Use Of Invert Emulsion Formulations In Aquatic Weed Control[1]

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For 20 years the phenoxy herbicides have been the standard chemicals for the control of most floating aquatic plants. In recent years there has been a noted increase in the amount of damage, by spray drift of these compounds, to susceptible crops (8). Aerial applications are often much more economical than the time-consuming ground and boat applications. The technique of making invert emulsions has been known for many years, but their practical usage with herbicides is relatively recent(1). Most of the research has been centered around brush control(1,2,3). Owing to the reduction of the number of fine droplets, 150 microns or less in size, several investigators(2,5,6,9) have effected excellent control of spray drift with invert emulsions.

The first major work was with a centrifugal spreader(4) since developed into a spinning disk. The invert (water-in-oil) emulsion for this system is formed by premixing the oil and water. The bifluid system is another method of applying an invert emulsion that has recently been developed(7). The invert is formed at the nozzle tip with the bifluid system. Robinson(10) has reported having treated one area for water hyacinth control at least twice with a rather light, 2 lb/A, application of the invert emulsion of emulsifiable 2,4-D acid. The reduction in the stand of water hyacinth was considerably lower than normally expected; this may have been due to factors other than the chemical or spraying system.

We tested the feasibility of using an invert emulsion formulation for the control of floating aquatic plants. We compared the general effectiveness of the invert emulsions with the conventional formulations of silvex for alligatorweed control, and 2,4-D for water hyacinth control.

METHODS AND MATERIALS

One of the systems for making and applying the invert emulsion used a spinning disk fitted with several nozzles located on the edge of the disk (Figure 1). The invert was made by premixing in a separate tank before loading it into the spray tank on the helicopter. Thus the invert flowed by gravity to the spinning disk.

For the other system the oil and water were carried in tanks and pumped separately to the nozzle, where the invert was formed. The nozzles were mounted on a fixed boom.

Tests on Alligatorweed

In 1965 we conducted two alligatorweed tests. One site was on Lake Marion, near Santee, South Carolina, and the other on the Loxahatchee Refuge near Fort Lauderdale, Florida. We selected a dense stand of alligatorweed, growing as a floating mat along with a small amount of rooted alligatorweed. Three plots, each containing 4.8 acres, were treated initially on June 15, 1965, with the bifluid system (Figure 2). Silvex was applied at 6 and 8 lb/A in a total volume of 12 and 16 gpa. We applied 2,4-D at 8 lb/A in 16 gpa. The 2-ethylhexyl ester of both chemicals was used. The chemicals were formulated in the oil carrier and diluted at a ratio of 1 part oil to 3 parts water. The water was preconditioned with sodium bisulfate. All three plots were

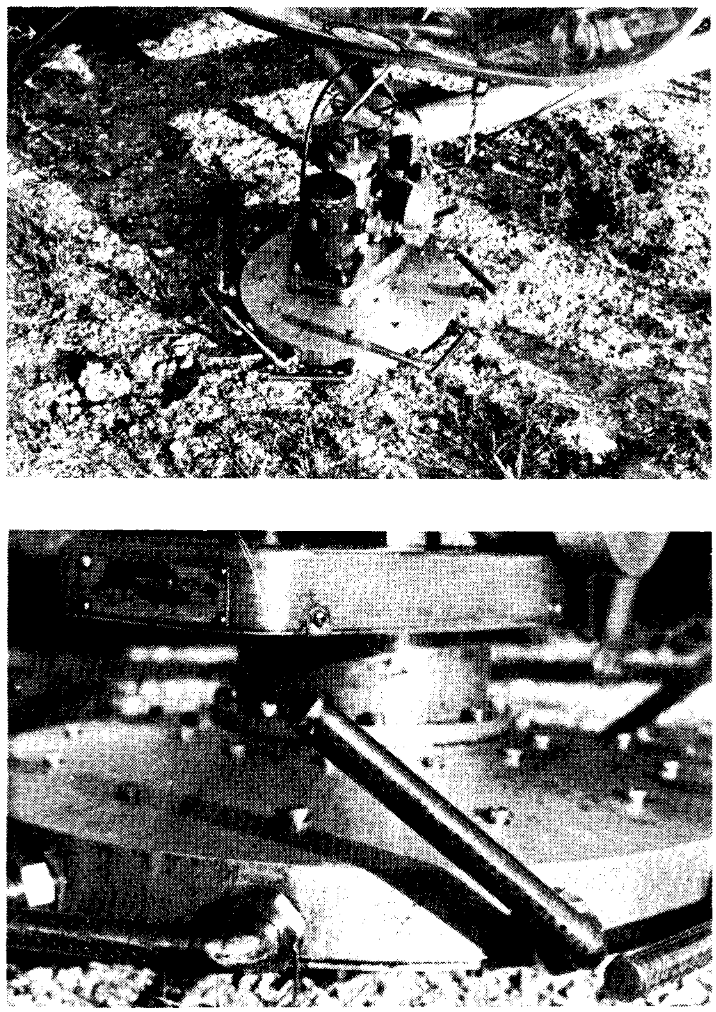

Figure 1. Spinning disk or centrifugal spreader, used for the application of pre-mixed invert emulsions.

