FIELD EVALUATIONS OF CHOLECALCIFEROL, GLIFTOR, AND BRODIFACOUM FOR THE CONTROL OF BRUSHTAIL POSSUMS (*TRICHOSURUS VULPECULA*)

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SUMMARY

Although sodium monofluoroacetate (1080) is an effective toxin for control of possums, public opposition and the need for a pesticide that unlicensed operators can use have led to the evaluation of alternative compounds for possum control. Cholecalciferol, gliftor, and brodifacoum were evaluated in bait stations in a series of replicated field trials to assess their efficacy in controlling possums. Control operations utilizing cereal bait containing cholecalciferol (0.8%) reduced possum populations on average by 71% (range 45-88%), cholecalciferol (0.8%) with calcium carbonate (10%) by 82% (range 66-97%), gliftor (0.4%) by 79% (range 64-95%), and brodifacoum (0.002%) by 68% (range 52-79%).

Keywords: brushtail possum, pesticide, cholecalciferol, gliftor, brodifacoum

INTRODUCTION

The brushtail possum (*Trichosurus vulpecula*) is now the major vertebrate pest species in New Zealand, not only as the principal vector in the transmission of bovine tuberculosis but also as the major conservation pest, causing environmental and economic losses through its defoliation of indigenous and exotic plants (Cowan 1991). Control of possums relies on sodium monofluoroacetate (1080) in carrot, cereal, or jam baits. Cyanide, phosphorus, pindone, and brodifacoum are also registered pesticides for the control of possums, but are less frequently used.

Issues of humaneness, toxicity to possums, learned and non-learned aversion to toxic bait, non-target kills, persistence in animals and the environment, and restrictions on use, may impinge on the usefulness of some of these poisons (Eason *et al.* 1994). Although brodifacoum and pindone can be used by unlicensed operators, their effectiveness for controlling possums has not been proven. Brodifacoum is more potent than pindone against captive possums (Eason *et al.* 1994) but has not been evaluated in the field.

Concern about the older toxins, such as 1080 and cyanide, and the comparative resistance of possums to anticoagulants (Eason and Jolly 1993) has led to the screening of an extensive range of alternative toxins for possum control. Of these, cholecalciferol and gliftor are palatable and highly toxic to possums in cereal baits at concentrations of 0.8% and 0.4% respectively (Eason *et al.* 1993). In trials on captive possums, cholecalciferol with calcium carbonate (10%) as a synergist was more toxic to possums than cholecalciferol alone (Jolly *et al.* 1993). This paper describes the effectiveness in field trials of cereal baits containing brodifacoum, cholecalciferol, cholecalciferol with calcium carbonate, and gliftor for the control of possums.

MATERIALS AND METHODS

Baits

Cholecalciferol with or without calcium carbonate, and gliftor together with 0.5% cinnamon oil and 0.02% acid brilliant green dye, were blended into a mixture of ground maize, pollard, and sugar (used by Animal Control Products to manufacture the RS5

Proc. 47th N.Z. Plant Protection Conf. 1994: 112-116

Possum Bait). Cholecalciferol and gliflor baits were formulated using lethal dose estimates derived from previous toxicity data (cholecalciferol LD_{90} = 49.3 mg/kg, cholecalciferol and $CaCO_3$ LD_{90} = 33.4 mg/kg, gliflor LD_{90} = 24.1 mg/kg). A lethal dose for a 2.5 kg possum would be contained in no more than 15 g of toxic bait. Three trial batches of toxic bait weighing 1-3 g were prepared with an orbital pelleter:

- (i) Cholecalciferol (0.8% wt/wt)
- (ii) Cholecalciferol (0.8% wt/wt) with $CaCO_3$ (10% wt./wt.)
- (iii) Gliflor (0.4% wt/wt)

Cereal bait containing brodifacoum (0.002% wt/wt) is commercially available (Talon Possum Bait) and was obtained from ICI Crop Care.

