

TOXICITY OF CERTAIN SINGLE DOSE ANTICOAGULANT RODENTICIDES AGAINST THE WESTERN GHATS SQUIRREL, *FUNAMBULUS TRISTRIATUS* WATERHOUSE*

S. KESHAVA BHAT and A. SUJATHA

Central Plantation Crops Research Institute, Kasaragod 671 124, Kerala

ABSTRACT

Three single dose anticoagulant rodenticides, viz., bromadiolone, brodifacoum and flocoumaten were screened for their toxicity against the Western Ghats squirrel, *Funambulus tristriatus* Waterhouse, a major pest of cocoa in South India. The studies have revealed that among these three rodenticides, brodifacoum was the most toxic followed by flocoumaten and bromadiolone. Brodifacoum killed all the test animals on one day exposure, whereas flocoumaten and bromadiolone did not kill any during that period. In the choice test, the squirrels did not prefer baits in wax cake form. This was very well evident from the results of the field trial wherein even after exposing the rodents to brodifacoum wax cakes three times, the success against the Western Ghats squirrel in cocoa was only about 50%.

INTRODUCTION

The Western Ghats squirrel, *Funambulus tristriatus* Waterhouse is an important rodent pest of cocoa, *Theobroma cacao* L. in South India (Bhat, 1978; Abraham and Remamony, 1979; Bhat, Nair and Mathew, 1981). The damage caused by this pest to cocoa at times reached 75% (Bhat, 1982). Efforts to control this pest using conventional rodenticides such as zinc phosphide and warfarin were not successful (Bhat, 1982). The introduction of single dose anticoagulants viz., bromadiolone, brodifacoum and flocoumaten, made the task of rodent control easier in several field crops. The present study is aimed at screening these poisons against the Western Ghats squirrel that damage cocoa.

MATERIALS AND METHODS

Live specimens of the Western Ghats squirrels were collected from the cocoa fields of the Central Plantation Crops Research Institute, Kasaragod (12° 30' N, 75° E), Kerala, India and housed individually in cages (45 x 30 x 30 cm) in the laboratory. The animals were acclimatized to the caged condition and to the laboratory diet for a week before the initiation of the experiment. During this period the unhealthy and pregnant animals were removed. Only healthy squirrels were used in the experiment.

Toxicity

The ready to use poison baits (0.005%) of bromadiolone (Pest Control India Ltd., Madras), brodifacoum (Indian Explosives Ltd., Bangalore), and flocoumaten (NOCIL, New Delhi) in wax cake forms were used in this study. Twelve animals each were provided with a known quantity of a particular poison bait for one day and the consumption recorded. Water was made available *ad libitum*. The animals were then kept under observation on the laboratory diet for three weeks and the mortality noted. In case there was less than 50% mortality after consuming the poison bait the experiment was repeated with that particular poison for more number of days.

Acceptability of the bait

The acceptability of the poison bait in wax cake form was tested by offering such cakes along with plain baits in cake as well as grain forms. All these three forms of the bait were exposed simultaneously in a petridish to the caged animal for one day and the consumption recorded. Twenty squirrels which have the earlier experience of eating cake forms of the bait as well as rice grains were used in this experiment.

* Contribution No. 759, Central Plantation Crop Research Institute, Kerala

Field trial with brodifacoum

Four areca-cocoa mixed gardens (0.5 ha each) situated more than 1 km apart in the adjacent villages near Kasaragod, Kerala were selected for poison bait application and another garden as untreated control. The efficacy of the poison bait was determined by trap index and also by damage assessment (Bhat and Sujatha, 1989). The damage caused by the Western Ghats squirrel was differentiated from that of rat-damaged ones based on their feeding patterns (Bhat, 1980). Assessment of damage was made by counting the freshly damaged and undamaged mature cocoa pods (Williams, 1973). The damage assessment was followed by trap index and poison baiting.

Fifteen bait points were selected at a distance of 20 m x 20 m in each plot and one poison bait block (20 g) was tied at each bait point. The poison bait application was repeated two more times at an interval of 10 days as the squirrels required 5-10 days for mortality. The post-control damage assessment was carried out after 10 days of each poison baiting which was followed by trap index. The data were then compared with the corresponding values for precontrol. Similar data were collected for the untreated plot as well.

