Dissipation Of Residues Of 2,4-D In Water, Hydrosoil, And Fish

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ABSTRACT

A field study was conducted to determine the uptake and dissipation of the dimenthylamine salt of (2,4-dichlorophenoxy)acetic acid (2,4-D) in water, hydrosoil, and fish in ponds located in Florida and Georgia. The residue in the treated water was dissipated to less than the negligible level of 100 ppb in 2 weeks, and did not attain this level at any time in the hydrosoil or fish flesh, from a treatment of 2.24 to 8.96 kg/ha ae of 2,4-D.

INTRODUCTION

The widespread occurrence and uncontrolled growth of various aquatic plants, especially in the southeastern United States, has caused many problems including interference with navigation, obstructed water flow, lowered real estate values, reduced fishing success, and impaired recreational use. In addition, the waterhyacinth (*Eichhornia crassipes* (Mart.) Solms.) promotes water stagnation and additional breeding areas for mosquitos.

Various methods have been used to control aquatic plants including mechanical harvesting, which, though feasible in some areas, is too costly and the results are short term. At present, no effective biological control method is operational for two of the most troublesome species; namely, waterhyacinth and Eurasian watermilfoil (*Myriophyllum spicatum* L.). However, Eurasian watermilfoil and waterhyacinth can be controlled by the use of phenoxy herbicides (2,3). The effects of these herbicides on the aquatic environment have been studied (1,4,5,6) but have not been fully examined for cause and effect in the field.

This paper is a compilation of data from experiments designed to determine the residue levels and rate of dissipation of the dimethylamine salt of 2,4-D in water, hydrosoil, and fish from ponds treated at 2.24, 4.48, or 8.96 kg 2,4-D acid equivalent per ha (2, 4, or 8 lb acid equivalent per acre). These applications are one-half, one and two times the recommended treatment rate. Ponds were located in two widely separated geographical locations to study the effects that different physical and chemical characteristics of the aquatic environment might have on the uptake and dissipation of the herbicide. The results of these studies of ponds in Florida and Georgia and the summary of treatment means for rates of applications and days after treatment are given in Table 1.

METHODS AND MATERIALS

Pond Studies in Florida

Three ponds were located on the Plantation Golf Course at Crystal River, Florida. These ponds serve only as water hazards on the golf course, and are not used for drinking and irrigation purposes. All three ponds were treated with rotenone in May 1971 and restocked in June 1971 with largemouth bass (*Micropterus salmoides* Lacepede), channel

TABLE 1. RESIDUES OF THE DIMETHYLAMINE SALT OF 2,4-D IN WATER (MG/1), HYDROSOIL (MG/KG) AND FISH (MG/KG) DROM PONDS IN FLORIDA AND GEORGIA TREATED WITH 2.24, 4.48 AND 8.96 KG 2,4-D AE PER HECTARE.

Pond	Rate kg/ha	Depth m	Temp. C	Time Days	Water mg/l	Hydro-soil mg/kg	Fish mg/kg
Florida	2.24	1.3	34	01	0.025	0.005	0.080
	4.48	1.0	31	01	0.155	0.014	0.048
	8.96	1.2	31	01	0.312	0.033	0.005
Georgia	2.24	1.3	27	01	0.025	0.018	0.005
	4.48	0.9	29	01	0.233	0.024	0.014
	8.96	1.2	30	01	0.657	0.026	0.022
Florida	2.24	1.3	30	03	0.005	0.005	0.005
	4.48	1.0	30	03	0.172	0.014	0.005
	8.96	1.2	31	03	0.345	0.046	0.005
Georgia	2.24	1.3	29	03	0.087	0.008	0.005
	4.48	0.9	32	03	0.390	0.018	0.005
	8.96	1.0	30	03	0.692	0.040	0.005
Florida	2.24	1.3	31	07	0.005	0.005	0.005
	4.48	0.9	31	07	0.048	0.010	0.005
	8.96	1.2	31	07	0.025	0.008	0.005
Georgia	2.24	1.3	26	07	0.059	0.010	0.005
	4.48	0.9	27	07	0.400	0.018	0.005
	8.96	1.0	29	07	0.395	0.042	0.005
Florida	2.24	1.3	32	14	0.005	0.005	0.036
	4.48	1.0	32	14	0.005	0.010	0.005
	8.96	1.2	31	14	0.005	0.013	0.043
Georgia	2.24	1.3	28	14	0.027	0.005	0.005
	4.48	0.9	31	14	0.008	0.005	0.005
	8.96	1.0	30	14	0.050	0.005	0.005
Florida	2.24	1.3	30	28	0.005	0.005	0.005
	4.48	1.0	32	28	0.005	0.007	0.005
	8.96	1.2	30	28	0.005	0.005	0.005
Georgia	2.24	1.3	27	28	0.005	0.006	0.005
	4.48	0.9	31	28	0.005	0.005	0.005
	8.96	1.0	30	28	0.005	0.005	0.010
Summary of Treatment Means							
Rates	2.24				0.020	0.006	0.018
	4.48				0.118*	0.010	0.009
	8.96				0.208*	0.018	0.009
Significant Difference P = 05*					0.099	0.018	NS
Days				1	0.235	0.020	0.029
				3	0.281	0.022	0.005
				7	0.155	0.016	0.005
				14	0.017*	0.007*	0.017
				28	0.005*	0.006*	0.006
Significant Difference P = 05*					0.127	0.008	NS

catfish (*Ictalurus punctatus* Rafinesque), bluegill (*Lepomis macrochirus* Rafinesque), and redear sunfish (*Lepomis microlophus* Gunther). One month prior to treatment the three ponds were stocked with waterhyacinth to cover to 10% of the surface area at the time of treatment.

