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A REPELLENT TO PROTECT RADIATA PINE SEEDLINGS FROM BROWSING BY SHEEP

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ABSTRACT

Repellents containing either thiram or egg, together with acrylic adhesive and red dye, were sprayed on 1-year-old radiata pine seedlings.

Browsing damage on the seedlings by sheep was compared, together with that on untreated seedlings, over a six-month period.

Formulations containing egg significantly reduced the incidence of browsing for 3-4 months but mixtures containing thiram, or acrylic adhesive and red dye without egg were not effective repellents.

Where radiata pine is planted on pasture and sheep are grazed amongst the seedlings, egg-based repellents may be useful in reducing spring and early summer browsing damage. They could also be used on forest sites to protect seedlings from sheep introduced to control weeds such as bracken fern.

INTRODUCTION

Livestock are being increasingly grazed in plantation crops of radiata pine in New Zealand (Knowles and Tustin, 1974). One problem encountered has been a high incidence of browsing damage to radiata pine seedlings in the first spring and summer after planting (Gillingham *et al.*, 1975; Anon, 1975).

One possible solution to this browsing problem is to spray the seedlings with a repellent to prevent or reduce browsing, thus allowing more intensive grazing in the first year following tree planting.

Most reports on the effectiveness of repellents relate to rabbits, hares and deer, in

North America and Europe (Knowles and Benson-Cooper, 1975). Two reports refer to sheep. In a comparison of seven American repellents in Germany (Crombugghe, 1964), a nicotine sulphate preparation was moderately repellent to sheep but repellents containing thiram, ziram, TNB-A (Trinitrobenzene-aniline), copper naphthalene and animal oils showed only slight repellency. Two unnamed German preparations were very repellent. One depended on a mechanical effect as it formed a protective coating, and the other, in addition to forming a protective coating, also repelled sheep by its smell.

In the United States, in two tests using 0.1% and 1.0% sprays of tetramethyl-butynylamine compound applied to pasture at 5.52 litre/ha, sheep seldom "drifted into"

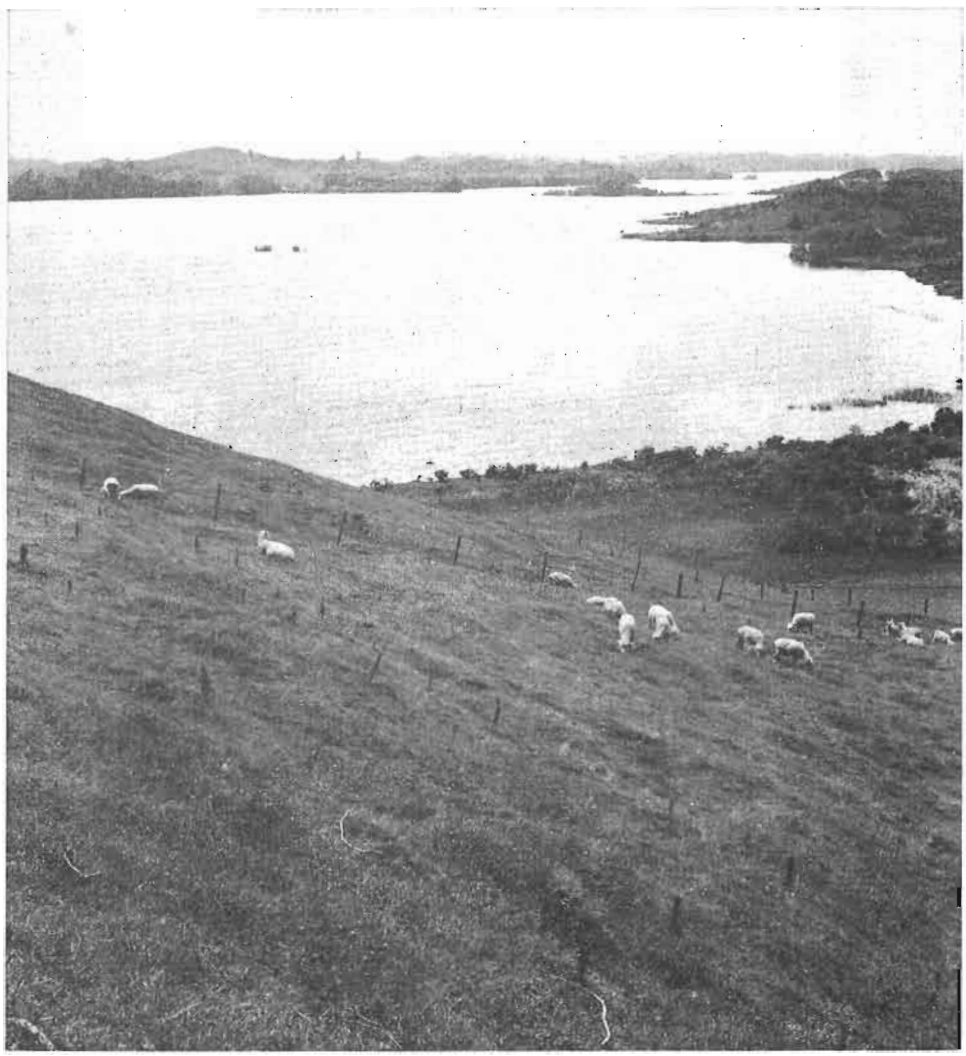

FIG. 1—The trial site at Tikitere, during the first grazing period

the 0.1% treatment areas for 4 days and in the 1.0% areas for 7 days. Grazing was apparent within 2 weeks in both of the areas, but of little importance in the 1.0% plots for 3 weeks (Howell and Goodhue, 1968).