RESULTS AND DISCUSSION

Toxicity

The results on the toxicity of bromadiolone, brodifacoum and flocoumafen to the Western Ghats squirrel are summarized in Table I. During one day exposure to the chemicals cent per cent mortality was achieved only where brodifacoum was used. To achieve cent per cent mortality with flocoumafen the Western Ghats squirrels had to feed the poison baits for three days. But with bromadiolone only 83.3% mortality was achieved even after three days exposure. The consumption of the poison bait per kg body weight varied from 23 g (1.15 mg a.i.) to 129 g (6.4mg a.i.). In brodifacoum even 31g bait (1.5mg a.i.) per kg was found lethal but in flocoumafen and bromadiolone even 74 g to 88 g bait (3.7mg to 4.4mg a.i.) per kg was not found lethal.

During the two and three days exposure periods bromadiolone was found lethal at 7.90 ± 0.46 mg/kg. Flocoumafen was, however, found to be slightly more toxic (7.62 ± 0.90 mg/kg) than bromadiolone. The mean day to death was the least with brodifacoum (6.33) followed by bromadiolone (8.25) and flocoumafen (8.41). The mortality was noticed from the fourth

Table I. Toxicity of three single dose anticoagulants to *F. tristriatus*.

Expt. No.	Feeding days	Poison bait	Consumption of		Mortality (%)	Minimum poison required for death (mg/kg)
			Bait (g/kg)	Poison (mg/kg)		
1	One	Bromadiolone	62.92±4.31	3.14±0.22	Nil	—
		Brodifacoum	92.67±7.62	4.62±0.38	100.0	1.52
		Flocoumafen	55.00±4.37	2.74±0.21	Nil	—
2	Two	Bromadiolone	116.83±12.87	5.83±0.65	16.7	—
		Flocoumafen	130.58±9.55	6.52±0.47	41.7	5.30
3	Three	Bromadiolone	162.33±10.27	8.12±0.51	83.3	5.25
		Flocoumafen	164.00±6.67	7.96±0.39	100.00	—

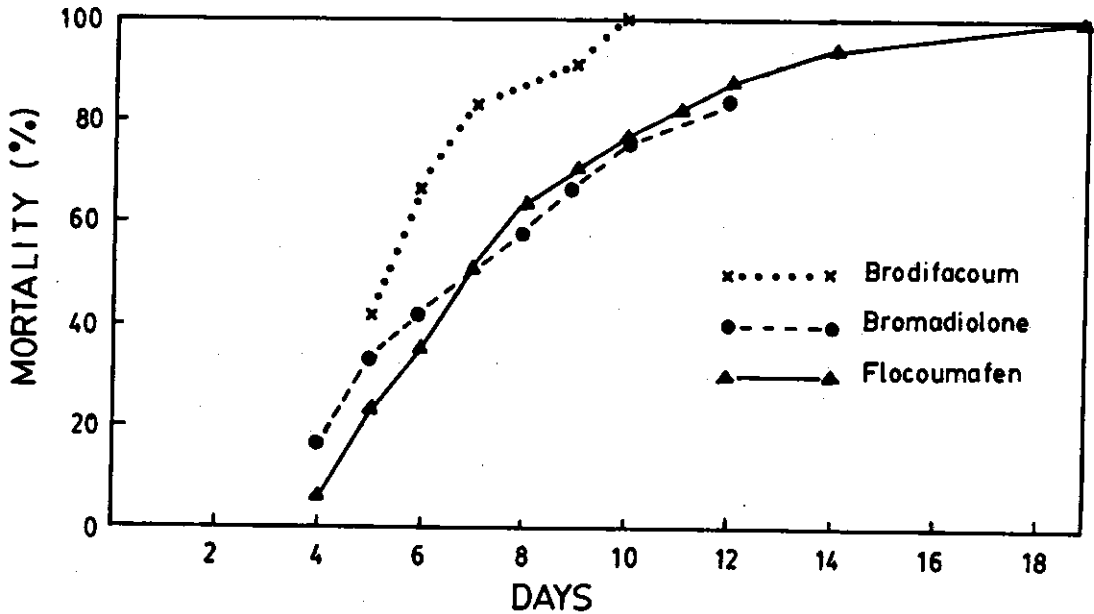


Fig. 1 Mortality of *F. tristriatus* in different days after poison consumption

day of consumption and extended up to 19th day with different poisons (Fig.1). With brodifacoum the period of mortality was confined between 5th and 10th day of poison consumption. It was also noticed that with bromadiolone and flocoumafen the average day to death reduced with the increasing the length of feeding period. The mean day to death during the two days feeding period was 14.0 with bromadiolone and 12.6 with flocoumafen, whereas it was 7.1, and 6.7 days, respectively with bromadiolone and flocoumafen during the three days feeding period.