Pond Studies in Georgia

Four private ponds, within a 16.1 km radius of Warm Springs, Georgia, were used as a second geographical site. These ponds, located on the piedmont Plateau, contained little, if any, submersed vegetation. Since the ponds contained established fish populations of the desired species, only enough fish were added to ensure an adequate number of fish for the experiment. Waterhyacinths were transported from Florida for stocking in the ponds. Total coverage of the waterhyacinths did not exceed 5% of the surface area of each pond.

Treatment

Ponds were sprayed with 2.24, 4.48, or 8.96 kg 2,4-D acid equivalent per ha (2, 4, or 8 lb/A) using a commercial formulation of herbicide [Weedar 64 (R), Amchem Products Ambler, Pennsylvania]. All dilutions were made with water, and no adjuvants were used. The Florida ponds were sprayed on 12 July 1971, and the Georgia ponds on 26 July 1971.

Sampling procedures

Samples of water, hydrosoil, and fish were taken at 0, 1, 3, 7, 14, 28, 56, 84, 112, and 140 days after treatment. Fish were placed in live cages in the Florida ponds for 1 and 3-day samples. Thereafter, fish were collected by hook and line, seine, or set line. They were wrapped in aluminum foil, bagged, and frozen on dry ice. Water samples were taken with a 2-liter Kemmerer water bottle, and were composites of samples from shallow (0.3m), medium depth (0.6 to 0.9 m), and deep (7 m or more) areas. Water for residue analysis was placed in quart jars, and acidified to a pH of less than 2 with concentrated sulfuric acid. The jars were capped with aluminum foil, and sealed with screws caps. Hydrosoil samples were taken with an Ekman dredge from shallow, medium, and deep sites. The three samples were composited for residue analysis. Samples were placed in plastic bags, frozen on dry ice, and kept frozen until analyzed (4).

Statistical analysis

The treatment effects are summarized in Table 1, using a pooled error of rates by dates as a test of significance.

RESULTS AND DISCUSSION

Water

The highest amount of 2,4-D residue in Florida pond water was 0.345 mg/1 found 3 days after treatment in the pond treated at 8.96 kg/ha (8 lb/A). Residue levels of 2,4-D found in Florida ponds decreased to 0.005 mg/1 within 14 days after treatment. In Georgia pond water the highest detectable residue was 0.692 mg/1 3 days after treatment at 9.96 kg/ha. Only trace levels or no residues were detected 14 days after treatment.

Hydrosoil

The highest 2,4-D residue detected in hydrosoil from Florida ponds was 0.046 mg/kg found 3 days after treatment at 8.96 kg/ha. In the Georgia ponds, the highest residue found was 0.042 mg/kg on the seventh day after treatment at 8.96 kg/ha. The dissipation of 2,4-D from hydrosoil is due in great measure to microbiological degradation (1,4,5).

Fish

The highest residues found in any fish were samples from the 1-day harvest from ponds in Florida. These fish

had been kept in live-cages for up to 3 days after treatment to facilitate sampling. Hence, they were unable to escape from the applied herbicide. No residues were detected in fish from Florida ponds at the 3- or 7-day samples; however, negligible residues were detected in fish at the 14-day sampling. This may have been due to the release of the herbicide from decaying vegetation. Only one fish from the Florida ponds contained a detectable residue after 14 days and this was less than the negligible level.

The highest 2,4-D residue found in fish from the Georgia ponds was 0.075 mg/kg found in one of three bluegills harvested at 14 days from the pond treated at 8.96 kg/ha. No detectable residues were found in any fish from the Georgia ponds at the 3- or 7-day harvests, parallelling the results found in the Florida ponds.

None of the control fish contained detectable residues of 2,4-D and the 2,4-D residues found in the exposed fish were well below the toxic levels for the dimethylamine salt formulations.

Waterhyacinth control

The effect of the 2,4-D application on waterhyacinth in the Florida and Georgia ponds was assessed by visual observation. Seven days after spraying, nearly all of the waterhyacinth in all ponds were brown and decomposing. An estimated 98% of the plants were killed by the herbicide application, with no differences in kill noted among the different treatment levels. Since all three treatment levels of the herbicide were equally effective, it would be best to use the lowest effective concentration (2.24 kg ae/ha) although retreatment may be necessary in some spots to prevent reinfestation.

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