The Response of Eurasian Watermilfoil to Various Concentrations and Exposure Periods of 2,4-D[1]

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INTRODUCTION

Eurasian watermilfoil (*Myriophyllum spicatum* L.) is a perennial submersed plant that can spread by vegetative reproduction and by seed (2). Each shoot node may produce roots even though the nodes may be several feet from the soil. The roots become attached to the bottom if they are in contact with or only a few inches from the soil. A cm long fragment may take root and grow 1 m or more in 3 months (2). The plant is also able to grow in a free-floating situation.

This submersed plant flourishes in Portugal and Southern Africa (5), and is found throughout the Eastern United States, with large infestations in Chesapeake Bay, Tennessee Valley Authority Lakes, and Chattahoochee and Homosassa Rivers of Florida (6).

Although the plant was first reported in the United States in the nineteenth century, it has become a problem only during the last 15 years (3). It was thought to have been planted in the Crystal-Homosassa River Basin in 1964 by tropical aquatic plant dealers (2). By 1967 Eurasian watermilfoil had spread over an estimated 3,000 acres in an area from the Withlacoochee River to Weekiwachee Springs (2). It can damage water resources by severely affecting shellfish production, and interfering with recreational activities such as sport fishing, skiing, boating, and swimming. It may clog channels used for navigation and drainage, and may destroy commercial fisheries.

The effective control of Eurasian watermilfoil through the use of herbicides has been of great value. A high degree of susceptibility to the phenoxy herbicides has been demonstrated (4). However, there is a need to define more closely the relationship between herbicide concentrations and their phytotoxicity to the plant. This study was designed to determine the optimum herbicide concentrations required for effective and economical control of Eurasian watermilfoil.

METHODS AND MATERIALS

Test 1. The plants were treated in a growth room under controlled environmental conditions. Apical cuttings of Eurasian watermilfoil approximately 7 cm in length were collected from stock cultures. Three cuttings were established in a small plastic pot filled with a 1:1 mixture of sand and muck, and then 24 of these pots were placed in each of four aquaria containing 14 liters of pond water. The plants were allowed to become established for a period of 8 days. Water in the aquaria was replaced every 3 days.

The butoxyethanol ester (BEE) of (2,4-dichlorophenoxy)acetic acid (2,4-D) was applied to the aquaria at concentrations of 0.5, 1.0, 2.5, and 5.0 ppmw, and the water thoroughly agitated to insure an even distribution of the chemical. Tests at all concentrations were replicated three times. Each of the four treatment rates was in contact with the plants for periods of 1, 2, 4, 8, 16, 24, 48, and 96 hr. After each exposure, the plants were removed from the treatment tanks and placed in a running bath of pond water for 30 minutes to remove any adhering herbicide. Then two pots, each containing three plants, were placed in a 4-liter glass jar containing fresh pond water (1). These jars were placed in a growth room with a photoperiod of 12 hr and a light intensity of 80 ft-c. The daytime temperature was 25 C, and the night-time temperature was 22 C. This test was performed in two parts: the first part employed contact periods of 1, 2, 4, and 8 hr, while in the second part, the contact times were 16, 24, 48, and 96 hr.

Test 2. The second test, held outdoors, employed four concrete tanks with dimensions of 218 cm by 76 cm by 48 cm. The tanks were filled to a depth of 43 cm, which brought the total volume of treatment solution to 71 decaliters. Apical cuttings of Eurasian watermilfoil were collected and established in a manner similar to Test 1. A single layer of green screen was placed over the tanks to shield the water surface from direct sunlight. Potted plants were placed in the treatment tanks and allowed to become established for a period of 2 weeks. Treatments were made with 0.5 and 1.0 ppmw of 2,4-D and exposure times of 1, 2, 4, 8, 16, 24, 48, and 96 hr; and with 2.5 ppmw of 2.4-D using exposure times of 1, 2, 4, and 8 hr. Following individual exposure periods, plants were rinsed in running water for 30 minutes and transferred to 4-liter jars. The jars were then placed in a growth chamber with conditions of light and temperature identical to those maintained in the growth room test. Evaluations were made at weekly intervals by rating plant injury from 0 to 100; 0 indicating no control, and 100 representing kill of the plants.

