INTERIM EVALUATION OF SEVERAL SOIL STERILANTS FOR THE CONTROL OF CONTORTA PINE

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Summary

Contorta pine *(Pinus contorta)* is a valuable pioneer for erosion control and site rehabilitation at high elevations, but its uninhibited spread in the Waiouru Military Reserve and Tongariro National Park has earned it the opprobrium of the Defence Department and conservationists. Interim results from a chemical control trial indicate that bromacil, GS29696, and karbutilate at 17 kg/ha applied to 2.3m² of rooting zone can kill young trees. There was no difference in effectiveness between granular and wettable powder formulations. Sodium chlorate at 224 kg/ha and a diuron /2,2-DPA/2,4-D mixture at 17 kg/ha were ineffective. December treatment appeared superior to October.

INTRODUCTION

Controta pine (syn. lodgepole pine) *(Pinus contorta* var. *latifolia)* is a valuable pioneer for erosion control and site rehabilitation. Its rapid spread in the central North Island is, however, causing increasing concern. The Defence Department's concern is that the spread is limiting use of the Waiouru Military Reserve as a training ground, while Conservation groups are concerned because the pine is rapidly invading the tussock lands of the Tongariro National Park.

The aggressiveness of the species first became apparent in the early fifties when it began spreading from existing plantations and shelterbelts in the Karioi-Waiouru area. Extensive areas of even-aged regeneration have given rise to the theory that the main invasions derive from "seed showers" dropped as a result of unusually turbulent atmospheric conditions which are known to occur in this area from time to time. Viable seed production commences when the trees are only four to five years old. Regeneration is currently spreading predominantly in a north-easterly direction.

It is estimated from earlier reports on the problem (Wardrop, 1964; Hogg, 1972) that the total area of infestation in the Waiouru-National Park-Karioi region now covers about 60 000 to 70 000 ha. Stocking varies from sparse or rare, say 1 to 10 stems/ha, to extremely dense with up to 120 000 stems/ha. Of this total area, approximately 17 000 ha lies within the Waiouru Military Reserve, some 3000 ha of this carrying between 12 and 120 000 stems/ha.

There have been several attempts to solve the problem. Hand cutting and rotary slashing have both proved ineffective because of regrowth from uncut lower branches. Where no regrowth has developed, a vigorous crop of seedlings often arises within the old crown area. Burning densely stocked stands shows some promise, but good burns are rarely attainable. No regeneration has been seen on burnt areas. This may be due to the fire consuming the seed in the litter layer and sporadic sheep grazing of the area. The influence of sheep numbers on contorta pine establishment has been investigated by Benecke (1967). The ultimate success of burning remains to be seen. There is also a high risk of fire-induced wind erosion on some sites.

Simulated aerial spraying trials were carried out in 1971 on dense stands by two agricultural chemical companies. Results were inconclusive due largely to application problems. Of nine different treatments applied by one company, 2,4-D at 4 and 8 kg/ha in diesel oil were reported to show most promise (J. Hawthorn, pers. comm.).

In 1973 the Forest Research Institute established the current trial on an area close to the Waiouru Military Camp. The trial was designed to evaluate spot application treatments to individual trees for areas of light infestation.

THE TRIAL

At the beginning of this work indications were that herbicides were only likely to be cost-effective in the so-called lightly infested areas, i.e. up to a few hundred stems/ha, leaving the problem of the more heavily infested areas to be dealt with by other means. The immediate aim was to find herbicides capable of killing individual trees, preferably without killing the indigenous vegetation (principally silver tussock — *Poa laevis*) over wide areas. Questions of application method, practicality, and cost were left in abeyance.

The treatments used consisted of waterborne sprays and granules applied to an area of 2.3 m^2 around the stem of each tree. The sprays were applied at the rate of 1100 litres/ha, using a CO_2-pressurised, hand-held, single-nozzle spray lance with a Hardi 4680-15F tip. Pre-measured doses of granules were applied by hand.

The chemicals used and rates of application are listed in Table 1. The treatments were applied on four different dates: 25 October and 17 December 1973 and 11 March and 30 May 1974. Only the results of the first two treatments are reported here. There were approximately 20 trees in each October treatment and 10 trees in each treatment at the subsequent times. Groups of widely scattered trees were subjectively chosen for each treatment. Trees chosen varied from 0.5 m to 4.0 m in height.

RESULTS AND CONCLUSIONS

Summarised results from the interim assessment carried out on 30 May 1974 are presented in Table 1. Each tree was rated for brown-off on a percentage basis, by two observers independently, and averaged.

It was evident from our inspection of the trial that there was a strong interaction between tree size and herbicide response. In all treatments the larger the tree the less the effect. This interaction is, however, probably spurious, resulting from a tactical error in placing the chemicals within a fixed area around each stem, rather than in a band further out where the feeding roots were. Thus the larger the tree the fewer the feeding roots in the treated area and the poorer the response. Occasionally large 'untreated' trees at some distance were seriously affected, whereas the treated tree suffered little or no damage. Obviously the results were strongly influenced by the size class distribution of the trees within each treatment; therefore, as well as presenting mean foliage brown-off and tree kill for all trees in each treatment, the results are also given for trees less than 2 m tall, and greater than 2 m, separately.

