

Evaluation of brodifacoum against the Indian black rat *Rattus rattus wroughtoni* in cocoa†

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Abstract. Brodifacoum, a second generation single dose anti-coagulant, was evaluated against the black rat, *Rattus rattus wroughtoni* Hinton, a major rodent pest of cocoa in South India. Laboratory feeding trials using brodifacoum (0.005%) wax blocks showed cent per cent mortality in these rats by 1 day feeding. The active ingredient consumed varied from 0.35 mg to 9.17 mg/kg body weight (mean 3.71 ± 0.53 mg/kg). The mortality occurred from the third day to the tenth day of feeding with a maximum on the fifth day in females and on the sixth day in males. One, two and three baitings with brodifacoum baits at intervals of 10 days between baitings reduced the rat population by 76%, 95% and 97%, respectively in cocoa gardens. Moreover, cent per cent reduction in the damage was achieved by two baitings itself.

Introduction

In South India cocoa is grown mainly as a mixed crop with coconut or arecanut. Rats and squirrels are the major rodent pests of this crop in this region causing as high as 29% damage to pods (Bhat *et al.*, 1981).

Multiple dose anticoagulants such as warfarin and fumarin are the two rodenticides presently used in India for rodent control operations in coconut and cocoa fields. Unlike zinc phosphide these anticoagulants do not require prebaiting, are safe to non-target animals and do not pose any problem of secondary poisoning. These anticoagulants, though safe in all these aspects, are effective if consumed for 8–10 days consecutively (Bhat and Sujatha, 1986). Hence, in fields they require persistent baiting for long periods for the animals to ingest a lethal dose. Further, resistance to the multiple dose anticoagulants by several species of rats and mice has been reported recently from several countries (Drummond and Rennison, 1973). All these characters of the multiple dose anticoagulants together lead to the discovery of a series of hydroxycoumarin compounds such as difenacoum, bromadiolone, brodifacoum, etc.

Brodifacoum, described in detail by Dubock and Kaukeinen (1978), is reported to be highly toxic and most effective against several rodent species (Dubock, 1980). The toxicity and field efficacy of this anticoagulant against the black rat, *Rattus rattus wroughtoni* Hinton that infests cocoa in South India are discussed in this report.

Materials and methods

Toxicity study

Live specimens of the black rats were trapped around Kasaragod (12°30'N; 75°E), Kerala, India, brought to the

laboratory and housed individually in animal cages (45 × 30 × 30 cm). They were acclimatized to the caged conditions for 15 days before the initiation of the experiment. During this period the unhealthy and pregnant animals were removed and the healthy ones sexed and weighed. Each animal was then provided with 20 g of the poison bait. Water was provided *ad libitum*. The poison bait was removed after 24 h, consumption recorded and the animals were kept under observation on the laboratory diet for the rest of the study period. The mortality and the cause of death were recorded every day for 3 weeks. For comparison, the absolute values of consumption were transformed into grams per 100 g body weight.

The brodifacoum (0.005%) wax blocks were prepared following Shah and Subiah (1978), but with slight modifications. Two millilitres of 0.25% liquid brodifacoum concentrate was mixed with rice flour (48 g), molasses (20 g) and molten paraffin wax (30 g). Each poison block weighed around 20 g.

Field trial

The field trial was conducted during April–June 1986 in five areca–cocoa mixed garden (0.5 ha each) situated more than 1 km apart in the adjacent villages near Kasaragod, Kerala. The cultural practices adopted by the farmers were similar in all these gardens. The poison blocks (20 g) were prepared as described earlier and applied in four gardens. One garden was kept as untreated to record the natural variations in the trapability of rats and the intensity of damage. The damages caused by rats and squirrels on cocoa pods were differentiated based on their feeding patterns. Bhat (1980) observed that the rats damage the cocoa pods near the stalk portion whereas squirrels damage near the centre. The efficacy of poison baiting was tested by trap index and also by damage assessment. Trap index was studied by setting 50 wooden 'live traps' (30 × 20 × 10 cm) for 24 h in each plot. The effective trap nights were calculated by applying the correction procedure (Spillett, 1968), wherein 50% of the traps sprung without animals inside or open but without baits inside were subtracted from the total number of trap nights.

