AN EVALUATION OF AN AQUATIC WEED CONTROL CHEMICAL ACROLEIN

By W. M. HOULKER, Shell Oil (N.Z.) Ltd.

SUMMARY

THE control of submerged and floating aquatic weeds presents a problem in lakes, dams, ponds, irrigation races, and drains. Recommendations for the effective control of these types of weeds are more difficult to make than for the control of emergent weed species, the majority of which have proved susceptible to dalapon, 2,4-D, and amitrole or a combination of these.

Acrolein has shown high effectiveness in the control of submerged and floating aquatics in the U.S.A., but trials in New Zealand so far have failed to show similar results.

It is considered possible that the relatively low water temperature experienced in New Zealand may be a limiting factor, which could possibly be overcome by higher rates of application of acrolein or the use of an emulsifiable formulation. Future trial work will involve the use of the emulsifiable formulation, which is expected to offset the conditions limiting the effectiveness of acrolein in this country.

INTRODUCTION

Aquatic vegetation has presented a problem of weed control in many areas of New Zealand and in the main there are four situations of concern.

1. Stock watering ponds and dams.
2. Lakes, particularly those used for recreation.
3. Drains.
4. Irrigation races.

Plants which colonise these areas are of three types, best described as the submerged, floating, and emergent groups and the species involved have been described by Schofield (1), Banfield (2), and Matthews (3), along with considerable valuable information concerning their control.

The control of most emergent aquatic species is reported to be adequate with materials such as dalapon, amitrole, and 2,4-D, but as stated by Matthews (3), the submerged and floating aquatics are usually difficult.

In considering the control of submerged and floating aquatics in the above situations three methods are possible; removal by hand labour, mechanical means, and by chemicals.

The use of chemicals is particularly attractive for the following reasons:

1. With lakes and watering ponds or dams hand or mechanical methods are generally impractical due to difficulty of access to the areas.
2. The difficulty of obtaining labour and/or machinery for this type of work.
3. The fact that hand or mechanical methods tend to widen and deepen drains or races and accumulate debris at the edges.
4. Regrowth of weeds normally occurs rapidly, aggravating the difficulties outlined above.
5. Hand and mechanical methods are costly.

As a possible method of aquatic weed control acrolein should first be considered in relation to the submerged and floating species, and second as a possible alternative to dalapon, amitrole, and 2,4-D for the control of emergent weed growth.

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PROPERTIES OF ACROLEIN

Acrolein is highly reactive chemically, is highly inflammable, and is a powerful irritant and lachrymator.

However, the material can be safely used by means of simple application equipment which is described below.

Though acrolein vapour is extremely unpleasant, it is practically impossible to remain voluntarily in atmosphere containing even small amounts long enough to produce harmful effects to man. The vapour concentration tolerable is far below the harmful concentration.

MODE OF ACTION

Acrolein is a general cell toxicant which reacts with various vital enzyme systems. The dead tissues gradually disintegrate and float downstream so as not to produce large masses of vegetation which might block a waterway.

The herbicidal effects are normally evident from a few hours to one or two days, while weeds disintegrate slowly and clear out over a period of three to four days to two weeks depending on the temperature.

WEED SPECIFICITY

Though acrolein appears to be toxic to all submersed weeds and algae, no special studies have been made to determine the relative susceptibility of the various species. There are indications that the totally submersed forms are more easily controlled than the floating forms.

Acrolein shows little effect on emergent weeds such as raupo (*Typha angustifolia*) at dosages sufficient to control submersed species. Floating forms can be controlled, but dosages at least double those for submersed species are necessary.

APPLICATION RATES

Flowing Canals and Ditches

The amount of acrolein required is primarily determined by the amount of water flow in the stream, though water temperature, velocity, and weed density must be considered. Water flow is generally stated in cubic feet per second and the amount of material used is expressed in terms of this value.

The acrolein is added over a time interval so that a blanket or wave of treated water is formed that moves downstream, bathing the weeds in toxicant.

The amount of toxicant the weeds receive is therefore determined by (1) its concentration in the water and (2) the time during which the treated water passes over the plants.

It has been found that a given quantity of acrolein may be introduced over a period of time ranging from 45 minutes to 300 minutes with equal effectiveness.

