EVALUATION OF REPELLENTS TO PREVENT POSSUM BROWSING

D.R.MORGAN¹ and A.D.WOOLHOUSE²

¹Manaaki Whenua-Landcare Research, P.O.Box 31-011, Christchurch

²Industrial Research Limited, P.O.Box 31-310, Lower Hutt

SUMMARY

Use of repellents is potentially an efficient means of reducing damage by brushtail possums to a variety of plantings in New Zealand, but only a few compounds have previously been evaluated. Six predator odours, two proprietary repellents containing bitter ingredients, olive oil in petroleum jelly, and synthetic fermented egg were applied to seedlings of *Pinus radiata* in possum pens. The amount of foliage left unbrowsed was assessed daily and compared with that on control seedlings treated with Treepel, a moderately effective egg-based repellent already on the market. Compounds found to be equally or more effective than Treepel were five mustelid predator odours, a repellent containing Bitrex, and synthetic fermented egg.

Keywords: repellents, possum, *Trichosurus vulpecula*, browse damage, pest management.

INTRODUCTION

Brushtail possums (*Trichosurus vulpecula*) damage a wide range of plantings, including exotic forest plantations, farm and horticultural crops, catchment protection plantings (Cowan 1990), and garden trees and shrubs (Grant 1975). Although poisoning and trapping are effective techniques for the control of possums in large uninhabited areas, they are less suitable for use where people, livestock, or pets are present. Furthermore, many plantings occupy small areas adjacent to larger outlying areas that will provide a continuing source of possums. If such plantings are to be protected by killing possums, continuous control efforts may be required.

The use of repellents is an alternative method for protecting such plantings from possum damage. Many compounds have been developed as repellents to other wildlife (e.g. Sullivan *et al.* 1988), including birds (e.g. Glahn *et al.* 1989). An egg-based compound now marketed as Treepel can be effective against rabbits and hares for up to 2 months (Crozier 1991), and deterred possums from eating apples in a pen study (Eason and Hickling, in press). Treepel and a range of other compounds were screened in this study as the first stage in the development of long-life repellents that would be effective against possums.

MATERIALS AND METHODS

Compounds tested

Eleven compounds were tested, including predator odours, proprietary animal repellents, and other compounds shown to be repellent to herbivores in other studies.

Predator odours tested were: the component from fox (*Vulpes*) faeces most repellent to rats, 2,5-dihydro-2,4,5-trimethylthiazoline (TMT) (Vernet-Maury *et al.* 1984), prepared using the methods given by Sullivan *et al.* (1988); and components of the anal gland secretions of the genus *Mustela*, iso-pentanylmethylsulfide (PMS), 2-propylthietane (PPT), 3-propyl-1,2-dithiolane (PDT), 2,2-dimethylthietane (DMT), and 3,3-dimethyl-1,2-dithiolane (DMD), prepared using the methods given by Crump (1978, 1980, 1982). Except for PMS, these compounds are also found in fox faeces (Vernet-Maury *et al.* 1984). All predator odours were prepared as 5% solutions in paraffin oil.

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Proprietary repellents tested were: Treepel (Cuddon and Stewart, Christchurch), containing a mixture of egg powder and adhesive (Crozier 1991); Ropel (Sulkem Co.Ltd, Auckland), containing the bitter compound benzyldiethylammonium saccharide (Swihart and Conover 1990); and Gori (Pest Management Services, Wellington), containing the bitter compound Bitrex (denatonium benzoate).

Other compounds tested were: a form of synthetic fermented egg (SFE) (Bullard *et al.* 1978) modified to avoid phytotoxicity and applied as a 5% solution in paraffin oil; and a mixture of petroleum jelly and olive oil (PJO) shown to be highly repellent to rabbits (C.Marks, pers. comm.).

Trial design

Compounds were tested in three groups of trials by spraying them on the foliage of *Pinus radiata* seedlings planted in outdoor possum pens. *P. radiata* seedlings are commonly damaged by possums in forest and shelter belt plantations, and are readily available in a relatively uniform size, facilitating assessment of browse. Three adjacent linked pens, each measuring 30 x 5 m, were used for all trials. Gates between the pens were left open so that possums had free access to all three. Three groups of six possums were used in rotation for the trials to reduce the likelihood of them becoming non-discriminating towards treated seedlings. The possums used a sheltered area with nest boxes at one end of each pen during the daytime and were provided with supplementary feed pellets and apples, as well as grass and clover growing in the pens and a continuous supply of clean water.

P. radiata seedlings were raised from seed planted in August 1992. In each of the trials a row of seedlings (up to 45 cm height) was planted in each of the end pens, one to be treated and one to act as a control. No seedlings were planted in the central pen so that treated and control groups of seedlings were separated. This was done to simulate field application of repellents to groups of seedlings, where each seedling reinforces the repellent effect of the group. Initially, 25 seedlings were planted in each row, but in later trials, only 15 were planted as the seedlings had by then grown to 60 cm height. This ensured that feeding pressure on seedling foliage was maintained at similar levels for each trial.

