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Field evaluation of difethialone, a new second generation anticoagulant rodenticide in the rice fields

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A new second generation anticoagulant rodenticide, difethialone (0.0025%), was evaluated in the rice fields at three different cropping stages, viz. Milky, Panicle formation and Panicle maturation, during *Kuruvai* and *Thaladi* seasons. The difethailone (0.0025%) yielded satisfactory control success suggesting a great potential as a rodenticide especially in the early stages of rice.

Keywords: Anticoagulant, Difethialone, *Oryza sativa*, Rodenticide

Rice (*Oryza sativa*) is the staple food crop and is predominantly grown in the entire southern part of India. Rodent damage is an important factor causing reduction in rice yields[1,2]. The rice fields of Cauvery deltaic region had four sympatric rodent species, viz. *Bandicota bengalensis*, *Millardia meltada*, *Mus booduga* and *Tatera indica* all cause colossal damage; howsoever, *B. bengalensis* is of principal economic significance because of its wide distribution[3-6]. Rodenticidal baiting which can knock-down mass population is considered to be an inexpensive and effective method to check the rodent population[7]. Considering the drawbacks such as poison aversion, bait shyness and low safety factor with conventional acute rodenticides, anticoagulants appears to be the possible alternatives. There are several kinds of anticoagulant rodenticides developed in many countries. Recently, difethialone (developed by LIPHA, France) has been introduced as a second generation anticoagulant rodenticide[8]. Difethialone (LM-2219) is the first representative of a new chemical family called hydroxy-4 benzothiopyranones. Eventhough its anticoagulant activities on several rodent species in field and laboratories conditions in the West have been described by Lechevin[8], its efficacy has not yet been tested in Indian field conditions. Hence the present study was carried out to evaluate the efficacy of difethialone (0.0025%) in rice fields at three crop stages, viz. Milky stage, Panicle formation stage and Panicle maturation stage during two crop seasons, viz. *Kuruvai* and *Thaladi*.

Study area—The study was conducted in the rice fields of Cauvery delta at the Nagai district, the rice bowl of South India (11° 06′ N and 79° 49′) during the crop seasons of *Kuruvai* (June to October) and *Thaladi* (November to March). Six plots, each of 1ha were selected for the study. Three such plots in different crop stages, viz. Milky, Panicle formation and Panicle maturation stages served as control plots and another three as treatment (difethialone treated) plots.

Bait preparation—Difethialone (20ml of 0.125% liquid concentrate) was added to 1kg of parched paddy to obtain desired concentration 0.0025% bait. Groundnut oil (10ml) was also mixed to this bait as a binding agent.

Baiting method—Burrow and station baiting method as suggested by Baskaran *et al.*[9] was adapted. Difethialone (20g; 0.0025%) bait was placed in front of each active burrow, and 50g of bait was placed at 10 m intervals along the bunds of study plots (as there is a wide scope of taking the bait by different rodents). The rodenticide bait was offered in the rice fields for 2 subsequent days.

Rodenticide efficacy—The efficacy of rodenticide was assessed following census evaluation method[10] by recording pre- and post-treatment census of rodent population. The efficacy of rodenticide was quantified in terms of percentage using the following equation[11].

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

where

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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.

Rodent population estimation — Rodent population was estimated by live burrow count method[12,13]. The live burrows were identified based on the methods adapted by Barnett and Prakash[14], Sivaprakasam and Durairaj[4] and Neelanarayanan *et al*[15]. Two transects of each of 50m length were laid in each plot traversing the whole study plot and the number of live burrows within 5 m on either side of the transects were counted by walking along the transects and compute the number of rodent burrows/ha.

