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FIELD EVALUATION OF SINGLE AND MULTIPLE DOSE ANTICOAGULANT RODENTICIDES IN REDUCING RODENT POPULATIONS AND DAMAGES IN COCONUT PLANTATIONS

Ranjan Advani
Touro College, New York, New York

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RANJAN ADVANI, Assistant Professor, Touro College, New York, New York 10035.

ABSTRACT: Comparative efficacy of brodifacoum, bromadialone (second-generation single-dose anticoagulant) was evaluated in a coconut crop on Minicoy Island. Pre- and postrodent control relative levels of rodent populations and damages were recorded as indices for assessing effectiveness of different concentrations and different bait formulations of three rodenticides. The black rat, Rattus rattus (Linnaeus), constituting a new record for Minicoy Island, was the predominant rodent species infesting the coconut crop.

On an average, application of brodifacoum (.005% and .002%), bromadialone (.005% and .002%) and warfarin (0.025%) reduced rodent populations by 74.5, 73.58, 79.1, 69.16 and 68.44% respectively, resulting in reduction of rodent damages to nuts by 74.93, 70.26, 78.24, 69.53 and 61.9% respectively. However, brodifacoum (.005%) impregnated with rice and coconut oil controlled rodents by 86.88% with reduction in damages by 82.85%. It was followed by bromadialone (.005%) mixed with rice and coconut oil giving 86.48 and 83.33% control of rodents and damages, respectively. Except in the case of brodifacoum (.005%), where pulse baits were more effective than ragi baits, the effectiveness of baits followed the order of rice>ragi>pulse. Similarly, coconut oil proved to be best attractant followed by groundnut oil and palm oil. Results of these field rodent control studies are compared with field/laboratory evaluations of respective rodenticides on Rattus rattus.

INTRODUCTION

Rodent damage to coconut has been reported in most of the Pacific territories and Jamaica and has been reviewed by Williams (1971). More recent estimates of damage in the Pacific have come from Tonga (Pierce 1971, Wheland and Wheland, 1971) Davao and Zamboango (Gallego et al. 1981), and Fiji (Williams 1974). However, in the case of India, with few exceptions (Advani 1982a), there is no detailed information about rodent ecology, status, and control in coconut crops. In the western ghat biome of India, the rodent damage to coconut crops was estimated to be about 24.7% (Advani 1982a). However, this problem is more acute in the islands of Lakshadweep where the coconut is the only crop of importance covering almost the entire cultivable area of 2233 hectares. Menon and Pandali (1953) reported a loss of up to 50% to coconut production in Laccadive islands. In 1975, the estimated loss was about 6 million nuts, worth Rs. 35 lakhs (Shamsuddin, pers. comm.), the overall rodent damage being 35%. Whereas, in some islands of Lakshadweep like Kavaratty, rodent populations and damage have been reduced effectively by using warfarin blocks (Shah and Subiah 1978), other islands like Minicoy, Kalpeni and Androth are relatively neglected. For the first time, studies were undertaken on Minicoy Island on the rodent ecology (population levels, species composition, relative abundance and food) and control.

This paper deals with experimental reduction of rodent populations and resultant damages in the coconut fields, by using two second-generation anticoagulants (brodifacoum and bromadialone) in a comparison with the already available and widely used rodenticide, warfarin.

STUDY HABITAT

Studies on ecology and control of rodents were carried out on Minicoy Island (73° -00'E - 10° 18' N) located at the farthest southern end of Lakshadweep Islands. The island is 10 km long and 0.44 km wide with a total area of 429.73 hectares. The atmospheric temperature varies from 20°C to 32°C with the annual rainfall and relative humidity being 160 cm and 76 to 85%, respectively. The soil is essentially coral sandy type with a shallow depth due to occurrence of a hard bed of limestone at about 1.2 metre depth. The vegetation is dominated by Screwpine, Pandanus odoratissimus, Scaevola koenighi, Thespesia popylanea, Spinfex spp., Cantharanthus roseus, Moringa clifera, Butea monosperma and herbs like Lauaea, Evolvulus, Rungia, Vernomia, Aerva lantana and Bacopa moniera. Coconut is the only crop of importance, covering almost the entire cultivated area. It is so thickly planted that it has become a limiting factor for good yield besides providing protection and favourable environment for survival and multiplication of rats and other insect pests.