Assessment of damage was made by counting the freshly damaged and undamaged cocoa pods (Williams, 1973) for 1 day in all the plants. For comparison the values were transformed into per cent values. The damage assessment was followed by trap index and poison baiting. Fifteen bait points were selected at a distance of 20 m × 20 m (based on

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Table 1. Toxicity of brodifacoum to the black rat when exposed for 24 h

Sex	Number	Consumption of		% of mortality	Days to death
		Bait (g/kg)	a.i. (mg/kg)		
Male	18	77.3 ± 12.90 (7.0-183.0)	3.86 ± 0.66 (0.35-9.17)	100.0	6.0 ± 0.38 (3.0-10.0)
Female	17	71.0 ± 17.20 (9.0-181.0)	3.55 ± 0.83 (0.44-9.05)	100.0	5.6 ± 0.33 (3.0-8.0)
Total	35	74.3 ± 10.67 (7.0-183.0)	3.71 ± 0.53 (0.35-9.17)	100.0	5.8 ± 0.26 (3.0-10.0)

Range values are given in parentheses.

our earlier observation of the movements of rats) in each poison application plot and one poison bait block was tied at every bait point. The poison bait application was repeated for two more times at an interval of 10 days. The post-control damage assessment was carried out for 1 day after 10 days of each poison baiting which was followed by trap index. The data were then compared with the corresponding values for pre-control. Similar data were collected for the untreated plot as well.

Results

Toxicity

Altogether, 35 rats (18 male and 17 female) were exposed to brodifacoum baits for 24 h (Table 1). The bait consumption per day per kg body weight of the animal varied from 7.0 to 183.0 g (mean 74.3 ± 10.67 g). On an average this comes to 3.71 mg of brodifacoum (a.i.) per body kg weight of the animal. All the experimental animals died within 10 days (mean 5.8 ± 0.26 days) of poison consumption.

Field efficacy

The data on the population index and the damage to cocoa pods for both the treated and untreated plots are furnished in Table 2. In the treated plots, the population of the black rat has reduced by 76% and 95%, respectively after the first two baitings, but did not reduce beyond 97% even after three baitings. However, cent per cent control over the damage was achieved after the second baiting itself. The untreated plot did not show any reduction in the population and the damage intensity.

Discussion

The results on the toxicity of brodifacoum indicated that the black rats were highly susceptible to this poison. At 0.005% concentration all the test animals died after consuming the poison for 1 day. This is in conformity with the observations of several other *Rattus* spp. (Dubock and Laukeinen, 1978; Buckle *et al.*, 1982; Chopra *et al.*, 1983; Soni *et al.*, 1984). To achieve cent per cent mortality with warfarin and fumarin at 0.025% level (the recommended concentration) the black rats had to feed for a continuous period of 10 and 12 days, respectively (Bhat and Sujatha, 1986).

Table 2. Effect of brodifacoum baiting on the population of rats and percentage of damage to cocoa pods

Treated plots	Population (No. per 100 trap nights) and number of damaged pods (percentage)†			
	Pre-control	After I baiting	After II baiting	After III baiting
I	50.0 (21.46)	17.39 (2.80)	0 (0)	0 (0)
II	64.0 (7.39)	20.41 (4.19)	4.00 (0)	0 (0)
III	45.0 (21.74)	0 (0)	0 (0)	0 (0)
IV	19.5 (12.28)	5.00 (2.70)	5.13 (0)	4.88 (0)
Mean	44.62 (15.72)	10.70 (2.67)	2.28 (0)	1.22 (0)
Untreated plot	42.55 (18.60)	50.00 (21.05)	37.21 (22.81)	41.86 (19.61)

†Percentages of damaged pods are furnished in parentheses.

