J. Aquat. Plant Manage. 17: 24-27

A New Approach For Salvinia Control

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ABSTRACT

A new concept involving application of a floating, hydrophobic herbicide has been developed. The herbicide floats on top of water and spreads rapidly over emergent plant surfaces. In replicated and randomised glasshouse trials, mature salvinia (*Salvinia molesta*, D. S. Mitchell) was contained in 1 m square by 20 cm deep, polyethylene-lined boxes. Plots were sprayed with the hydrophobic kerosene plus surfactant (calcium dodecylbenzene sulfonate) with and without 2,4-dichlorophenoxy acetic acid (2,4-D), 2-(2,4-dichlorophenoxy) propionic acid (dichlorprop), and 3-(3,4-dichlorophenyl)-1, 1-dimethyl urea (diuron). Rates as low as 0.15 kg/ha diuron gave complete control. The method has been used successfully in the field to control salvinia, water lettuce (*Pistia stratiotes* L.), red azolla (*Azolla filiculoides* Lam.), and water hyacinth (*Eichhornia crassipes* (Mart.) Solms).

INTRODUCTION

Salvinia is an important water weed in many tropical countries of the world, where its rapid growth (6, 7, 8) causes serious problems in still or slowly-moving fresh water

(1). The weed is a serious problem in rice (*Oryza sativa* L.) (4) and causes physical obstruction of water-bodies and irrigation canals (2). Salvinia is widely distributed throughout Queensland, Australia, and infestations vary from small farm ponds to an area of several hundred hectares on Lake Moondarra at Mt. Isa in the north-west of the State (11).

Salvinia is difficult to control due to the high cost of mechanical clearing and the variable results using available herbicides. Present methods using water-based herbicides require high spray volumes because of the difficulty of wetting the plant. This often results in unnecessarily high residues and additional costs.

The objectives of these experiments were to study a new concept involving a hydrophobic formulation based on kerosene plus surfactant. The optimum concentration of surfactant is investigated, as well as the most effective additive among 2,4-D, dichlorprop and diuron to ensure complete control.

MATERIALS AND METHODS

Experimental glasshouse plots were contained in wooden-framed boxes (1 m square by 20 cm deep) lined with polyethylene sheeting and filled with water from domestic supplies. Mature salvinia plants from the field were floated to provide a 95-98% surface cover.

The plots were treated firstly by spraying with solutions of various concentrations (0.0, 0.25, 0.50, 1.0, 1.5, 2.0% W/V) of the oil-soluble surfactant calcium dodecylbenzene sulfonate in kerosene, to determine the level of surfactant that would maximize the mixtures spread over salvinia. In further trials, salvinia plots were sprayed with various rates (0.0, 0.15, 0.30, 0.75, 1.50, 3.0 kg/ha) of the herbicides 2,4-D, dichlorprop and diuron. Incorporation of the herbicides into kerosene was achieved with acetone as co-solvent at the rate of 5% of the final volume. The rate of surfactant used was 1% with all levels of 2,4-D and dichlorprop, and 2% with all levels of diuron.

Application was with a hand-operated pressure sprayer to give a rate equivalent to 300 l/ ha of solution. Treatments were randomized within a complete block design, and were replicated at least twice.

Because of the high asexual reproductive potential of salvinia, it was assumed that all growing points were capable of producing a new plant (11). All surviving axillary and terminal buds following treatment were regarded as potential plants, and were counted as such. Counting surviving growth points was facilitated by suspending over each plot a wire grid of 50 equal quadrats. Counts of surviving growth points were made 12 days after treatment.

RESULTS AND DISCUSSION

The phytotoxic properties of kerosene have been recognized for many years. It is a commonly used solvent and carrier for oil-soluble herbicides (5). Further, kerosene is used as a water surface treatment for the control of air-breathing aquatic insects, particularly mosquitoes (10).

Laboratory tests showed that although kerosene would float on water, its spread was very limited. The addition of low concentrations of the oil-soluble surfactant calcium dodecylbenzene sulfonate to kerosene, greatly increased its spread over both water and emergent fronds of salvinia. Plants sank within seconds.

Data from the glasshouse treatments to determine the optimum concentration of surfactant are presented in Table 1. The addition of surfactant at all concentrations gave a significant improvement ($p < 0.01$) in control. Also the surfactant at 1.5% and 2.0% gave significantly better results ($p < 0.01$) than at lower concentrations, although there was no significant difference between the two.