Laboratory and field research has shown that acrolein is more effective at high temperatures than at low temperatures. At low temperatures the amount of acrolein needed for effective weed control must be increased.

Suggested dosages:

Temperature above 70°F
¾ to 1½ gallons per cusec
Below 70°F
1½ to 2½ gallons per cusec

Acrolein is used up as the treated water moves downstream due to absorption by weed tissue and vapour loss. The distance that a given dose will remain effective depends on temperature, density of vegetation, and rate of flow, but at recommended rates control has been achieved for distances up to 15 miles.

Ponds and Static Ditches

In these situations acrolein will remain in contact with the weeds for a longer period than in a flowing waterway. Lower concentrations may therefore be used.

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Acrolein is added to ponds and static ditches by injection at various points, approximately 15 ft apart. Injection may also be obtained by means of a boom suspended over the drain, with the outlet moving approximately 1 ft below the surface.

Suggested dosages:

Temperature above 70°F
½ to 1½ gallons per acre foot.
Below 70°F
¾ to 2½ gallons per acre foot.

APPLICATION

Though acrolein is extremely irritating to the eyes and vapours cannot be tolerated, it is possible to apply the material safely and conveniently.

This is achieved by the use of a closed system, whereby the acrolein is delivered from the holding drum to the water without being exposed to the atmosphere. In our trial work we have used the standard type of agricultural spraying equipment with a simple modification.

The inlet and outlet hoses of a hydro pump are placed in the water and the acrolein is introduced by a connection on the inlet side of the pump.

From the holding drum the acrolein passes through a meter before entering the pump inlet so that the rate of addition to the water can be accurately adjusted.

With this equipment the acrolein is mixed with the water being pumped to and from the area being treated.

EFFECT OF ACROLEIN ON FISH LIFE

Acrolein is toxic to fish life and herbicidal rates have been observed to kill trout and eels. It may be possible to prevent harm to fish by releasing a small amount of acrolein into a stream or flowing drain before commencing treatment, to act as a repellant.

In ponds or static ditches it may be possible to treat part of the area and allow the fish to migrate to the untreated section. After the material has dissipated (approximately 48 hours), the remainder of the area could be treated.

TRIAL WORK IN NEW ZEALAND

Two trials have been carried out in New Zealand, one in Alexandra involving the control of submerged aquatic weeds, the other in Shannon concerning floating and emergent weed species.

1. **Alexandra trial:** An irrigation race was adjusted to flow at the rate of 1 cusec. The water temperature was 59°F and 2 gallons of acrolein was introduced to the water over a time interval of 45 minutes. The point of introduction of the acrolein was 1¼ miles distant from the entry of the race to a major river.

Weed species present: *Myriophyllum elatinoides, Potamogeton cheesemanii, Ranunculus fluitans,* and *Glyceria fluitans.* Algal slime was also present.

Results: Fourteen days following treatment slime and *Myriophyllum elatinoides* appeared well affected and under control. *Potamogeton cheesemanii* also appeared under control. *Ranunculus fluitans* was reduced in bulk in shingly areas, but not in silt areas. *Glyceria fluitans* was also affected, as were grasses and clovers growing on the edges of the race and overhanging the water. Six weeks later the weeds appeared to be recommencing growth, and after three months there were indications that the weed infestation was approaching its original level.

2. **Shannon trial:** A drainage channel 10 ft wide and 2 ft 3 in. in depth was treated by injecting acrolein at the rate of approximately 14 fl. oz. each 15 ft. This was equivalent to 8½ gallons per acre/foot. The water temperature was 52°F. Water flow was practically static.

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Weed species present: Bamboo grass (*Stipa* spp.), *Glyceria fluitans, Glyceria maxima, Alisma plantago aquatica, Azolla filiculoides* var. *rubra, Lemna minor, Spirodela oligorrhizia,* and *Wolffia arrhiza.*

Results: Weed control was unsatisfactory generally, when the area was inspected 14 days after treatment. There was evidence that the duckweed had been controlled close to the points of acrolein injection, *Glyceria fluitans* and *Alisma plantago aquatica* were affected where the material had contacted the plants. The diffusion of acrolein throughout the water had, however, been poor as shown by the limited amount of damage to the weeds, and this was confined to the small areas where the acrolein had been introduced.