Field trials

Replicated field trials were carried out in plantations of exotic forest and reserves of indigenous forest in Canterbury and Hawke's Bay (Table 1). Before the application of toxic bait, the approximate density of the possum populations was estimated using Victor soft-catch leg-hold traps, that allow possums to be caught and released without injury. Density was assessed by comparing the percentage of traps that caught possums with the frequencies of capture in an existing database of trapping records and possum abundance (Warburton unpubl. data).

In most trials, bait stations (Thomas 1994) were distributed at approximately 1/ha. Fewer stations were used where the forest understorey was sparse and more where it was dense (Table 1). They were located mainly around the edge of each forest block at approximately 100-m spacings, although some were also sited within the forest to ensure bait was readily accessible to all possums. For cholecalciferol and gliflor 10 - 15 g of bait is lethal to possums. Therefore, only 250 g of toxic baits were placed in each bait station. Most possums need to eat more than 120 g of brodifacoum possum bait to receive a lethal dose (Eason *et al.* 1993). Therefore 1200 g of brodifacoum baits were placed in each bait station. Throughout most trials the consumption of bait was monitored, and baits were replenished at intervals of 1, 2, and 5 weeks or until negligible amounts were being eaten. In two scenic reserves (Maraetotara and Mohi), where possums had previously been controlled and reinfestation was occurring, the baiting was continued for 1 and 2 years respectively to assess whether continued poisoning could maintain or further reduce possum numbers.

After eating a lethal dose of brodifacoum, possums take several weeks to die (Eason *et al.* 1993). During this time possums may eat unnecessary additional toxic bait. ICI therefore recommends "pulse baiting", where bait is made available for 2-4 days every 2 weeks. Trials using this method were compared with those where brodifacoum bait was available continuously.

On completion of each field trial, the percentage of the population killed was estimated from the percentage decline in the proportion of traps that caught possums after poisoning, relative to the proportion of traps that caught possums before poisoning. For each area an estimate of the average amount of bait eaten for each possum killed was calculated from the total amount of bait eaten, divided by the approximate number of possums killed (ie. possum density x area of the field trial x the proportion of possums killed). The amount of bait eaten was assessed at different stages of the poisoning. To provide an estimate of the rate of bait consumption, the amount eaten at different time points was divided by the total amount of bait eaten throughout poisoning, and the quotient multiplied by 100 to give the cumulative percentage of bait eaten. For the acute toxins (cholecalciferol, with or without calcium, and gliflor) the cumulative percentage of bait eaten was plotted against the time elapsed since poisoning began, using a gompertz curve (Zach 1988).

RESULTS

The average kill achieved with toxic bait containing cholecalciferol and calcium carbonate was 82% (range 66-97%), with gliflor it was 79% (range 64-95%), and with cholecalciferol alone it was 71% (range 45-88%). Brodifacoum was least effective, killing on average 68% of possums in these trials (range 52-79%) (Table 1).

TABLE 1: Details of field trials with cholecalciferol, gliftor, and brodifacoum baits and the percentage of possums killed and the average weight of bait eaten for each possum killed.

Study area (ha)	Approx. no. of possums/ha	Total no. of bait stations	Toxin (concentration)	Days bait available	% pop. killed	Mean wt bait eaten/possum killed (g)
Banks Peninsula (30)	8 - 10	28	Cholecalciferol (0.8%)	29	79	36.0
Coalgate ("Homebush1") (18)	12 - 15	31	"	28	45	47.8
Darfield (Blk79W) (26)	2 - 4	30	"	35	88	35.7
Darfield (Blk70) (21)	4 - 6	25	Cholecalciferol (0.8%) + CaCO ₃ (10%)	35	83	19.3
Darfield (Blk79E) (27)	7 - 9	32	"	35	97	13.6
Coalgate ("Tara") (23)	3 - 5	30	"	35	66	15.2
Hawke's Bay (Mungapakahu) (76)	2 - 4	50	Gliftor (0.4%)	28	95	23.7
Hawke's Bay (Maraetotara) (50)	1 - 2	50	"	375	91	4
Coalgate ("Homebush2") (18)	8 - 10	28	"	49	78	14.0
Coalgate ("Sandown") (15)	5 - 7	15	"	33	64	17.5
Coalgate (Blk90) (15)	2 - 3	30	Brodifacoum (0.002%)	103	76	1669
Coalgate ("Homebush3") (29)	7 - 9	50	"	63	79	633
Southland (Awiki) (24)	7 - 9	30	"	6 ¹	52	593
Mackenzie Basin (65)	0.4 - 0.6	22	"	12 ²	66	128
Hawke's Bay (Mohi) (50)	1 - 2	41	"	155 ³	100	4

