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Field evaluation of anticoagulant rodenticides, bromadiolone and difethialone in sugarcane fields of Cauvery delta

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Second generation anticoagulant rodenticides bromadiolone (0.005%) and difethialone (0.0025%) were evaluated in the sugarcane fields at two different crop stages viz., cane growth stage and cane maturation stage. The results revealed that the difethialone (0.0025%) is a potent anticoagulant rodenticide and can prove more effective if applied at cane growth stage of sugarcane.

Rat damage of Sugarcane (*Saccharum officinarum*), a major cash crop of India, has always been a matter of economic concern. In India, rodents eat about 1250 to 1500 tonnes of sugarcane, inflicting a loss of Rs.257.4 crores annually[1,2] not withstanding the secondary infection of canes with bacterial and fungal diseases after rodent damage[3]. Rodenticidal baiting has been considered to be a more economic and effective method to control pest rodents[4]. Eventhough the second generation anticoagulant rodenticide, bromadiolone has been evaluated against various rodent pests under laboratory and field conditions, limited information is available on the efficacy of bromadiolone in sugarcane fields[4-7]. Similar is the case with regard to another second generation anticoagulant rodenticide *viz.*, difethialone, a hydroxy-4 benzothiopyranone. Its anticoagulant activities on several rodent species in field and laboratory conditions have been described by Lechevin[8,9]. However, the efficacy of difethialone has not yet been tested in Indian field conditions. Hence the present study has been under taken to evaluate the efficacy of bromadiolone and difethialone in sugarcane fields at two stages, viz. 1. cane growth stage and 2. cane maturation stage.

Materials and Methods

Study area—The present investigation was carried out in Arupathy and Vilanagar areas of Mayiladuthurai Taluk, Nagai district (latitude 11°2' N and longitude 79°2' E) of Tamilnadu. This district is called "granary" of Tamilnadu due to its large scale agricultural operations. The study plots had clay loamy soil. This soil has 6.95 *p*H; 0.0095 mMHo/cm electric conductivity; 81.2 kg/ha N; 36 kg/ha P_2O_5; 0.585 % organic carbon and 1.01 % organic matter.

Selection of study plots—A total area of 4 ha plot was selected to evaluate the efficacy of bromodialone (0.005%) and difethialone (0.0025%) in sugarcane field. The total area was divided into 4 plots of 0.5 ha each for cane growth and cane maturation stage with treatment and control plots.

Bait preparation—Bromadiolone (0.005%) ready to use wax cake was used to evaluate its efficacy in sugar cane fields. Difethialone sample (20 ml of 0.125% liquid concentrate) was added into 1kg husked rice to obtain desired concentration of 0.0025% bait. Coconut oil (10ml) was also mixed into this bait as a binding agent.

Baiting method—Burrow and station baiting method as suggested by Baskaran *et al*[10] was adopted. Difethialone (20g of 0.0025%) bait was placed in front of each active burrows and, 50 g difethialone (0.0025%) bait were placed at 10m intervals along the bunds of study plots (as there is a wide scope of taking away the bait by rodents). The same procedure was also adapted for bromadiolone (0.005%) wax cake treatment.

Rodenticide efficacy—The efficacy of rodenticide was assessed following census evaluation method[11] by recording pre and post-treatment census of rodent population. The efficacy of rodenticide was quantified in terms of percentage using the following equation[12].

$100\ (1-[(T_2 \times C_1)/T_1 \times C_2)])$

where

T_1 = pre-treatment population of rodents in treatment plot,

T_2 = post-treatment population of rodents in treatment plot,

C_1 = pre-treatment population of rodents in control plot and

C_2 = post-treatment population of rodents in control plot.

Results and Discussion

Rodent population was estimated by live burrow count method[13,14]. Live burrows were identified following Barnett and Prakash[15] and Sivaprakasam and Durairaj[16]. Two transects each of 50 m, length were laid in each study plot traversing the whole study area. Number of live burrows within 5 meters on either side of the transects were counted and later transformed on per ha basis.