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Figure 2. Application of an invert emulsion with the bifluid system.

Figure 3. Application of an invert emulsion on water hyacinth by means of spinning disk.

retreated on August 24 in the same way as for the original applications. Two additional treatments were initiated on August 24 testing silvex at 8 lb/A in total spray volumes of 12 gpa and 17.4 gpa.

For the Loxahatchee test, we treated two 5-acre plots with silvex at 8 lb/A on July 27 employing the spinning disk system. One plot was treated with a premixed invert emulsion, and one with the conventional oil-in-water formulation. The invert emulsion was applied in a mixture of 4 gpa of oil containing the silvex and 12 gpa of water, to give a total volume of 16 gpa. The invert was made by the addition of the water to the oil while the solution was being agitated. The conventional butoxyethanol ester of silvex was applied in a total volume of 16 gpa of water. Each of the plots had about 55% of the water surface covered with alligatorweed, 30% with water hyacinth, and 20% with aquatic grasses. There was an overlapping mixture of species in part of each plot. The plots were retreated on October 3, 1965, in the same manner as the initial applications.

Tests on Water Hyacinth

In 1964 we selected a canal covered with a dense growth of water hyacinth near Fort Lauderdale. We treated five plots, 2,100 ft long, each containing 2.4 acres and covering the entire 50-ft-width of the canal. We compared the invert emulsion of the 2-ethylhexyl ester of 2,4-D at 2.5 and 4.0 lb/A with the invert emulsion of the oil soluble amine at 2.0 and 3.7 lb/A. The conventional oil-in-water emulsion formulation of 2-ethylhexyl ester was applied at 4 lb/A. The 2.0-and 2.5-lb rates were applied in 2 gpa of oil plus 8 gpa of water, for a total volume of 10 gpa of spray solution. The 4-lb/A rates were applied in 20 gpa total solution, or 4 gpa of oil plus 16 gpa of water. Applications began on August 5, 1964, for observation over a 4-month period.

In 1965 we conducted a second test on water hyacinth near Boynton Beach, Florida. The site was a large canal approximately 50 ft wide. We applied four treatments of 2,4-D by helicopter, using the spinning disk applicator (Figure 3). Each treatment consisted of one plot, the entire width of the canal; and covered 3.64 acres. All treatments were applied in a total volume of 8 gpa. The invert emulsions were prepared by adding and agitating the water to the oil.

We made the following invert emulsion treatments: the butoxyethanol ester of 2,4-D at 4 lb/A; 2,4-D emulsifiable acid at 4 lb/A alone and in combination with diquat at 0.25 lb/A. The 2,4-D emulsifiable acid-diquat combination was prepared by placing the diquat in the water before adding the oil that contained the 2,4-D. We applied this on July 27, 1965 and observed results over a 4-month period as before.

RESULTS AND DISCUSSION

Tests on Alligatorweed

In the Santee alligatorweed test all treatments had effected almost complete topkill. The area treated with 2,4-D responded best at first. By August 25, about 10 weeks after the initial treatment, the alligatorweed had made a 30% recovery from the 8 lb/A treatments of both silvex and 2,4-D, the area treated with 6 lb/A silvex had made a 40% recovery.

One month after retreatment in the area that had been treated twice with silvex at 6 lb/A, regrowth began. The other treatments had not yet begun regrowth. Regrowth often occurs sooner after the second treatment than after the first. The plot which received two applications of silvex at 8 lb/A had more open water; the mat was beginning to sink. Judging from observations of other tests with conventional spray solutions, retreatment should have been made at least 2 weeks earlier for the most favorable results—that is, 8 weeks or less after initial treatment instead of 10 weeks.

The alligatorweed was beginning regrowth on all treatments by November 3, 10 weeks after the second treatment. The 8-lb rate of silvex had resulted in about 50% control, with only 3% regrowth. The 8-lb rate of 2,4-D was giving 20% control, and had 12% regrowth. The 6-lb rate of silvex applied twice had 15% control of the alligatorweed with 6% regrowth. We noted only slight regrowth on the plots initiated in August. It was apparent that the 17.4 gpa application was giving better initial control than the 12 gpa volume.

