CHEMICAL CONTROL OF *EUPATORIUM ADENOPHORUM*, CROFTON WEED

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ABSTRACT

An investigation is described which was aimed at finding a more suitable treatment for chemical control of E. adenophorum *than 5% sodium chlorate solution. Screening trials indicated that 2,4-D as amine and 2,4-D/2,4,5-T mixture as esters could be useful. A more detailed experiment confirmed that these two herbicides could be used as substitutes for sodium chlorate if applied in autumn when vegetative growth rate is high. A 0.6% solution of 2,4-D amine applied in autumn is regarded as a suitable and more economical alternative to sodium chlorate for chemical control of* E. adenophorum.

INTRODUCTION

Eupatorium adenophorum. (Compositae), crofton weed, is a many stemmed erect perennial herb, growing up to six feet in height. It has been a troublesome weed in grass dominant pastures on the north coast of New South Wales and south eastern Queensland for several years. A recent mail questionnaire survey indicated that it is still regarded as a serious problem by many farmers on the north coast of New South Wales (Auld 1971). It is also a weed of California (Fuller 1961) and Hawaii (Hosaka and Thistle 1954).

Biological control of this species has been fairly successful in Hawaii (Bess and Haramoto 1959) but in Australia it appears that only the rate of spread of the plant has been significantly effected by this method (Haseler 1966; Auld 1969). It can be easily controlled by ploughing or slashing followed by ripping and the subsequent sowing of replacement species. However, large quantities of scattered *E. adenophorum* occur on difficult terrain where the use of machinery is impractical and large scale pasture improvement is costly. It is these infestations which are most likely to be controlled successfully by herbicides.

Although there is no published experimental data dealing with chemical control of *E. adenophorum,* Whittet (1968) states that "a measure of control can be achieved by using 5% sodium chlorate spray, or 0.3% 2,4-D—2,4,5-T mixture". Sheldrick (1968) recommends 2,4-D and 2,4-D/2,4,5-T mixture for control of *E. odoratum* in Nigeria. Landholders in northern New South Wales have used these herbicides as well as 2,4,5-T as ester, amitrole and 2,4-D/picloram mixture with extremely variable results. Many found that two applications were needed to achieve satisfactory control.

Sodium chlorate as a 5% solution has been the most favoured herbicide because of consistently satisfactory kills. It does, however, have a number of disadvantages. It is non-selective, residual, relatively expensive and a strong oxidising agent and highly inflammable. Borates or other fire suppressants added to this herbicide will reduce fire risk but such formulations are not in common use. In addition, salt-hungry animals may eat enough treated vegetation to become poisoned (Thompson 1967).

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This paper reports the results of experiments directed to find a herbicide more suitable than sodium chlorate for the chemical control of *E. adenophorum*. The experiments discussed were carried out on six sites on the far north coast of New South Wales from 1967 to 1970.

PRELIMINARY EXPERIMENTS

The effectiveness of herbicides can vary with seasonal growth of perennial species (Klingman 1961). In order to obtain a quantitative estimate of seasonal growth rate of *E. adenophorum,* monthly increase in stem length was recorded. Readings were made during the vegetative growing period of the plant from the end of January to the end of October on ten plants at two sites during 1968 and 1969 (Fig. 1). New shoot growth commences with the first sustained rains of summer usually in late January. Vegetative growth rate is high during late summer and autumn; it decreases during winter and ceases in spring as plants flower and fruits form. The production of flowers and fruits also involves changes in translocation pattern. There would therefore appear to be more likelihood of success, particularly with hormone-type herbicides, when applications were made in autumn rather than spring.