Two-, three- and four-factor analyses of variance were performed on various balanced data sets. F values and significance levels derived from these analyses are shown in Table 2. With the interim nature of the observation in mind the following conclusions are tentatively drawn:

(1) There appear to be significant differences between the seven chemicals used but not between the formulations as far as brown-off and kill are concerned

TABLE 1. CHEMICAL CONTROL OF CONTORTA PINE: SUMMARY OF TREATMENTS AND RESULTS AS ASSESSED ON 30 MAY 1974

Herbicide	*% Active Ingredient and Formulation*	*Application Rate*	*Application Date*	*Assessment Results*								
				All Trees			*< 2 Metres*			*> 2 Metres*		
		kg/ha		*No. trees*	*% foliage brown-off*	*% dead*	*No. trees*	*% foliage brown-off*	*% dead*	*No. trees*	*% foliage brown-off*	*% dead*
sodium chlorate	50% granule	224	25.10.73	17	5	0	8	8	0	9	2	0
			17.12.73	10	10	0	5	14	0	5	7	0
bromacil	2.5% prill	17	25.10.73	20	74	55	17	80	65	3	37	0
			17.12.73	7	91	57	2	100	100	5	87	40
bromacil	80% w.p.	17	25.10.73	20	42	20	6	97	67	14	19	0
			17.12.73	10	89	70	9	91	78	1	73	0
karbutilate	4% prill	17	25.10.73	18	14	6	13	24	8	5	10	0
			17.12.73	9	50	0	5	85	0	4	5	0
karbutilate	80% w.p.	17	25.10.73	19	32	5	10	58	10	9	3	0
			17.12.73	10	81	30	9	96	33	1	25	0
GS 29696	10% prill	17	25.10.73	—	—	—	—	—	—	—	—	—
			17.12.73	10	77	30	9	82	33	1	30	0
GS 29696	80% w.p.	17	25.10.73	20	46	15	8	80	37	12	24	0
			17.12.73	10	83	20	9	89	22	1	28	0
diuron+ 2,2-DPA+ 2,4-D	32% w.p. 36% w.p. 12% w.p.	17	25.10.73	20	2	0	11	2	0	9	0	0
			17.12.73	10	13	0	9	14	0	1	8	0

Each tree was rated for brown-off on a percentage basis by two observers independently, and averaged.

(2) December treatment was significantly superior to October in terms of brown-off and kill

(3) Trees less than 2 m tall suffered significantly more brown-off and kill than those taller than 2 m

(4) The significant chemicals x tree size (CS) interaction suggests that the effectiveness of some chemicals is less dependent on tree size than others

(5) Bromacil, karbutilate, and GS 29696 are all capable of killing young contorta pine when applied within the rooting zone at 17 kg/ha. Bromacil is the fastest acting and may be the most effective

(6) Sodium chlorate at 224 kg/ha and the diuron/2,2-DPA/2,4-D mixture at 17 kg/ha are probably ineffective.

It is too early to assess ultimate success as complete kill is the only acceptable criterion of a successful treatment. Many severely browned-off trees will undoubtedly die.

The three most promising chemicals all killed off the silver tussock in the treated areas around each tree. The fact that 'untreated' trees were occasionally killed suggests that band or grid treatments at regular intervals might be an effective practical method of low-cost treatment which would, however, leave most of the indigenous flora intact.

Observation of the effects of treatment will continue until the autumn of 1975. The trial will be supplemented with further treatments applied to the drip zone and also in bands at regular intervals.

TABLE 2. F VALUES AND SIGNIFICANCE LEVELS FROM ANALYSES OF VARIANCE PERFORMED ON VARIOUS BALANCED FACTORIAL SETS OF TREATMENT MEANS

Factors	*F Values and Significance Levels*							
	C x D 7 x 2		*C¹ x F* 3 x 2		*C x D x S* 7 x 2 x 2		*C² x D x S x F* 2 x 2 x 2 x 2	
	Brown-off	*Kill*	*Brown-off*	*Kill*	*Brown-off*	*Kill*	*Brown-off*	*Kill*
C	11.31**	5.11**	2.05	6.51	8.25*	39.80**	10.56*	37.76**
D	18.59**	2.09			7.24*	6.60*	6.70*	4.30
S					24.36**	128.93**	18.67**	43.52**
F			1.38	0.90			0.10	0.26
CD	e	e			0.39	5.75*	0	2.13
CS					1.51	22.30**	0.48	20.26**
CF			e	e			1.03	3.81
DS					0	0.05	0	0.19
DF							0	0.46
SF							0.55	1.28
CDS					e	e	)	)
CDF							)	)
CSF							) e	) e
DSF							)	)
CDSF							)	)

C = chemicals
C¹ = bromacil, karbutilate, and GS 29696
C² = bromacil and karbutilate
D = dates of application
S = tree size
F = formulation
* = 5% significance level
** = 1% significance level
e = interactions used to estimate error mean squares

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