in controlling many of the smaller leaved floating plants with surface applied herbicides, make these plants an especially troublesome group.

Giant duckweed (*Spirodela polyrhiza* L.) is a native North American plant species, cosmopolitan in its distribution of both temperate and tropical regions of the world. Reproduction is primarily by asexual budding and under optimal growing conditions may double their population in several days (1, 2). difficulties associated with the chemical control of the duckweeds lie partly in their small size. The fronds average less than 6 mm long and leaves rest directly on the water surface making them vulnerable to herbicide "wash off" and reduced contact time. Other problems include a highly cuticularized epidermis that is not easily wetted and "bunched plants" as a result of winds crowding plants into thick piles often several cm thick sheltering plants from surface sprayed herbicide applications (2, 3).

Waterlettuce (*Pistia stratiotes* L.) is a densely pubescent, rosette leaved, floating stoloniferous plant forming daughter plants as a primary means of reproduction (2). Major problems associated with waterlettuce are the formation of dense mats clogging waterways in a similar manner to problems associated with the waterhyacinth (*Eichhornia crassipes* (Mart.) Solms.).

Common salvinia (*Salvinia rotundifolia* Willd.) is a floating fern with dense pubesence on the upper surface of the fronds and a modified leaf which performs the function of the absent roots (3). Salvinia is thought to be an exotic with a range restricted to the southeastern United States. As with the duckweed, salvinia is often difficult to treat chemically due to its close proximity to the water surface. Additionally, pubesence prevents optimal herbicide coverage.

A herbicide widely used in Florida for control of these three plants is diquat (6,7-dihydrodipyrido(1,2-*ac*:2′,1′-*c*) pyrazinediium ion), which is also the only herbicide that list all three plant species on the same label. Developed in the late 1950's, diquat is a fast acting contact herbicide used on a wide range of submersed, emersed, and free-floating aquatic weeds. With the cost of research and development of new herbicides escalating, the prospects for many new materials in aquatic plant management are bleak. We were, therefore, interested in evaluating currently registered products to determine their effectiveness for control of these species.

MATERIALS AND METHODS

Floating frames (1 m^2) were constructed from PVC pipe (2.54cm dia.) to confine the plants for the duration of the experiments. The duckweed was treated in a 0.04 ha pond located within the Austin Cary Memorial Forest, N.E. Alachua County and the water lettuce and salvinia were treated in 0.03 ha ponds located at the Bivins Arm Agronomy research facility in Gainesville, Florida. The frames were anchored from shore with nylon rope and stocked to capacity with the floating plant species. The ponds were all fertilized several days prior to treatment with an ammonium nitrate and triple phosphate preparation that provided 2 mg N/1 and 0.7 mg P_2O_5/1.

Each of the frames were treated with the equivalent of 935 1/ha water using a manually operated trigger pump sprayer. The herbicides evaluated for each plant species included 2,4-D ((2,4-dichlorophenoxy)acetic acid), diquat, endothall (7-oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid), and glyphosate (N-(phosphonomethyl)glycine) at varying treatment rates having three replications each. All treatments were made in combination with the non-ionic surfactant Induce[3] (unless otherwise indicated) at a standard rate of 2.34 1/ha.

Efficacy was evaluated on five day intervals up to 15 days after treatment with 60 day ratings for several treatments. Evaluations of efficacy were based on three evaluators rating control on a scale of 0-10 where 0 = no effect and 10 = complete control.

RESULTS AND DISCUSSION

Mean efficacy ratings at 15 DAT (days after treatment) for all three plant species are listed in Table 1. Results for duckweed indicate that all rates of diquat essentially controlled 100% of the treated plants. The other herbicides tested had minimal impact on duckweed at 15 DAT and by 4 weeks post-treatment (data not shown) plants showed no herbicidal symptoms.

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[2]Assistant in Aquatic Weeds and Professor, Center for Aquatic Weeds, University of Florida, 7922 NW 71st Street, Gainesville, FL. 32606.