TABLE 1. SALVINIA GROWING POINTS SURVIVING 12 DAYS AFTER TREATMENT WITH KEROSENE PLUS VARIOUS CONCENTRATIONS OF SURFACTANT.

Surfactant concentration (% W/V)	Surviving growing points per plot[a]
Control (no treatment)	1500
0.00 (kerosene only)	1145
0.25	425
0.50	580
1.00	410
1.50	185
2.00	100

[a] Each value is mean of 3 replicates.

When a kerosene/surfactant solution is applied to water, it spreads out as a very thin layer. Because of its lower surface tension, the layer is able to penetrate among the surface hairs of salvinia, destroying its buoyancy and submerging the plant. Some limited regrowth may occur as the axillary and terminal buds are normally submerged and escape contact with the surface treatment. The addition of a translocated herbicide ensures complete control.

Data from the trial to determine the most effective translocated herbicide (at various concentrations) among 2,4-D, dichlorprop and diuron are presented in Table 2. The herbicides 2,4-D and dichlorprop significantly improved ($p<0.01$) the effects of the kerosene/surfactant base, but did not differ from one another. Diuron at all levels gave complete control.

TABLE 2. SALVINIA GROWING POINTS SURVIVING 12 DAYS AFTER TREATMENT WITH KEROSENE/SURFACTANT AND VARIOUS HERBICIDES[a]

Herbicide rate (kg/ha)	2,4-D plus surfactant (1%)	Dichlorprop plus surfactant (1%)	Diuron plus surfactant (2%)
Control (no treatment)	4500	4500	4500
0.00 (Kero/surf. only)	895	895	300
0.15	[b]	[b]	0
0.30	[b]	[b]	0
0.75	220	355	0
1.50	175	245	0
3.00	265	355	[b]

[a] Each value is mean of at least 2 replications.
[b] Not treated.

Aquatic weeds have previously been treated with kerosene (3) and emulsions of kerosene (9). Both herbicides relied wholly on direct impact on the plant, as surface spread was negligible. High volumes (650-1100 l/ha) were required to control "immature, flat-phase salvinia" (3, 9).

In the present work, the floating water-immiscible herbicide spread laterally over water and plant surfaces. Spread

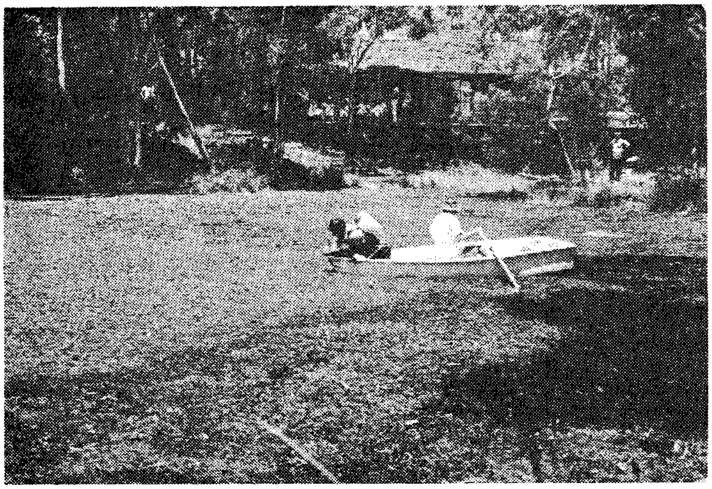

Figure 1. Salvinia covered pond at Buderim, Queensland, being sprayed with AF 101. Note sprayed plants in foreground.

of up to two meters over a free water surface was observed in the field. The lateral spread enabled complete control of mature salvinia with volumes as low as 50 l/ha using aircraft and hovercraft application.

Salvinia is susceptible to diuron (14). In aqueous suspension, rates of up to 7 kg/ha[1] were required; in the present experiment, rates as low as 0.15 kg/ha achieved complete control.

As a result of these and other trials a commercial product has been formulated as a mixture of 20 g diuron and 150 g calcium dodecylbenzene sulfonate per liter of formulation with acetone and kerosene as co-solvents. The mixture is then diluted 1 in 10 with kerosene (domestic, industrial or aviation grade). Water should be kept out of the mixture. This herbicide has been made available in Queensland for large scale experimental purposes under the code name AF 101.

The solution is more effective on lighter infestations where some free water is present to aid maximum spread over the leaves and stems. Sprayed areas are instantly visible,

[1]James, P. 1977. Progress report—salvinia trials (Unpublished) Department of Lands, Brisbane, Australia.