In the first and last trials untreated seedlings were planted in both end pens to test whether possums had a preference for feeding in either pen. In the second trial, the repellent action of Treepel was tested against non-treated seedlings. As Treepel was confirmed as a possum repellent (see Table 1), it was then used as a positive control in all the other trials. All treatments were sprayed in calibrated 5-ml amounts on the foliage of each seedling.

The initial height of each seedling was recorded after planting, and the proportion of each seedling left unbrowsed was assessed daily until only 10% on average of each seedling remained in one of the pens, usually within 7-10 days. Trials were started only during fine weather and rainfall was measured for each 24-h period before assessing seedlings. The percentage of each seedling left unbrowsed each day was plotted against time. The mean area under the curve (AUC) for treatments was divided by the mean AUC for controls as a measure of treatment effectiveness and durability in relation to Treepel. Values exceeding 1 therefore indicated that treatments were more effective than Treepel. The mean AUCs for treatments and controls were also compared by ANOVA to test for significant differences in effectiveness.

RESULTS AND DISCUSSION

The amount of browsing of untreated seedlings planted in the two end pens in the trials at the beginning and the end of the study did not differ significantly (Table 1). Since both test and control compounds applied to seedlings in both pens in most trials proved repellent, there was no inducement for possums to develop any preference for feeding location.

Three of the predator odours were more effective repellents than Treepel (Table 1). The most effective was DMD, which had some activity at the end of the trial when the control seedlings had been almost completely eaten (Fig. 1a). Rain on 3 days during

this trial caused no loss in the repellency of DMD. Both PPT and PMS were also significantly more repellent to possums than Treepel. Seedlings treated with PDT and DMT were browsed to the same extent as the controls, and TMT was significantly less repellent than Treepel (Table 1).

TABLE 1: Trial details and effectiveness of repellents relative to control.

Compounds tested Treatment	Control	Mean AUC treatment/ mean AUC control	P value
Untreated	Untreated	1.08	0.21
Treepel	Untreated	1.45	<0.001
Predator odours			
DMD	Treepel	2.29	<0.001
PPT	Treepel	1.78	<0.001
DMT	Treepel	1.13	0.15
PDT	Treepel	1.03	0.65
PMS	Treepel	1.30	0.006
TMT	Treepel	0.60	<0.001
Proprietary repellents			
Gori	Treepel	2.23	<0.001
Ropel	Treepel	0.36	<0.001
Other compounds			
SFE	Treepel	2.23	<0.001
PJO	Treepel	0.50	<0.001
Untreated	Untreated	1.04	0.34

The effectiveness of predator odours as herbivore repellents may depend on whether the predator and prey occur sympatrically, the duration of association between predator and prey, and the ability of prey to learn to avoid predator odours (Swihart *et al.* 1991). Possums in Australia came into contact with foxes and mustelids only after these predators were introduced by Europeans and therefore did not develop sympatrically. Although possums in New Zealand could have learnt to avoid mustelids by smell detection, such a response to foxes could not have been learned. This may explain why TMT (from foxes) was the only predator odour that was not repellent to possums. Alternatively, the repellency of the compounds may not have been a response to particular predators but a generalised response to some by-products of meat digestion common to many predators, possibly including species such as the dingo or carnivorous marsupials.

Of the two proprietary repellents tested, Gori was more effective than Treepel whereas Ropel was less effective (Table 1; Figs. 1b and 1c). Gori, like DMD, remained effective after the controls had been eaten despite rain on 2 days. Both Gori and Ropel are intended to repel animals through their bitter taste. The Bitrex used in Gori is more bitter than alkaloids such as brucine and strychnine (Payne 1988), which occur naturally in plants and protect them from browsing animals. The bitter ingredient of Ropel was ineffective: treated seedlings were browsed immediately while the Treepel treated controls were unbrowsed for 4 days.

Of the other compounds tested, SFE was more repellent than Treepel (Figure 1d) but PJO was much less effective than Treepel. The effectiveness of SFE is most probably due to four components, three volatile fatty acids and trimethylamine, which are all found in canid anal gland secretions (Bullard *et al.* 1978).

This study has identified several compounds that could be further developed as

possum repellents. Combinations of these compounds may prove to be even more effective if, for example, the bitter taste of Bitrex were used to reinforce the repellent odour of a compound such as DMD or SFE. Future research will focus on formulating such combinations with adhesives and surfactants to extend field life, and field-testing them in areas where possum damage to new plantings is common.

Figure 1: Effectiveness of four repellent compounds (bold line) compared with Treepel (dotted line), and daily rainfall recorded throughout the trials.

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