The present observation revealed that brodifacoum was more toxic than bromadiolone and flocoumafen to the Western Ghats squirrel. Contrary to this, flocoumafen was found to be more toxic than brodifacoum and bromadiolone to the North Indian palm squirrel, *F. pennanti*. Jain and Mathur (1987) reported cent per cent mortality in the North Indian palm squirrel at

one day feeding with flocoumafen bait. The poison was lethal at 2.67 mg/kg. This is much less than 7.62 mg/kg arrived at for the Western Ghats squirrel. Both brodifacoum (Mathur and Prakash, 1980) and bromadiolone (Subiah and Mathur, 1984) did not kill all the test animals of the North Indian palm squirrel in one day feeding. This shows that within the same genus the toxicity of single dose anticoagulants differ considerably between the species.

Acceptability of the bait

When the squirrels were given a choice of the three different forms of the bait (Table II) it was noticed that they significantly ($P < 0.05$) preferred grain forms of the bait to wax cake forms. The consumption of plain wax cakes was however, higher than that of the poisoned ones, but the difference was not significant. Of the 20 animals tested, 15 animals preferred grain

Table II. Acceptance of different baits by *F. tristriatus* in choice test (No. of animals used: 20)

	Bait	
	Consumption of the bait (g/kg)+	Animals preferring the bait* (%)
Brodifacoum		
wax cake	0.25 ± 3.82	5.0
Plain wax cake	16.95 ± 4.51	5.0
Plain rice grains	46.50 ± 4.23	75.0

* CD at P = 0.05 is 12.10

+ Three animals did not prefer any of the baits

baits. Nearly 50% of the test animals totally avoided the cake forms of the bait and only one animal consumed lethal quantity of the bait. This showed that the baits in wax cake forms were not acceptable to the Western Ghats squirrel, unlike most other rodents which preferred the cake forms of the baits to grain forms (Jain and Tripathi, 1987).

Field trial with brodifacoum

In all the four gardens wherein the poison cakes were applied the percentage of reduction in both the population as well as damage was very less (Table III). The success was from 16.4 to 23.4% after first baiting and 21.4 to 26.2% after second baiting. Even after the third baiting the success against the Western Ghats squirrel in cocoa was only around 50%. In contrast to this, the black rats, which readily accepted the brodifacoum wax cakes, were completely controlled in cocoa gardens after two baitings itself

Table III. Effect of brodifacoum wax blocks on *F. tristriatus* in cocoa fields.

	Population of squirrels*	Damage to cocoa pods (%)	Percentage of reduction after each baiting	
			Population	Damage
Pre-control	20.55±4.77	52.53±10.81	—	—
After I baiting	17.18±4.73	40.22±8.10	16.40±5.05	23.43±6.25
After II baiting	16.15±3.10	38.74±8.36	21.41±5.96	26.25±3.83
After III baiting	10.14±2.74	20.29±3.78	50.66±8.57	61.37±9.41

* No. per 100 trap days

(Bhat and Sujatha, 1989). In several field crops including wheat and rice two applications of brodifacoum wax blocks were reported to give more than 90% success against rodents (Jain and Tripathi, 1987).

The poor success of brodifacoum against squirrels in cocoa fields was mainly because of the poor acceptability of poison cakes. This was already proved in the laboratory experiments wherein most (75%) of the squirrels preferred grain forms of the baits to cake forms. However, brodifacoum wax cakes were very successful against other rodents including the black rats which damage cocoa.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. M.K. Nair, Director, CPCRI for providing necessary facilities for the work and encouragement. Thanks are also due to Dr. P.S.P.V. Vidyasagar, Senior Scientist (Entomology) for critically going through the manuscript and Mr. K. Vijayakumar, Scientist (Stat.) for the statistical analysis of the data.

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