Rodent pest species in the order of their predominance in the sugarcane fields under study were *Bandicota bengalensis, Mus booduga* and *Millardia meltada* (Table 1). *B. bengalensis* is most abundant and destructive rodent pest of sugarcane in India[1,17,18]. *M. meltada* breeds all the year maintaining relatively constant population in the sugarcane field and *B. bengalensis* increases at sugarcane grows[19]. Mus musculas and Nesokia indica are the other rodent species reported to be fairly common in this crop[15].

Efficacy of rodenticides

Bromodialone (0.005%)—A significant ($P<0.05$; 't' test) difference was observed between the pre-treatment and post-treatment population of rodents (except *M.meltada*) in the bromadiolone treated plots (Table 1). On the otherhand, no significant difference was observed between the pre-treatment and post-treatment population of rodents in the control plot, which indicated that the bromadiolone significantly altered the rodent population in sugarcane fields.

Action of 0.005%, bromadiolone was better during cane growth stage, which cleared 59.8 ± 4.37% rodent population (Table 2).The control success of bromadiolone (0.005%) against *B. bengalensis* and *M. booduga* were 63.0 ± 2.52% and 59.8 ± 3.48% respectively. *M. meltada* population was not altered by bromadiolone during this stage. During cane maturation stage, bromadiolone found to yield lesser control success than that of cane growth stage. In this stage, 50.0 ± 3.87 per cent control was achieved by bromadiolone. Mathur and Bhadauria[5] have reported that the bromadiolone loose bait and wax cake respectively gave 97.6% and 96.4% control for *B. bengalensis* in sugarcane fields of Kanpur. In Bangalore, 70% control success was achieved by bromadiolone (0.005%) loose bait against *B. bengalensis*[6]. The PAU[20] report stated that bromadiolone (0.005%) loose bait yielded 78.8 to 100% control for M. meltada in sugarcane fields of Ludhiana. The present results are more or less similar to the above.

Difethialone (0.0025%)—A significant ($P<0.05$; 't' test) difference was observed between pre-treatment census and post-treatment census of rodent population in difethialone treated plot (Table 1). On the other hand no significant difference was observed between pre-treatment census and post-treatment census of rodent population in control plot (Table 1).

The action of difethialone (0.0025%) against rodents in cane growth stage was better than cane maturation stage. In cane growth stage, difethialone (0.0025%) cleared 72.2 ± 2.82 % rodent population. While in the maturation stage, 60.0 ± 1.20 % rodent population was cleared (Table 2).

Difethialone (0.0025%) caused 64.9 ± 9.24% reduction in activity of B. bengalensis; 72.2 ± 7.31% reduction in *M. booduga* and 100% reduction in *M. meltada* population during cane growth stage. Its action against *B. bengalensis* was sluggish in cane maturation stage. Whereas difethialone (0.0025%) was more effective against *M. booduga* and *M. meltada*.

Earlier, laboratory tests have shown difethialone (0.0025%) baits to be effective against various strains of rats and mice, both in Denmark and France[9]. Nahas[21] reported that one day feeding of difethialone (0.0025%) gave 96% mortality of warfarin susceptible *M. musculus*, and 94% mortality of warfarin resistant *M. musculus*. In India, difethialone (0.0025%) yielded 100% mortality of *B. bengalensis* and *M. booduga*[22]. In field condition it gave good control of field voles[9]. It has also given successful control of rats and mice in USA[23].

In the present study, both the anticoagulant rodenticides significantly alter the rodent population during cane growth stage than that of cane maturation stage. The difethialone (0.0025%) yielded more control success and effectively cleared the population of *M. meltada*, *M. booduga* and *B. bengalensis*, while the bromadiolone (0.005%) effectively cleared only the predominant rodent pest of *B. bengalensis* in both two stages of sugarcane.