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RESULTS AND DISCUSSIONS

Test 1. Plants subjected to a 1-hr exposure at a concentration of 5 ppmw 2,4-D were killed in 8 weeks (Table 1). A period of 4 weeks was required to kill the plants in the 5 ppmw treatments lasting 24, 48, and 96 hr (Table 2). A 4-hr exposure was required to kill the plants 8 weeks after the 2.5 ppmw treatment. Control of the plants was obtained with the 1.0 ppmw treatment and the 8-hr exposure, while the results of the second part of this test (Table 2) indicate only partial control at the same rate with all exposure periods. The failure of the control plants to remain in a healthy state in part one of Test 1 may indicate that the plants were not as vigorous as the ones used 11 days later in the second part of this test.

The 96-hr exposure to the 2.5 ppmw treatment resulted in a 99% control of plants after 4 weeks. The 4-hr exposure period provided 100% control after 8 weeks, while the 1 and 2 hr exposures resulted in an average of 95% control.

The 0.5 ppmw concentrations, at all exposures, caused injury to Eurasian watermilfoil plants. Injury reached a maximum at 6 to 8 weeks following treatments and an apparent recovery of the plants began during the eight to tenth week (Tables 1 and 2).

A darkening of the lower half of the plant stems occurred 1 week after the plants were exposed for 2 hr in a solution of 5.0 ppmw of 2,4-D. During the second week, the plants began to slump. The stems of plants exposed to the 2.5 and 5.0 ppmw concentrations for 24 hr and longer became soft from the breakdown of tissue.

Test 2. Eurasian watermilfoil exposed to 2.5 ppmw 2,4-D for a period of 8 hr was dead 8 weeks later (Table 3). Injury for the 2-hr exposure was at the maximum at 6 weeks after the treatment with a rating of 85%, while 78% injury was recorded for this treatment 6 weeks after the 1 hr of exposure. A decrease in control was observed following the sixth week, indicating that regrowth had commenced. The 1.0 ppmw treatment for 48 hr controlled the plants after 8 weeks (Figure 1). Maximum injury within the 0.5 ppmw treatment was noted 6 weeks following a 96 hr exposure. Regrowth was in evidence throughout the remaining 4 weeks of the test. Figure 2 illustrates the effect of 1 ppmw treatments at 4 different periods of exposure on Eurasian watermilfoil grown outdoors.

TABLE 1. THE EFFECT OF 2,4-D ON EURASIAN WATERMILFOIL GROWN AND TREATED UNDER CONTROLLED ENVIRONMENTAL CONDITIONS. PART ONE OF TEST 1.

Rates of 2,4-D (ppmw)	Exposure Time (hr)	Percent control[a] Weeks following treatment 2	4	6	8	10
Control		0	2	12	18	20
0.5	1	5	13	40	42	40
	2	5	18	55	60	57
	4	12	28	58	57	52
	8	13	30	68	73	63
1.0	1	7	12	50	82	77
	2	10	20	67	87	88
	4	15	32	78	93	93
	8	18	38	80	99	100
2.5	1	13	48	87	98	97
	2	15	65	90	93	90
	4	18	77	96	100	100
	8	20	87	97	100	100
5.0	1	17	90	95	100	100
	2	32	95	98	100	100
	4	28	97	99	100	100
	8	37	98	99	100	100

[a]0—no control; 100—complete kill of the plants. Each value is the average of three replications.

TABLE 2. THE EFFECT OF 2,4-D ON EURASIAN WATERMILFOIL GROWN AND TREATED UNDER CONTROLLED ENVIRONMENTAL CONDITIONS. PART TWO OF TEST 1.

Rates of 2,4-D (ppmw)	Exposure Time (hr)	Percent control[a] Weeks following treatment 2	4	6	8	10
Control		0	1	1	1	1
0.5	16	10	32	67	62	55
	24	10	28	70	62	60
	48	12	42	85	73	63
	96	13	37	82	65	60
1.0	16	13	47	72	55	53
	24	17	42	75	65	60
	48	20	67	88	85	85
	96	20	75	90	87	90
2.5	16	25	92	99	100	100
	24	25	92	99	100	100
	48	48	97	100	100	100
	96	50	99	100	100	100
5.0	16	37	98	100	100	100
	24	67	100	100	100	100
	48	80	100	100	100	100
	96	87	100	100	100	100

[a]0—no control; 100—complete kill of the plants. Each value is the average of three replications.