The LD₅₀ value of brodifacoum for *R. rattus* was around 0.7 mg/kg body weight (Mathur and Prakash, 1981). This dose would be contained in about 14.0 g of 0.005% brodifacoum bait. From the present study, it was revealed that in one day the black rats consumed the poison nearly five times more than the LD₅₀ value. Nearly 50% of the animals consumed the poison bait more than 50.0 g/kg and as many as 35% of the animals consumed the poison bait more than 100.0 g/kg. This revealed that most of the animals overconsumed the bait within 24 h and they were not averse to the bait materials. The data from the field study were also in support of this. More than 75% of the animals in the field died after the first treatment itself.

In cocoa, where the husk of the pod is very thick the rodents have to learn the act of breaching the pod by trial and error gnawing or by imitating other experienced animals feeding on it (Everard, 1968; Williams, 1973). The presence of some live rats in the field even after second and third baitings could be attributed to the immigration of a few new rats which were unaware of the presence of the edible substance inside the cocoa pods.

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References

- BHAT, S. K., 1980. Studies on rodent damage to cocoa in south India: identification of their damage. *Planter* **56**, 101–104.
- BHAT, S. K., NAIR, C. P. R. and MATHEW, D. N., 1981. Mammalian pests of cocoa in south India. *Tropical Pest Management* **27**, 297–302.
- BHAT, S. K. and SUJATHA, A., 1986. Laboratory evaluation of two anticoagulants against *Rattus rattus wroughtoni* Hinton. *PLACROSYM-VII, October 1986, Coonoor, India*. Abstract No. 38, p. 24.
- BUCKLE, A. P., ROWE, F. P. and HUSIN, A. R., 1982. Laboratory evaluation of the anticoagulants coumatetralyl and brodifacoum against *Rattus argentiventer* in peninsular Malaysia. *Tropical Pest Management* **28**, 126–130.
- CHOPRA, G., PRASHAD, V. R. and AHAMAD, N., 1983. Laboratory evaluation of brodifacoum against five murid species. *Rodent Newsletter* **7**, 7.
- DRUMMOND, D. C. and RENNISON, B. D., 1973. The detection of rodent resistance to anticoagulants. *Bulletin of World Health Organisation* **48**, 239–242.
- DUBOCK, A. C., 1980. The development and practical use of the novel anticoagulant rodenticide brodifacoum. *Plant Protection Bulletin (Taiwan)* **22**, 223–238.
- DUBOCK, A. C. and KAUKEINEN, D. E., 1978. Brodifacoum (Talor rodenticide)—a novel concept, pp. 127–137. In *Proceedings of the 8th Vertebrate Pest Conference, California*.
- EVERARD, C. O. R., 1968. *A Report on the Rodent and Other Vertebrate Pest of Cocoa in Western Nigeria*. Ibadan, Nigeria: Research Division, Ministry of Agriculture and Natural Resources, Moor Plantation.
- MATHUR, R. P. and PRAKASH, I., 1981. Evaluation of brodifacoum against *T. indica*, *M. hurrianae* and *R. rattus*. *Journal of Hygiene* **87**, 179–184.
- SHAH, D. K. and SUBIAH, K. S., 1978. Notes on rodent control in Lakshadweep islands with rodafarin (warfarin) wax blocks. *Pestology* **2**, 36–42.
- SONI, B. K., JAIN, A. P. and SONI, G. R., 1984. Trials of wax blocks of brodifacoum (WBA 8119) against desert rodents. *Rodent Newsletter* **8**, 10–11.
- SPILLET, J. J., 1968. *The Ecology of the Lesser Bandicoot Rat in Calcutta*. Calcutta: Bombay Natural History Society and the Johns Hopkins University Centre for Medical Research and Training.
- WILLIAMS, J. M., 1973. Rat damage assessment and control in cocoa. *Fiji Agricultural Journal* **35**, 15–25.