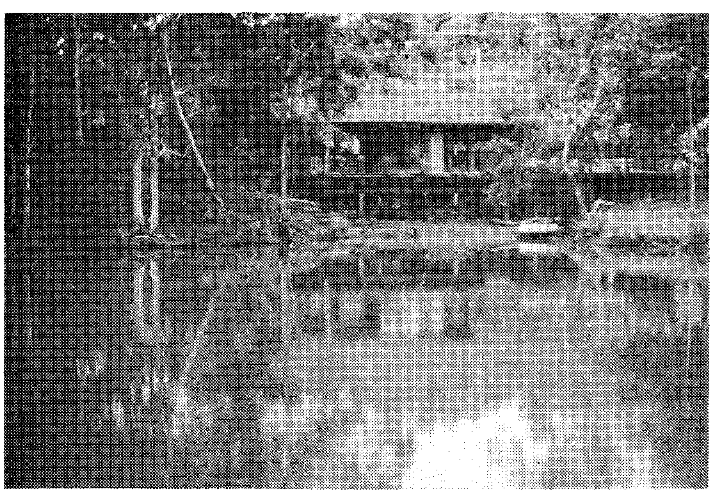

Figure 2. Same area as figure 1, 12 days after treatment.

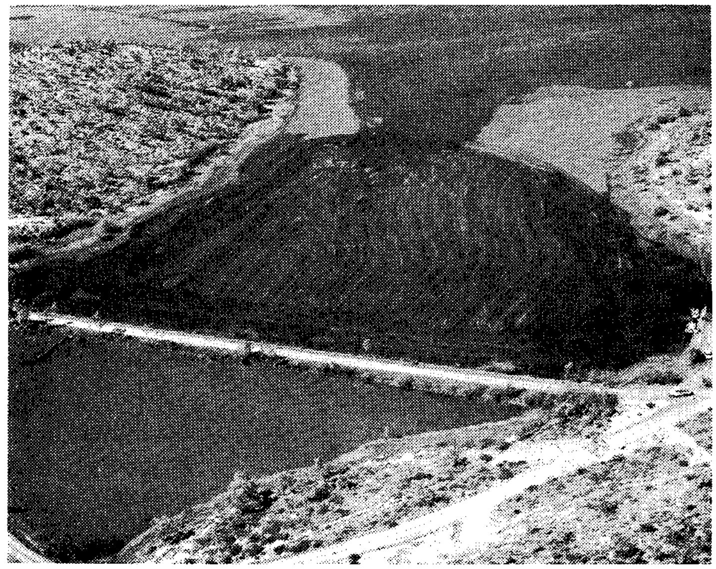

Figure 3. Aerial view of Lake Moondarra, Queensland during hovercraft spraying with AF 101. Note the easily visible spray pattern with dense untreated salvinia in the foreground and background.

making field application, particularly aerial spraying, more accurate.

AF 101 has been used successfully for the large scale experimental treatment of red azolla *Azolla filiculoides* var. rubra (R.Br.) and water lettuce (*Pistia stratiotes* L.). A modification of the formula to incorporate 2,4-D acid in place of diuron has given excellent control of water hyacinth (*Eichhornia crassipes* (Mart.) Solms.) where some free water is still present among the plants. Submersed species appear to be unaffected by the floating herbicide.

Contamination of water following application of AF 101 appears to be minimal (6) and it would appear that this technique is environmentally acceptable. The short-term deleterious effects of diuron on fish life and on invertebrate fish food appear to be minimal, though little is known of the long-term effects (12).

Although data are not yet available, general observations indicate a useful degree of selectivity of AF 101, with limited damage to grasses and bottom-rooted plants. Preliminary glasshouse trials on paddy rice indicate that with careful placement of AF 101, salvinia can be removed selectively from the crop.

Manipulation of water levels (13) can be used with advantage to protect desirable species, and/or to facilitate placement of the floating herbicide on to target plants. For example, in paddy rice the water level could be raised temporarily to protect the crop during treatment. In the case of submersed species in non-crop situations the water level could be lowered to expose the plants to treatment with AF 101.

ACKNOWLEDGMENTS

The authors are grateful to Mr. C. Lucas of the Biometry Branch of the Queensland Department of Primary Industries for statistical analysis of results; also to Mr. W. H. Haseler, Director of the Sir Alan Fletcher Research Station for helpful criticism of the text.

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