Rodent pests species in all stages of the rice crop under study were *Bandicota bengalensis, Mus booduga* and *Millardia meltada*. Of these *B. bengalensis* was found to be highly populated followed by *M. booduga* and *M. meltada*. It is concurrence with the findings of pest in rice fields at Karnataka[16], West Bengal[17], Andhra Pradesh[18] and Tamilnadu[4,5,9]. In both the two crop seasons, the total rodent population was higher in the milky and panicle formation stages of rice crop when compared to the panicle maturation stage. It may be because the rodents are confined to bunds and adjacent pathways during early stages of rice crop, thereafter they migrate inside the fields at crop maturity. Chopra[19] also reported that the *B. bengalensis, M. meltada* and *M. booduga* were most abundant rodent pests in the rice fields and their populations have been found to be low at the crop maturation. Further he has observed the rodent burrows inside the fields during maturation stage.

Efficacy of difethialone rodenticide — During pre-treatment census the rodent population was higher than that of post treatment census in the difethialone treated plots for both the *Kuruvai* and *Thaladi* seasons (Table 1). On the other hand the rodent population during pre-treatment and post treatment census was found to be similar or higher during the post treatment census in the control plots, which indicates that the intensive baiting of difethialone appreciably reduced the rodent activity.

The efficacy of difethialone was better against rodent pests in all stages of rice fields during *Kuruvai* season, whereas it was modest in the *Thaladi* season (Table 2). Because almost all agricultural lands of this area have been cultivated during *Thaladi* season, there is a wide variety of food available for rodents and thus bait acceptance may be low. While in the *Kuruvai* season limited areas were cultivated depending on the availability of bore well and there is more chance of high bait acceptance due to less availability of food.

Among three crop stages, during Milky stage, the control success with that of difethialone was found to be high during both the two crop seasons, whereas in the case of Panicle maturation stage, the difethialone action was low in both the seasons (Table 2). Availability of maturing grains may reduce the intake

Table 1 — Pre-treatment and post treatment population (no/ha) of rodent species in control and treated plots of rice fields at different crop stages during two cropping seasons

[Values are mean ± SD of rodents burrows]

Season	Plot type	CS	Pre-treatment census (N=6)				Post treatment census (N=6)			
			B.b	*M.b*	*M.m*	Total	*B.b*	*M.b*	*M.m*	Total
Kuruvai	Control	M	18.1 ± 11.11	8.7 ± 4.79	1.2 ± 2.50	28.1 ± 16.76	21.2 ± 9.25	10.0 ± 3.54	5.8 ± 5.78	35.6 ± 10.81
		PF	26.2 ± 6.62	8.7 ± 3.23	0	35.0 ± 7.90	27.5 ± 4.57	8.7 ± 3.22	2.5 ± 2.89	38.7 ± 7.78
		PM	15.0 ± 7.90	16.2 ± 8.29	1.8 ± 3.25	33.1 ± 12.48	19.3 ± 19.9	15.0 ± 11.73	1.2 ± 2.50	35.6 ± 19.84
	Treatment	M	22.5 ± 17.44	16.8 ± 8.51	3.7 ± 1.41	43.1 ± 26.25	5.8 ± 2.28	4.1 ± 2.81	0	10.0 ± 19.84
		PF	17.5 ± 7.07	11.8 ± 4.27	3.7 ± 1.77	31.2 ± 9.69	6.8 ± 7.19	1.8 ± 1.25	0	7.6 ± 2.50
		PM	8.7 ± 1.45	20 ± 10.89	2.5 ± 5.00	26.2 ± 11.64	3.3 ± 1.45	10.0 ± 7.07	0	10.0 ± 9.02
Thaladi	Control	M	24.1 ± 6.51	7.8 ± 3.61	0	31.9 ± 9.48	33.0 ± 8.73	22.5 ± 16.11	0	55.6 ± 10.77
		PF	14.8 ± 7.93	8.3 ± 5.72	0	22.9 ± 9.30	14.5 ± 8.02	10.1 ± 7.91	0.8 ± 1.42	25.3 ± 10.55
		PM	11.8 ± 5.01	6.5 ± 5.63	0	18.4 ± 9.25	13.1 ± 5.32	6.4 ± 1.49	0.4 ± 0.78	19.8 ± 6.23
	Treatment	M	31.0 ± 6.41	16.6 ± 9.33	2.4 ± 1.48	49.9 ± 12.42	18.3 ± 6.30	8.6 ± 6.33	0	26.8 ± 12.36
		PF	44.9 ± 15.48	10.4 ± 9.80	0.9 ± 1.61	56.3 ± 7.28	16.4 ± 7.23	5.1 ± 7.28	0	21.6 ± 2.33
		PM	20.7 ± 914	8.5 ± 6.28	0	30.9 ± 2.78	11.2 ± 4.45	2.6 ± 0.57	0	13.8 ± 4.19