Recent developments with egg-based repellents in the United States suggest better repellency against certain species of deer than previously achieved with either thiram or ziram (Rochelle *et al.* 1974; Hartwell, 1975). The repellent formulation used by Rochelle *et al.* is given as: egg powder 1-10%, acrylic adhesive 10-15%, and water 80-90% applied as a spray to seedlings either in the nursery or after planting in the field. In view of the promising results obtained, egg-based repellents were tested against sheep in two trials near Rotorua.

Methods

The site for the trial consisted of a fenced, grassed paddock of 2 ha sloping to the east at about 30° (Fig. 1).

Trial I. Three hundred 1/0 radiata pine seedlings were planted on one half of the paddock on 7 October 1976. The seedlings were planted in five groups with three lines per group, each line containing 20 seedlings at a spacing of 2.8 × 1.8 m. A 20 m unplanted area was left between each of the five groups. On 27 October, in a sequence which was repeated along the rows, the first seedling was handsprayed with a thiram mixture, the second with an egg and dye mixture, and the third left unsprayed as control. Each treatment contained 100 seedlings (Table 1). Romney wether hoggets (14-20 months old) were grazed at a stocking rate of 112-131 per hectare on five occasions for periods ranging from 2 to 7 days over the following 6 months (Table 2). Seedling heights were measured before and after each period of grazing. Browsing damage to lateral branches and needles, and to leaders, was recorded after each grazing period.

TABLE 1—Repellent composition (per litre of mixture)

Trial	Treatment	Thiram[1] (ml)	Egg Powder (gm)	Adhesive[2] (ml)	Dye Concentrate (ml)	Water (ml)
I	1 thiram	220		220		560
	2 egg + dye		83	450	40	450
	3 control	—	—	—	—	—
II	4 egg + dye		160	340	11	535
	5 egg		160	340		535
	6 adhesive + dye			380	12	608
	7 adhesive + extra dye			380	40	508
	8 treatment 4 diluted		16	34	1	453
	9 control		—	—	—	—

[1] Arasan 42-S, containing 42% thiram [2] Rhoplex AC-33

TABLE 2—Grazing history

Grazing Period	Date in	Date out	Days Grazing	No.	No./ha
1	29 Oct.	3 Nov. 1976	5	260	130
2	24 Nov.	26 Nov. 1976	2	262	131
3	14 Jan.	21 Jan. 1977	7	261	130
4	11 Mar.	14 Mar. 1977	3	224	112
5	7 Apr.	13 Apr. 1977	6	224	112

Trial II. One thousand 1/0 radiata pine seedlings were marked off in a uniform bed at the Forest Research Institute nursery into five groups of about 200 seedlings per group. On 3 November 1976, treatments 4-8 as shown in Table 1 were applied (spraying by hand to run-off).

On the 5 November 1976, 50 seedlings from near the centre of each group were lifted together with 50 untreated seedlings for a control treatment (treatment 9). The seedlings were planted in the same paddock as Trial I at a uniform spacing of 2.8 × 1.8 m, with a sequence of treatments repeated along each planted row similar to Trial I. At the same time, 10 seedlings from each treatment were planted at the FRI nursery to see if the treatments adversely affected the seedlings. The sheep which were grazing Trial I also had access to Trial II, so these trees were subjected to four periods of grazing between November 1976 and April 1977. As in Trial I, browsing damage was noted at the end of each grazing. Seedling heights were measured after the second, third and fourth grazing.

Seedling mortality, incidence of browsing, and severity of browsing (as indicated by changes in seedling heights) were compared for the various treatments.

RESULTS

1. Seedling Mortality

No phytotoxic effects caused by any of the repellent mixtures were apparent in the field, but 5-12% of seedlings died in all treatments. Although some seedlings were found pulled out and others were browsed down almost to ground level, it was not always possible to distinguish between "natural" and "sheep induced" mortality. In all treatments, mortality was considered low, particularly in view of the late planting and the heavy grazing pressure given the trial paddock. After five months, all the seedlings planted in the nursery were healthy.