Table 1—Pre-treatment and post-treatment popolation of rodents in control and treated plots
[Values are mean ± SD of rodents in 6 plots. Figures in parantheses are ranges]

Plot type/ stage		Pre-treatment No.of rodent burrows/ha				Post-treatment No. of rodent burrows/ha			
		B.b	M.b	M.m	Total	B.b	M.b	M.m	Total
Cotrol plot Cane growth stage	A	22.5±1.26 (21-24)	8.5±0.96 (7-10)	1.7±1.40 (0-4)	32.8±2.19 (29-36)	21.8±1.46^{Ns} (20-24)	7.8±0.69^{Ns} (7-9)	1.7±1.25^{Ns} (0-3)	31.7±1.60^{Ns} (29-33)
	B	25.9±4.34 (20-30)	6.6±2.36 (5-10)	1.0±1.15 (0-2)	33.5±5.74 (20.5-37)	27.3±5.69^{Ns} (20.5-33.5)	8.0±2.70^{Ns} (6-12)	1.5±1.29^{Ns} (0-3)	36.3±6.56^{Ns} (27.5-42.5)
Treatment plot Cane growth stage	A	31.7±1.25 (30-33)	9.3±0.75 (8-10)	1.5±0.96 (0-3)	42.5±1.71 (40-45)	11.3±0.94* (10-13)	3.3±0.47* (3-4)	1.5±0.96^{Ns} (0-3)	16.2±2.26* (14-19)
	B	21.5±7.64 (15-32.5)	6.5±2.34 (3-8)	0.9±1.08 (0-2)	28.8±8.18 (21-40)	8.9±3.25* (6-13.5)	1.6±1.21* (1-3)	0.00^{Ns}	10.9±3.59* (7-15.5)
Control plot Cane matura-tion stage	A	23.0±3.56 (20-30)	10.6±2.50 (7-15)	1.7±1.70 (0-5)	34.3±6.30 (27-45)	22.6±3.54^{Ns} (20-30)	10.3±2.05^{Ns} (7-14)	1.3±1.3^{Ns} (0-4)	34.0±6.92^{Ns} (27-48)
	B	20.9±3.14 (18.5-25.5)	4.4±2.13 (3-7.5)	0.8±0.95 (0-2)	26.0±5.49 (21.5-34)	22.9±3.14^{Ns} (20.5-27.5)	3.8±0.64^{Ns} (3-4.5)	1.9±0.62^{Ns} (1-2.5)	28.5±3.46^{Ns} (25-33.5)
Treatment plot Cane matura-tion stage	A	28.5±1.38 (26-30)	8.3±1.49 (6-10)	1.5±1.50 (0-3)	38.3±2.35 (36-42)	14.3±1.69* (12-16)	3.8±0.68* (3-5)	0.8±0.89^{NS} (0-2)	18.8±1.86* (17-21)
	B	26.4±2.01 (23.5-28)	3.3±0.91 (2-4)	1.5±0.70 (1-2.5)	31.0±2.90 (27.5-34)	12.6±2.52* (15.5-21.5)	1.0±0.81* (0-2)	0.4±0.75^{Ns} (0-1.5)	13.0±2.85* (16.5-23)

A = Bromadialone treated; B = Difethialone treated

B. b = *Bandicota bengalensis*; *M. b* = *Mus booduga*; *M. m* = *Millardia meltada*

* = Significant difference between pre-treatment census and post-treatment census ($P<0.05$; 't' test).

Ns = No significant difference between pre-treatment census and post-treatment census ($P>0.05$ 't' test).

Table 2—Control succes of bromadiolone (0.005%) and difethialone (0.0025%) rodenticides in sugarcane fields
[Values are Mean ± SD of perccentage of control success in 6 plots. Figures in paranthesis are ranges]

Stage of crop		Control success, %			Total
		B. b	M. b	M. m	
Cane growth stage	A	63.0±12.14 (52-76)	59.6±20.59 (43-83)	0.00	59.0±19.05 (47-81)
	B	64.9±9.24 (55-76)	72.2±7.31 (66-82)	100.00 (100-100)	72.2±2.82 (62-79)
Cane maturation stage	A	50.0±8.00 (42-58)	52.5±17.28 (39-72)	16.8±29.02 (0-50)	38.6±9.75 (29-48)
	B	45.9±5.34 (31-52)	82.7±20.79 (57-100)	79.7±24.22 (52-100)	60.0±1.20 (40-83)

A = Bromadiolone treated ; B= Difethialone treated.
B.b = Bandicota bengalensis; M. b = *Mus booduga*; M. m = *Millardia meltada*

Thus, from the present study it is inferred that the difethialone (0.0025%) is more potent rodenticide than the bromadiolone (0.005%) and can be used to manage rodent pests in sugarcane fields during cane growth stage.

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