CS = Crop stage, M = Milky stage; PF = Panicle formation stage; PM = Panicle maturation stage
B.b = B. bengalensis; M.b = M. booduga; M.m = M. meltada

Table 2 — Control success of difethialone to (0.0025%) rodenticide in rice fields at different crop stages during two cropping seasons

[Values are mean ± SD of per cent control success]

Season	Crop stage	Control success (%) (N=6)			
		B. bengalensis	*M. booduga*	*M. meltada*	Total
Kuruvai	Milky	80.5 ± 32.80	90.4 ± 6.49	100 ± 0.0	86.3 ± 14.20
	Panicle formation	62.6 ± 15.18	66.1 ± 29.34	100 ± 0.0	86.0 ± 9.95
	Panicle maturation	65.3 ± 44.50	82.8 ± 25.79	100 ± 0.0	74.8 ± 27.88
Thaladi	Milky	54.5 ± 29.28	76.8 ± 18.68	100 ± 0.0	71.4 ± 6.12
	Panicle formation	62.6 ± 8.45	66.1 ± 29.34	100 ± 0.0	63.2 ± 10.05
	Panicle maturation	51.1 ± 8.24	55.9 ± 28.38	—	53.2 ± 6.27

— *M. meltada* population was not recorded during pre-treatment and post treatment census

of poison bait by rodents[19]. In this study it may be a limiting factor of unsatisfactory results of this rodenticide at the crop maturity. However West *et al.*[20] stated that more than one factors contribute to the unsatisfactory results of the rodenticide baiting in the rice fields.

Comparison of these results with those from different authors are more or less same. Nahas *et al.*[21] reported that 25 mg/kg difethialone bait was more potent than 250 mg/kg of bromadiolone. Further, they have also reported that the difethialone is more active against *M. musculus* than the bromadiolone and brodifacoum. Kanakasabai and Saravanan[6] have reported that difethialone effectively cleared the population of *B. bengalensis, M. booduga* and *M. meltada* in the sugarcane fields of the Cauvery delta regions. Similarly several authors have reported that the difethialone gave good control of field voles[22], mice and rats[23] under field condition. The warfarin resistant mice got only 28% of mortality by the one day feeding of 0.005% bromodialone[24], while the difethialone rodenticide yielded 95% mortality against the warfarin resistant mice[21].

Effect of difethialone in the species composition — The rodent species composition in the untreated rice fields were observed in the order of *B. bengalensis*> *M. booduga*>*M. meltada* during *Kuruvai* and *Thaladi* seasons. Difethialone (0.0025%) was potentially acted on individual species and the efficiency of the control success may be arranged in the following order. *M. meltada*>*M. booduga*>*B. bengalensis* during *Kuruvai* season and *M. meltada*>*B. bengalensis*> *M. booduga* during *Thaladi* season. The action of difethialone on the population of M. meltada was severe when compared to other rodent species in the same crop fields as 100% of metads had cleared in all treatment plots. Earlier in the laboratory 100% mortality was observed in *M. booduga* and *B. bengalensis* with single day exposure of difethialone (0.0025%)[25].

The present study reveals that the difethialone could serve as an economic rodenticide when applied at earlier stage of rice crop at any season.

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