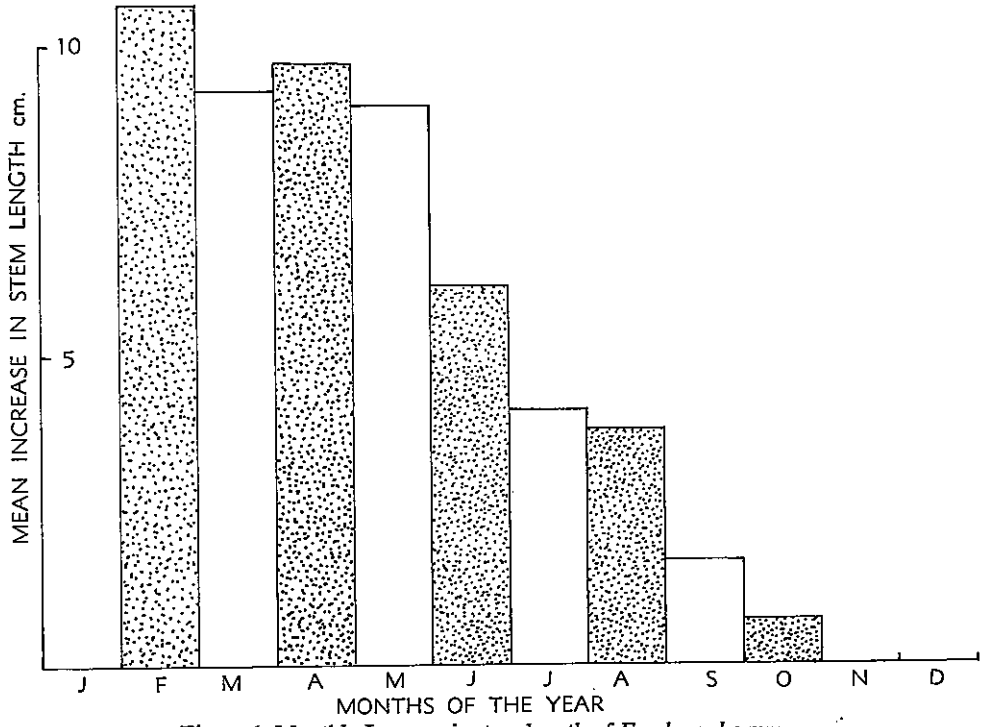

Figure 1. Monthly Increase in stem length of *E. adenophorum*.

Pilot investigations with a number of herbicides indicated that the plant could only be killed if the leaves, stems and crown of each plant were sprayed with herbicide. The volume output per acre necessary to achieve complete coverage was found to vary with density of the infestation, but at least 250 gallons of liquid per acre of *E. adenophorum* were required. However, because the plant generally occurs in scattered patches in semi-arable areas, volume per acre of land would be considerably lower when the weed is spot sprayed by landholders.

In practice, the application of even moderately high volumes of liquid on semi-arable land can present difficulties in the transportation of water. An alternative method considered was the use of granular forms of some herbicides to obviate the need for water. Sodium chlorate, 2,4-D as sodium salt, bromacil and 2,4-D/picloram mixture were tested either by placing powder or pellets at the base of individual plants or by uniformly covering plots at ground level and allowing the herbicide to dissolve in dew and rain water. Although sodium chlorate and 2,4-D as sodium salt were effective at rather high rates when applied to individual plants, costs are prohibitive for general use. Thus further work was restricted to the examination of liquid forms of herbicides.

Screening trials of a total of twelve herbicides at various rates at four sites and four times of application during 1968 and 1969 were made (Table 1). Treatments were applied from a hand operated knapsack sprayer calibrated to deliver 250 gallons per acre. Plants were determined as dead when they could be easily removed from the ground by gently pulling the stems and all parts of the plant were dry and brittle.

TABLE 1

Herbicides examined in Screening Trials

Herbicides	Range of Solution Concentration %	Non-selective* at Certain Rates	Residual* at Certain Rates
2,4-D amine	0.2–1.2		
2,4-D ester	0.3–1.0		
2,4,5-T amine	0.3–1.2		
2,4,5-T ester	0.3–1.0		
2,4-D/2,4,5-T esters (mixture)	0.2–2.4	x	
Fenoprop	0.2–0.8		
2,4-D/picloram (mixture)	0.2–0.8	x	x
2,2-DPA/amitrole (mixture)	1.3–5.2	x	x
Amitrole	0.8–3.2	x	x
2,3,6-TBA	0.5–2.0	x	
Diquat	0.3–1.2	x	
Sodium chlorate	5.0	x	x

*Herbicides which displayed non-selective action or residual activity at certain rates or times of application are indicated by x.

All herbicides showed some activity against the plant. Many treatments were non-selective, causing varying degrees of damage to associated *Axonopus affinis* and *Paspalum dilatatum* (Table 1). Many treatments showed residual activity after several months on indicator pasture species sown in the plots (Table 1). It was observed that *E. adenophorum* being typically an invader of bare areas, was often the first species to colonize the denuded plots.

On the basis of effectiveness, selectivity and cost, 2,4-D amine and the lower concentrations of the mixed ester formulation of 2,4-D/2,4,5-T were selected for further comparison with sodium chlorate. The results for these two herbicides indicated a possible effect of time of application; the lower rates being more effective in autumn than in spring. Accordingly, the main experiment compared times and rates of application.