DISCUSSION

The excellent reputation which acrolein possesses as an aquatic weed control chemical has arisen mainly from extensive trial work and commercial use of the material in the U.S.A. It has also been used commercially in Australia with success.

In the two trials recorded here we have been unable to achieve adequate aquatic weed control with acrolein, and the reasons for this are not clear.

One reason may be the relatively low water temperatures present under the conditions of our trials. Though the dosage rate was estimated to allow for the low temperature, it may be necessary to increase this still further to achieve results. It is obvious also that a considerable amount of acrolein is lost by vaporisation, thereby reducing the concentration in the water available for weed control. It is considered possible that an emulsifiable concentrate formulation of acrolein will result in better dispersion and diffusion of the chemical throughout a water mass, and will allow a higher concentration of acrolein to remain in water for a longer period. This is expected to increase the efficiency of acrolein under New Zealand conditions, and for this reason future trials will involve an emulsifiable formulation.

Acknowledgment: Information was supplied by Shell Chemical Corporation, New York, and Shell International Chemical Company Limited, London.

References:

1. Control of weeds in irrigation races. R. C. Schofield, Proceedings of the 9th New Zealand Weed Control Conference 1956.

2. New aspects of chemical control of weeds in drains. G. L. Banfield, Proceedings of the 12th New Zealand Weed Control Conference 1959.

3. Aquatic weed control. L. J. Matthews. Proceedings of the 13th New Zealand Weed Control Conference 1960.

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DISCUSSION ON MR HOULKER'S PAPER

Mr F. B. Thompson—Does Mr Houlker think there is a place for acrolein in New Zealand in view of the hazard to the operator?

Mr Houlker—We have to prove that the material is effective, but supposing it were so, I think the next thing is that it would have to be restricted to people who are trained in the use of it. I am fully aware of the fact that it is extremely unpleasant to use. It can be used quite safely, but I realise that trained operators would be the only ones able to use it, if it proved to be effective.

Dr Mason—Do the inequalities of water flow due to the density of weed growth in the Alexandra trial limit the effects of acrolein or does the vapour from the acrolein overcome these inequalities of the water flow?

Mr Houlker—The weeds were pretty evenly dispersed over the width of the channel. We could test down to 1 p.p.m. We did different tests throughout the channel and we did not notice any difference in the concentration at different points.

Mr Isaacs—In the Shannon trial the failure of the acrolein to disperse could have been overcome by continuous injection over the length of the drain rather than at fixed points.

Mr Houlker—Unfortunately in this area there were a lot of humps and hollows. Static ditches do cause a problem with acrolein. In this situation we could not trail a hose in the water due to the irregularity of the banks.

Mr Bascand—Would the speaker please elaborate on the effect of water temperature on acrolein?

Mr Houlker—The limiting factor is the solubility of the acrolein in water. With higher temperatures you are getting a little more solubility in the water. It is very volatile at low temperatures.

Mr Porter—What will the position be if the chemical does become widely used in view of the fact that all drainage waters eventually reach rivers which have fish and other valuable organisms.

Mr Houlker—Normally when an irrigation race is treated it is not possible to trace acrolein when the race meets a waterway due to dilution. It seems from overseas work fish need 3 parts per million to affect them. By correct techniques you can warn the fish so that they move to safety.

Mr Boyce—What is the effect of acrolein in a diluted state on stock having access to treated areas.

Mr Houlker.—In practice the material is not particularly toxic to stock. Its main effects are on the mucous membranes. Dairy cows have been given water containing 90 parts per million for 24 hours and there has been no effect on the cows. I am sure that a precaution in its use would always be to keep stock out of the area. I do not think there is a great chance of harm arising even if they drank treated water. In addition acrolein is extremely repellent to stock. In studies with rats, they have died of thirst rather than drink water with acrolein in it.

Mr Gordon—How do chlorinated benzines compare with acrolein in view of the fact that chlorinated benzines are much easier to handle.

Mr Houlker—The acrolein should have a wider spectrum of control than the emulsifiable solvents on chlorinated benzines.

Comment:

Mr Hall—Acrolein is being used in New South Wales for the control of weeds in drainage canals.

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