¹ possums were controlled by "pulse baiting" with poison for 2 days with 10 days between pulses (duration of trial = 37 days)

² possums were controlled by "pulse baiting" with poison for 4 days with 7 days between pulses (duration of trial = 33 days)

³ possums had "pulses" of bait each month with the duration of each pulse ranging from 1-9 days (duration of trial = 623 days)

⁴ an unknown number of immigrant possums also fed on the bait, and therefore this could not be assessed.

On average, 16.0 g (range 13.6 - 19.3) of bait containing cholecalciferol with calcium carbonate, 18.4 g (range 14.0 - 23.7) of gliftor bait and 39.8 g (range 35.7 - 47.8) of cholecalciferol bait were eaten per possum killed. Substantially more brodifacoum bait was eaten per possum killed. With continuous feeding, an average of 1150 g of brodifacoum bait (range 633 - 1669) was eaten for each possum killed, whereas with pulse-baiting an average of 360 g (range 128 - 593) was eaten per possum killed. The mean kills for the four toxic baits were inversely correlated with the mean bait consumption ($r^2=0.94$, $P=0.02$). The rate at which brodifacoum bait was eaten was inconsistent, but depended mainly on whether it was pulse baited or fed continuously. For cholecalciferol and gliftor, however, there was a consistent trend in the rate at which toxic bait was eaten, which was similar for both toxins. A kill of about 80% was achieved by both toxins after 5 weeks, thereafter only small amounts of bait were eaten (Figure 1).

DISCUSSION

Baits containing brodifacoum, gliftor, and cholecalciferol (with and without calcium) were all effective at killing possums. The increased toxicity of cholecalciferol bait containing calcium carbonate shown in earlier trials on captive possums (Jolly *et al.* 1993) was confirmed by the field trials. The rate of consumption of cholecalciferol and gliftor bait becomes negligible in the fifth week. Therefore when these toxins are used in bait stations, possums should be allowed access to toxic bait for at least 5 weeks to achieve the best possible kill. To consistently achieve the highest kills possible, a toxic bait should deliver a lethal dose in the smallest amount of bait possible. Of the

Figure 1: Cumulative percentage of cholecalciferol (•) and gliflor (o) bait eaten throughout poisoning.

four baits evaluated in these trials, bait containing cholecalciferol and calcium carbonate best fitted this criterion.

Brodifacoum, as an anticoagulant, differs markedly in its mode of action to that of the acute toxins cholecalciferol and gliflor. Several feeds of brodifacoum bait are required for a possum to consume a lethal dose and it may then take 3 weeks to die (Eason *et al.* 1993). As a consequence large quantities of bait are eaten in the field for each possum killed. It is therefore more cost-effective to restrict its use to low-density populations. Pulse-baiting reduced the amount of bait eaten for each possum killed, although the kill was also lower (59% cf. 77%). If this strategy is used, more than three pulses are needed.

Monthly pulses with brodifacoum were applied over a 2-year period at Hawke's Bay (Mohi) to maintain possums at very low densities. This was effective at killing possums that had survived previous control measures and those that immigrated into the area.

Cholecalciferol, gliflor, and brodifacoum may play an increasing role in possum control in the future, and could to some extent replace 1080 and cyanide. However, their toxicity to non-target species, persistence in livestock, secondary poisoning risks, and their breakdown in soil, water, and possum carcasses need evaluating.

ACKNOWLEDGEMENTS

We thank Hugh Fitzgerald (Landcare Research) and Ken Hunt, Harry Verwey (Department of Conservation - Hawkes Bay) for helping with the field trials. Dave Morgan and Joanna Orwin provided editorial advice and comments. The research was supported by the Animal Health Board.

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