[3]Mention of a trademark or a proprietary product does not constitute a guarantee or warranty of the product by the University or the U.S.D.A. and does not imply its approval to the exclusion of other products that also may be suitable. Herbicide test results in this paper are experimental data and do not constitute a recommendation or endorsement for use. Herbicide use restrictions vary among states. Be sure to read and follow all herbicide lable directions.

TABLE 1. EFFECTIVENESS OF SEVERAL HERBICIDES FOR CONTROL OF DUCKWEED, WATERLETTUCE, AND SALVINIA, FIFTEEN DAYS AFTER TREATMENT WITH THE VARIOUS HERBICIDES.

Treatment	Rate (kg/ha)	Visual efficacy ratings[1] Mean ± S.D.	
	Duckweed		
2,4-D[2]	1.1	0.2	0.4
2,4-D	2.2	0.2	0.4
2,4-D	4.5	1.0	0.7
diquat	1.1	9.9	0.3
diquat	2.2	10.0	0.0
diquat	3.4	10.0	0.0
endothall[3]	1.7	0.6	0.7
endothall	3.4	0.7	0.7
endothall	5.0	1.0	0.7
glyphosate	2.2	1.2	0.8
glyphosate	4.5	1.4	1.6
glyphosate	6.7	1.7	0.5
	Waterlettuce		
2,4-D + H_2O	4.5	0.6	0.7
2,4-D + Kover II	4.5 + 1% v/v	1.7	0.7
2,4-D + JLB010684	4.5 + 1% v/v	1.4	0.5
2,4-D + LIQUA-NOX	4.5 + 1% v/v	2.0	1.1
2,4-D + Dermagene	4.5 + 1% v/v	1.3	1.2
diquat	1.1	10.0	0.0
endothall	1.7	7.6	0.7
endothall	3.4	7.9	0.6
endothall	5.0	8.1	0.8
glyphosate	2.2	7.1	1.8
glyphosate	4.5	9.6	0.5
glyphosate	6.7	9.9	0.3
	Salvinia		
2,4-D	4.5	0.8	0.3
diquat	1.1	8.7	0.5
endothall	1.7	7.5	1.1
endothall	3.4	8.0	0.3
endothall	5.0	8.0	0.6
glyphosate	2.2	8.7	0.6
glyphosate	4.5	8.6	0.5
glyphosate	6.7	8.5	0.6

[1]Efficacy ratings were based on a sale of 0 to 10 with 0 having no effect and 10 having complete kill. Values for control are the mean of three replications per treatment and three evaluators rating efficacy.
[2]As dimethylamine salt.
[3]As dipotassium salt.

Waterlettuce often occurs in mixed populations with waterhyacinth. Because 2,4-D is often used for waterhyacinth management, it would be desirable to find some additive that may make waterlettuce susceptible to this systemic herbicide at field application rates. The most efficacious of all the 2,4-D plus adjuvant treatments was that of 2,4-D plus the industrial strength detergent, LIQUA-NOX. At five DAT it appeared as though 50% of the treated plants would be controlled as indicated by necrosis and typical phenoxy type symptoms; however, by 15 DAT regrowth decreased efficacy ratings to 20% of the control.

Plots treated with diquat had 100% control at the 1.1 kg/ha rate. Waterlettuce treated with Endothall were rated at about 80% control with all three treatment rates 15 DAT, however regrowth occurred rapidly as new leaves sprouted from the central bud. Glyphosate treatments at 4.5 and 6.7 kl/ha were rated at greater than 90% control at 15 DAT and increased to 100% control by 30 DAT. The 2.2 kg/ha treatment rate with glyphosate resulted in no more than 70% control at 15 DAT and by 60 DAT, waterlettuce had re-established in 100% of the frames through formation of multiple daughter plants from the decaying parent plants.

With the exception of 2,4-D, all herbicides and herbicide rates tested for salvinia control were rated at about 80% control 15 DAT. Later ratings (30 DAT) of salvinia again indicated little difference between herbicidal treatments.

In summary, it appears that of the herbicides and rates tested, diquat provided the most effective long term control of duckweed and diquat and glyphosate were efficacious against waterlettuce. None of the herbicides provided over 80-90% control of salvinia as diquat, endothall, and glyphosate appeared to be equally effective at the rates tested.

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