MATERIALS AND METHODS

The rodent control operations were carried out in about a 60-hectare area of Bhandarkar (government) lands belonging to Bada, Boduathiri, Kudehi, Rammedu and Fallessery villages of Minicoy Island. Three anticoagulant rodenticides applied for field efficacy were brodifacoum, bromadialone, and warfarin. The first two are single-dose anticoagulants (second-generation rodenticides) whereas, warfarin is a multiple-dose pesticide. To assess comparative efficacy of brodifacoum (.005%, .002%) bromodialone (.005%, .002%)

*Correspondence address: 48-24, 64th Street, Woodside, N.Y. 11377.

and warfarin (.025%), poison baits were prepared with combinations of rice (Oryza sativa), pulse (Vigna radiata), ragi (Eleusine coracana) and wheat (Triticum aestivum) as bait material. Coconut oil, groundnut oil and palm oil were used as attractants. A small quantity of jaggery was mixed in all poison baits to increase its acceptance by rodents. All bait formulations were mixed in molten wax to make cakes. For each treatment, 30 bait points were selected on infested palms per hectare. Each bait point had about 200 grains poison wax cakes kept in the crowns, following Williams (1971). Prior to control operations, the population levels of rodents were estimated through trap index (rodents/100 traps/24 hours) method following Barnett and Prakash (1975). Trap indices were calculated using formula I = M/A X T, where 'A' is number of traps used in the treatment area. 't' is number of nights during which traps were set and 'M' is total number of rodents trapped. The treatment was continued for 5 days, wherever necessary. To assess effectiveness of different concentrations of rodenticides and bait formulations in reducing rodent populations the postcontrol rodent populations were estimated through trap indices. Following Williams (1971), the reduction in rodent damage was calculated by collecting the fallen nuts from treatment areas daily throughout the operations. Each day nuts were collected, counted and removed from the respective plots.

The farmers and field workers were involved and trained during the entire operation period regarding on-the-spot methods of rodent trapping and poison baiting.

RESULTS AND DISCUSSION

Rodent species involved

The black rat, Rattus rattus (Linnaeus), constituting new record for Micicoy Island, was the predominant rodent species responsible for about 55% of damage to coconut crop in the island. Several nests were found in the crowns of infested trees occupied by pregnant female rats or lactating females along with weaning young ones. The nest composition included dried leaves, bark and inflorescences. The density of R. rattus population was very high as evidenced from average trap index being 18.75 (rodents/100 traps/24 hrs). Almost all nuts were damaged in the middle portion (Fig. 1), while similar species bore holes on the perianth portion of nuts in the coconuts in Kerala.

Figure 1. Black rat damage to coconuts on Minicoy Island, India.

Relative efficacy of rodenticides

Brodifacoum

Brodifacoum (.005%) provided about 74.5% control of rodents when data obtained for various treatments were pooled. However, poison impregnated with rice and coconut oil proved to be highly effective in managing rodents by 86.82%, followed by a rice and groundnut oil combination (Table 1). With ragi as well as pulse, the effectiveness of poison baits mixed with coconut oil was highest. On an average, 74.9% reduction in nutfall due to rodent attack was achieved with this treatment, the highest success being with rice and coconut oil followed by rice and groundnut oil baits (Table 2). In the laboratory studies, Redfern et al. (1976) obtained 100% mortality rates among R. rattus with .005% brodifacoum, whereas with the same concentration Dubock and Kaukeinen (1979) recorded 90% control. Mathur and Prakash (1981a) reported 100% mortality after a 4-day feeding period in R. rattus.

Table 1. Comparative field efficacy of different concentrations of three anticoagulant rodenticides in reducing rodent populations in coconut plantations of Minicoy.