2. Incidence of Browsing

In Trial I, the egg-based repellent resulted in a significantly lower incidence of browsing damage than that with either thiram or the control, and this extended through until the second to last grazing (Table 3). By this stage, new growth which was unprotected by the repellent was browsed. In Trial II, the adhesive, either with or without the dye, was not an effective repellent. However whenever egg was included in the mixture, browsing was reduced significantly unless the mixture was excessively

TABLE 3—Incidence of browsing damage

Trial	Treatment	Damage category	Grazing period 1		2		3		4		5	
I	1 thiram	a	11	ns	4	ns	4	ns	1	ns	—	ns
		b	89		96		89		89		90	
	2 egg + dye	a	85	**	63	**	38	**	14	ns	—	ns
		b	15		37		58		81		95	
	3 control	a	9		6		5		3		—	
		b	91		94		92		89		90	
II	4 egg + dye	a			43	**	37	**	19	**	—	ns
		b			7		12		27		46	
	5 egg	a			39	**	33	**	14	*	—	ns
		b			11		15		33		47	
	6 adhesive + dye	a			15	ns	8	ns	3	ns	—	ns
		b			35		41		44		47	
	7 adhesive + extra dye	a			13	ns	10	ns	4	ns	—	ns
		b			36		39		41		45	
	8 treatment 4 diluted	a			23	ns	19	ns	10	ns	—	ns
		b			26		30		37		47	
	9 control	a			15		13		3		—	
		b			34		35		41		44	

Note: 100 seedlings per treatment were planted in trial I, and 50 per treatment in trial II. The above figures may not sum to these totals because of mortality.

(a) Unbrowsed, or lateral branches and/or needles browsed only.

(b) Terminal leader browsed, with or without lateral browsing.

Chi-squared test:

** Significantly different from the controls at the 99% level.

* Significantly different from the controls at the 95% level.

ns Not significantly different at the 95% level.

diluted as in treatment 8. It should be noted that production woodlots would not usually be grazed as intensively as this trial paddock, and the levels of browsing damage recorded here should be viewed accordingly.

3. Height Growth

In Trial I, the heavier browsing received by the thiram and control treatments resulted in these seedlings being significantly shorter than those sprayed with the egg repellent (Table 4). However, in Trial II, grazing incidence and seedling heights do not seem to be linked and although the egg treatments received less browsing during the first two grazings, the mean heights of trees treated with egg were not significantly different from the controls except treatment 8 (diluted egg). This rather anomalous result is difficult to explain, particularly as seedling heights were not measured in Trial II at the time of planting.

TABLE 4—Mean heights (cm)

Trial	Treatment	Before grazing	Grazing Period 1	2	3	4	5
I	1 thiram	30.72 ns	24.74 ns	24.72 ns	28.43 ns	30.63 ns	30.57 ns
	2 egg + dye	30.72 ns	30.75 **	31.58 **	36.37 **	42.82 **	42.25 **
	3 control	30.69	25.82	25.83	29.64	32.98	32.89
II	4 egg + dye				33.41 ns	40.74 ns	37.43 ns
	5 egg				36.96 **	41.91 ns	39.13 ns
	6 adhesive + dye				35.27 *	44.21 ns	40.68 *
	7 adhesive + extra dye				38.06 **	44.76 *	41.49 **
	8 treatment 4 diluted				39.39 **	49.78 **	46.00 **
	9 control				33.10	41.93	37.93

** Significantly different from the controls at the 99% level
* Significantly different from the controls at the 95% level
ns Not significantly different at the 95% level.

DISCUSSION

An egg-based repellent applied either in the nursery or the field reduced the incidence of browsing by sheep on 1/0 radiata pine seedlings, for up to 3-4 months after treatment. Thiram was not an effective repellent.

Mixtures of acrylic adhesive and red dye alone confirmed that egg was the repellent ingredient.

One litre of repellent mixture, containing 10% (w/v) of egg powder and 25% adhesive, treats 2 m^2 of nursery bed, containing about 140 seedlings. At a cost in New Zealand of $6.45/kg for whole egg powder, and $1.51/litre for acrylic adhesive, treating 1000 seedlings would cost $7.30 for materials.

One possible problem not investigated in these trials, but indicated by the high level of browsing in the final (April) grazing, is the transference of browsing damage into

the autumn—a period previously regarded as safer than spring (Anon, 1975). It has been suggested that the combination of rank grass and legumes available in previously ungrazed pasture in the autumn accounts for the low incidence of browsing then. If the pasture can be grazed more intensively in the spring and summer by using repellents a higher level of autumn damage may result. The consequences of using repellents should therefore be considered for a longer period than is indicated by these trials.

In addition to extending the period for early grazing amongst woodlots established on pasture, one practical use for egg-based repellents, could be in protecting seedlings in forests from sheep being used to graze weeds such as emerging bracken fern immediately following planting. At Te Wera forest in Taranaki, perendale sheep at 3-5 per hectare are grazed from October onwards to control new growth of bracken fern amongst radiata pine seedlings planted on a burnt site the previous winter. This grazing has markedly reduced the cost of hand releasing the seedlings from competing bracken fern, with little browsing damage to the trees. Generally, however, sheep are not widely used to graze weeds on forests. An egg-based repellent would appear to give the 3-4 months protection needed for the seedlings and should allow more confidence in grazing sheep amongst recently planted radiata pine seedlings.

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