MAIN EXPERIMENT

Methods

It is extremely difficult to find uniform stands of *E. adenophorum* at any one site which are sufficiently large and otherwise suitable to meet all experimental

needs. As a result of this limitation, some replications although applied on the same day were made on different sites.

2,4-D amine, 2,4-D/2,4,5-T mixed esters and sodium chlorate were each examined at two solution strengths (Table 2). These treatments, with the exception of 2.5% sodium chlorate solution, had all been used in the screening trials. Each treatment was replicated four times at two applications, March and September, 1970.

Plot size was 12 ft x 20 ft and 6 ft x 20 ft buffer area was left between each plot. An adjacent area of 12 ft x 20 ft was left untreated at each site as a control. Six months after treatment all living *E. adenophorum* material above ground level was harvested by hand from each plot and oven dried. The dry weight of this material was compared with the dry weight of all living *E. adenophorum* above ground level in the control plot. This comparison is expressed as a "percentage kill" using the formula:—

$$\text{Percentage kill} = \frac{C - T}{C} \times \frac{100}{1}$$

where C and T are the dry weights of *E. adenophorum* harvested from control and treated plots respectively.

Results

March applications produced a total kill in each replication of both sodium chlorate treatments. All other treatments produced high percentage kills (Table 2).

September applications of all treatments were less effective and produced more variable results than March applications. Only the 5% solution of sodium chlorate gave an acceptable level of control.

At each time of application both sodium chlorate treatments were equally non-selective; no plant growth was apparent in the plots for several months.

TABLE 2

Mean percentage kill of E. adenophorum

Herbicide	2,4-D		2,4-D/2,4,5-T		Sodium Chlorate	
Concentration %	0.6	1.2	0.3	0.6	2.5	5.0
Application Time						
March, 1970	95 (1.65)*	95 (4.67)	91 (5.45)	99 (0.50)	100 (0.00)	100 (0.00)
September, 1970	75 (5.43)	80 (7.88)	60 (10.66)	79 (8.95)	79 (4.84)	94 (4.25)

*Standard errors in brackets below mean values.

The variations in the effectiveness of treatments with time are attributed to differences in growth rate of the plant at the time of treatment application as the effect occurred in each year's experiments. In 1970 it was probably more pronounced because of the rainfall distribution. Rainfall before March was quite adequate to promote active translocation and growth but from May to September it was far below average and the effect on plant growth was noticeable. The monthly rainfalls for 1970 and mean values for the nearby town of Mullumbimby show this (Table 3).

Some of the poor results obtained by landholders in *E. adenophorum* control are attributable to the fact that applications are often made in spring when the

plant is conspicuous by its white flowers. The marked influence of time of application on results could also account for the conflicting reports on the effectiveness of particular herbicides.

TABLE 3

Monthly Rainfall, Mullumbimby, N.S.W. (inches)*

Month	1970	Average (1898-1968)
January	7.80	8.22
February	11.13	8.79
March	8.11	9.40
April	3.69	6.85
May	0.93	6.42
June	0.58	4.89
July	0.18	4.33
August	1.68	3.13
September	2.34	2.69
October	7.54	3.54
November	5.34	4.38
December	19.72	5.58

*These data were kindly supplied by the Commonwealth Bureau of Meteorology, Sydney.

It appears that the currently used concentration of 5% for sodium chlorate solutions is unnecessarily high if treatments are applied in March. However, like the 5% solution, the lower concentration of sodium chlorate was non-selective and residual. The lack of selectivity in this herbicide is its greatest shortcoming for *E. adenophorum* control.

The low rate of 2,4-D/2,4,5-T mixture produced more variable results than the low rate of 2,4-D in March. Although mixed esters of 2,4-D/2,4,5-T are in common use in cut stump and basal bark treatments for other local woody weeds, the volatility of most formulations containing esters, in high volume applications, creates a hazard to nearby susceptible crops.

2,4-D amine, as an 0.6% solution when applied in autumn is selective and produces a high mortality of *E. adenophorum*. It is less volatile than an ester formulation and was the cheapest of all treatments examined. Based on current (October, 1971) retail prices, the cost of herbicide needed for control of one acre of scattered (say 10% ground cover) *E. adenophorum* is approximately $1.30 for 0.6% 2,4-D amine and $2.50 for 5% sodium chlorate. 2,4-D applied in autumn is considered to be a suitable alternative to sodium chlorate solution. There is however, scope for investigation of the possibility of reducing the volume of application of herbicides.

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