BAIT	Brodifocoum (.005%)			Brodifocoum (.002%)			Bromadiolone (.005%)			Bromadiolone (.002%)			Warfarin (.025%)		
	Pr.C.	Po.C.	%Control	Pr.C.	Po.C.	%Control	Pr.C.	Po.C.	%Control	Pr.C.	Po.C.	%Control	Pr.C.	Po.C.	%Control
Rice + Coconut oil	24.52*	3.23*	86.82	23.42	4.01	82.87	22.27	3.01	86.48	20.34	5.23	74.28	18.78	5.03	73.21
Rice + Groundnut oil	23.16	4.66	80.31	22.02	3.79	82.78	21.32	3.21	84.94	16.72	4.32	74.18	19.73	5.45	72.37
Rice + Palmoil	20.52	5.45	73.44	19.84	5.12	74.19	20.10	3.36	83.28	20.13	5.97	70.34	20.32	6.63	67.37
Pulse + Coconut oil	26.71	6.67	76.02	19.37	5.40	72.12	18.85	4.55	75.86	16.75	5.35	68.05	17.32	6.10	64.78
Pulse + Groundnut oil	25.23	7.25	71.62	21.32	6.03	71.71	15.73	4.08	74.06	19.32	6.89	64.33	19.34	6.98	63.90
Pulse + Palmoil	18.23	5.21	71.42	26.21	7.28	71.21	19.71	5.26	72.80	22.31	8.32	62.70	20.55	7.32	64.37
Ragi + Coconut oil	16.78	4.38	73.89	23.32	5.21	77.66	18.38	4.12	77.58	18.39	5.05	72.53	26.72	8.23	69.1
Ragi + Groundnut oil	22.45	6.85	69.48	21.45	8.16	62.00	24.25	5.03	79.25	23.42	6.94	70.36	22.32	7.32	67.20
Ragi + Palm oil	24.75	7.70	68.88	25.42	8.20	67.74	22.32	5.85	73.79	20.22	6.91	65.82	18.24	6.45	64.63
Wheat +	-	-	-	-	-	-	20.25	3.42	83.11	-	-	-	18.79	4.25	77.38
Average	-	-	75.5	-	-	73.58	-	-	79.1	-	-	69.16	-	-	68.44

*Trap index - Rodents/100 traps/24 hrs; Pr. C. = Pre Control; Po. C. = Post Control

Table 2. Comparative field effectiveness of different concentrations of three anticoagulant rodenticides in reducing rodent damage to coconut crop in Minicoy.

BAIT	Brodifacoum (.005%)			Brodifacoum (.002%)			Bromadialone (.005%)			Bromadialone (.002%)			Warfarin (.025%)		
	Pr.C.	Po.C.	%Reductn.	Pr.C.	Po.C.	%Reductn.	Pr.C.	Po.C.	%Reductn.	Pr.C.	Po.C.	%Reductn.	Pr.C.	Po.C.	%Reductn.
Rice + Coconut oil	35	6	82.85	37	8	78.37	36	6	83.33	34	9	73.52	32	8	75.00
Rice + Ground-nut oil	33	7	78.78	42	10	76.19	34	7	79.41	36	10	72.22	25	7	72.00
Rice + Palmoil	30	8	73.33	36	11	69.44	35	6	79.81	38	12	68.42	28	8	71.42
Pulse + Coconut oil	41	10	75.60	28	10	64.28	35	8	77.14	42	13	69.04	31	11	64.51
Pulse + Ground-nut oil	31	8	74.19	26	9	65.38	35	9	74.28	32	12	62.5	19	8	57.89
Pulse + Palmoil	27	7	74.07	30	12	60.00	32	8	75.00	26	21	57.69	21	9	57.14
Ragi + Coconut oil	25	7	72.0	24	6	75.00	28	6	768.57	29	7	75.86	20	6	70.00
Ragi + Ground-nut oil	32	9	71.80	30	8	73.33	25	6	76.47	29	8	72.41	19	7	63.6
Ragi + Palm oil	33	9	71.80	30	8	70.37	34	8	76.47	29	8	72.41	19	7	63.15
Wheat +	-	-		-	-		41	7	82.92	-	-	-	32	7	78.12
Average	-	-	74.93	-	-	70.26	-	-	78.24	-	-	69.53	-	-	61.9

Brodifacoum (.002%) provided an average control success of 73.58% as revealed by pre-and post-control estimation of rodent populations. The highest percent control (82.3) was obtained when it was mixed in rice and coconut oil and rice and groundnut oil. Coconut oil as an attractant provided highest efficacies, in the case of all three respective baits. On an average, rodent damage to coconut was reduced by 70.26%, with the maximum reduction achieved when the rodenticide was impregnated with rice and coconut oil. In Malaysia, Kok (1980) obtained control success ranging from 64.4 to 85.0% when .003% brodifacoum-treated baits were applied in oil palm plantations, whereas, 100% mortality was observed (4-day feeding period) among JR. rattus in the laboratory with .022% brodifacoum (Mathur and Prakash, 1981a).