Observations made in May, 1966, showed that two applications of silvex at either 6 or 8 lb/A gave 85% control of the alligatorweed 11 months after the intial treatment, and 9 months after the second treatment. Two applications of 2,4-D at 8 lb/A reduced the stand of alligatorweed over the 11-month period by only 50%. The single fall applications of silvex, not nearly so effective, reduced alligatorweed only 35%. There was no apparent difference between the two volumes of application, 12 and 17.4 gpa.

The Loxahatchee test with the spinning disk application indicated that the two formulations of silvex were quite comparable in activity on alligatorweed (Table 1). The initial invert application was not uniform, since the spinning disk did not distribute the particles in as wide a spray pattern as anticipated. There was better lateral distribution of the conventional material. However, the spinning disk applicator is not designed for use with regular formulations; better equipment for conventional formulations can be employed. The small difference between the two chemicals is probably due to distribution. The second application appeared to be considerably more uniform than the first treatment. The test showed that alligatorweed can be successfully controlled with aerial aplications of either the invert emulsion or conventional formulations of silvex. Two or more treatments were required for satisfactory control.

Table 1. A comparison of 2 formulations of silvex for the control of alligatorweed in an experiment initiated on July 27, 1965, at the Loxahatchee Refuge.

			Months after initial treatment		
			2	5	
Treatment number	Chemical	Rate	Regrowth	Regrowth	Control
		lb/A	%	%	%
1	Invert emulsion	8	25	10	90
2	Conventional spray	8	17	3	95

Tests on Water Hyacinth

Results of the 1964 water hyacinth test with the bifluid system indicated that the most effective control was obtained with the invert formulation of 2,4-D at 3.7 to 4.0 lb/A (Table 2). Regrowth began 4 months after treatment with all rates, but was considerably more advanced in the areas treated with the lighter rates. There was no apparent difference in effectiveness between the oil-soluble amine and the ester. However, an oil-soluble amine is generally more expensive to formulate than the ester. The conventional, ester-in-water, formulation of 2,4-D gave the same degree of control as the invert emulsion, but the amount of drift by the former was much greater. To maintain control of water hyacinth with any formulation of 2,4-D a good respraying program would have to follow.

Table 2. A comparison of 3 formulations of 2,4-D for the control of water hyacinth.

			6 weeks	4 months	
Treatment	Rate	Formulation	Regrowth	Control	Regrowth
	lb/A		%	%	%
Oil-soluble amine	2.0	Invert	5	80	20
Oil-soluble amine	3.7	Invert	T	99+	T
Ester	4.0	Invert	1	99+	2
Ester	2.5	Invert	1	85	25
Ester	4.0	Conventional	1	95	3

During the treatment in the 1965 water hyacinth test large areas were missed by the spinning disk applicator. Observations were largely confined to the treated portions of the plot. To measure the degree of drift, we placed cards treated with an emulsion at various distances, perpendicular to the canal. The invert emulsions neither drifted nor landed more than 5 or 6 ft from the intended spot in the spray swath. This accounted in part for the irregular control, because the invert had actually to contact the water hyacinth for effective control. Aerial applications of conventional materials depend upon propwash to aid in the distribution over the spray swath. Results indicated that all of the treatments were fairly comparable in activity, except for the invert emulsion of the butoxyethanol ester of 2,4-D which was slightly less effective (Table 3). However, larger areas were missed in this plot during the application. Invert emulsions are effective for water hyacinth control, but uniform distribution is much more critical than with conventional formulations.

Table 3. A comparison of 2,4-D formulations for the control of water hyacinth in an experiment initiated on July 27, near Boynton Beach, Florida.

				Months following treatment		
				2	4	
Treatment number	Chemical	Carrier	Rate	Regrowth	Control	Regrowth
			lb/A	%	%	%
1	2,4-D BE ester	Invert	4	6	70	25
2	2,4-D emulsifiable acid	Invert	4	1	80	15
3	2,4-D emulsifiable acid+ diquat	Invert	4+ 0.25	T	85	10
4	2,4-D amine	Water	4	1	80	20

SUMMARY

The control of herbicidal drift is an important consideration in the operational programs for aquatic weed control. Invert emulsion formulations of silvex and 2,4-D appear to be comparable, in activity, to the conventional formulations; and they require the same treatment rates for the control of alligatorweed and water hyacinth. Uniform distribution is essential. In the 2 years of testing the bifluid system resulted in better distribution of the invert emulsion on floating aquatic weeds than treatment by means of the spinning disk applicator which we used only in the 1965 tests.

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