TABLE 3. THE EFFECT OF THREE CONCENTRATIONS OF 2,4-D ON EURASIAN WATERMILFOIL WHEN APPLIED IN OUTSIDE TANKS AT VARIOUS EXPOSURE TIMES. PLANTS WERE PLACED UNDER CONTROLLED CONDITIONS AFTER EXPOSURE TO THE 2,4-D. TEST 2.

Rates of 2,4-D (ppmw)	Exposure Time (hr)	Percent control[a] Weeks following treatment 2	4	6	8	10
Control		0	1	1	1	1
0.5	1	5	10	23	35	28
	2	5	12	32	45	38
	4	8	15	37	45	40
	8	10	27	53	63	53
	16	10	33	58	68	58
	24	12	43	68	73	63
	48	15	45	77	77	70
	96	17	52	88	78	75
1.0	1	5	13	42	53	47
	2	8	17	43	53	48
	4	12	18	43	55	50
	8	13	33	67	67	68
	16	15	48	83	88	92
	24	17	55	88	90	92
	48	18	68	97	100	100
	96	23	82	99	100	100
2.5	1	10	25	78	68	53
	2	12	33	85	82	77
	4	15	53	88	88	90
	8	17	70	97	100	100

[a]0—no control; 100—complete kill of the plants. Each value is the average of three replications.

Figure 1. Observations on the percent control of Eurasias watermilfoil after 42 days exposure to 0.5 and 1.0 ppmw of 2,4-D for 48 hr.

The high degree of control obtained in Test 1 with short exposure times may be explained by the difference of temperatures encountered between the two tests. Treatments were applied in the first test with temperatures held at 25 C, while the water temperature at treatment time in the second test conducted outdoors was 18 C. The short-term exposure treatments in the second test might have been more effective if the temperature of the treatment solutions were at a higher level and could increase the metabolic rate and 2,4-D uptake of the plants.

SUMMARY

Both tests showed gradual but increased injury to the plants as concentrations and exposure times of the herbicide were increased. Tests conducted in the outside tanks indicate that Eurasian watermilfoil may be controlled in a static situation with a 1.0 ppmw concentration of 2,4-D at a minimum exposure time of 48 hr. The high susceptibility of Eurasian watermilfoil to 2,4-D was demonstrated by the 100% injury of plants exposed to 5 ppmw treatments for only a 1-hr. period.

Careful observations of Eurasian watermilfoil treated with 2,4-D showed a high degree of phytotoxicity. Results of the tests indicate that, providing there is no water movement, control may be expected with a 1.0 ppmw treatment. The treatment contact time is significant in the control of Eurasian watermilfoil with 2,4-D. Insufficient exposure time may mean the difference between extended control and fast regrowth.

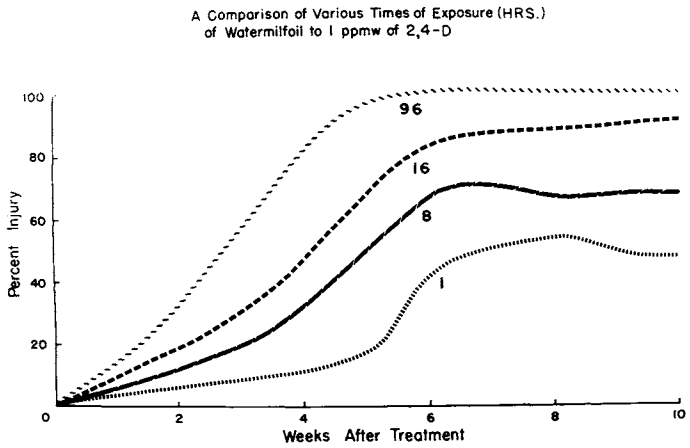

Figure 2. A comparison of injury to Eurasian watermilfoil during a 10-week period following treatments for 1, 8, 16, and 96 hr with 1 ppmw of 2,4-D.

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