Bromadialone

Bromadialone (.005%) reduced rodent populations by about 79.1%. All three replications of poison treatment with rice as bait mixed with coconut/groundnut or palm oil resulted in more than 83% control success. The poison bait with wheat was also effective in reducing rodent densities by 83%. Except in the case of ragi, where groundnut oil as an attractant proved more effective, coconut oil-mixed baits with rice and pulse gave better results. The effectiveness for baits was in the order of rice>ragi> pulse. About 78.2% reduction in rodent-damaged nuts was observed with .005% bromadialone application. Recently Fradois (1977) obtained 84% control when .005% bromadialone baits were fed to R. rattus, whereas recently Jain and Rana (1985) observed that same concentration produced 100% mortality among Rattus rattus when the poisoned bait was exposed only for 1 day. However, with a higher concentration, 0.01%, percent control was achieved only on the third day.

With .002% bromadialone about 69% rodent populations were controlled. Preference for baits was similar to rice>ragi>pulse, whereas coconut oil provided best results with all baits. Parallel to reduction in rodent numbers, the pre- and postcontrol nutfall showed a reduction of 69.5% of rodent damage.

Warfarin (.025%), a widely used rodenticide in India, reduced populations of rodents by about 68.4%, the highest being when the poison was mixed with wheat. The damage inflicted by rodents to coconuts declined by about 62% after treatment. Excluding wheat cakes, the effectiveness of rice was higher than ragi and pulse baits. Similar to other treatments, coconut oil-mixed baits proved more effective in comparison to the other two edible oils. Kok (1980) obtained mortality ranging from 56.4 to 82.7% when oil palm crop was treated with warfarin. In the house (dwelling) habitat, 80% of rodents (predominated by R. rattus) were controlled with 0.025% warfarin application (Advani 1982b), whereas in the laboratory mortality was 91.6% when treated baits were fed for 7 days to R. rattus (Mathur and Prakash 1981b).

Of the eight most effective rodenticidal treatments, .005% brodifacoum + rice + coconut oil; 0.005% bromadialone + rice + coconut oil; 0.005% bromadialone + wheat; and 0.005% bromadialone + rice + groundnut oil resulted in lower nutfall as well as rodent trapping on the third day after application of poison baits (Table 3). A significant and constant trend of low nutfall rate was observed on the fourth day (0.005% brodifacoum + rice + groundnut oil), fifth day (0.005% bromadialone + rice + palm g.n. oil), sixth day (.002% brodifacoum + rice + coconut oil), and seventh day (.002% brodifacoum + rice +groundnut oil) for remaining treatments.

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Table 3. Pattern of reduction in rodent damages in case of promising rodenticidal treatments (above 80% control successes).

Treatment	Days precontrol			Poison Baiting	Days during control				Days postcontrol			
	1	2	3		4	5	6	7	8	9	10	11
Brodifacoum												
.005% + Rice + coconut oil	11	10	14		9	6	2	3	2	2	1	1
.005% + Rice + groundnut oil	10	9	14		12	8	4	2	3	2	2	-
.002% + Rice + coconut oil	13	13	11		9	9	6	4	3	2	1	1
.002% + Rice + groundnut oil	12	14	10		10	8	7	5	4	4	2	1
Bromadialone												
.005% + Rice + coconut oil	13	9	14		8	6	2	2	2	2	2	1
.005% + Rice + groundnut oil	10	12	12		7	7	2	2	2	2	2	1
.005% + Rice + palm oil	7	10	12		6	6	4	4	2	2	1	1
.005% + wheat	13	14	14		7	7	2	2	2	2	1	1

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