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Field Evaluation of Rodenticide Treated Baits for the Effective Control of Field-Rats in Rice Crop

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Abstract: Field-rats may damage rice at all stages, from sowing through to ripening and harvest and causing significant damage to agricultural production throughout the world. The present study was carried out to evaluate the effectiveness of different rodenticide treated baits (rodenticides mixed with a bait substrate, usually mixed and coated onto grains such as broken rice or wheat) for the effective management of field-rats population in rice crop. Different assessed damaging variables were investigated. Results showed that all tested rodenticide treated baits have highly significant impact on the assessed damaging variables. Maximum and minimum post-field-rats activity (5.50% and 2.75%) was observed due to baits treated with Racumin-57 and Hit-Rat 80% WP, respectively. The highest and least field-rats reduction activity (89.10% and 80.64%) was observed due to baits treated with Hit-Rat 80% WP and Racumin-57, respectively. Maximum and minimum tiller damage reduction at flowering (87.58% and 81.07%) was observed due to baits treated with Hit-Rat 80% WP and Racumin-57, respectively and ripening stage (83.98% and 68.82%) was observed due to baits treated with Hit-Rat 80% WP and Racumin-57. Maximum and minimum bait consumption rate by field-rats at flowering (69.75% and 67.75%) was observed due to baits treated with Klerat 0.005 WB and Ractophos 80% WP, respectively and ripening stage (70.00% and 65.00%) was observed due to baits treated with Ractophos 80% WP and Klerat 0.005 WB. Yield losses in rice due to the field-rats may be reduced by using these tested rodenticides at farmers' field with different time intervals throughout the rice cropping season.

Key words: Field-rats · Rice Crop · Rodenticides · Baits · Damaging Variables

INTRODUCTION

Field-rats are one of the most important pests in the world [1] and cause serious damage to agricultural production worldwide [2, 3]. It is estimated that less than 10% of rat species are important pest species in agriculture and urban areas [4-5]; however, field-rats have generally greater impacts in poorer developing countries. In Pakistan, field-rats are considered to be the most important pests before rice harvest, with estimation of 10-15% damage [6] and 2-43% loss [7]; in Indonesia, field-rats are estimated to cause about 15% [8]; in Tanzania, field-rats are estimated to cause 5-15% loss of maize [9]. Farmers report yield losses between 0 and 100% and small farmers occasionally have devastating outbreaks [10, 11]. A survey of rice growers shows that field-rats are considered the most important rice production restraint for 98% of farmers and are described as pests that they control less [12].

From sowing to maturity and harvesting, field-rats can damage rice at all stages. After sowing, the field-rats can consume all the seeds or seedlings, completely eliminating the plants. Once the tillers appears, the field-rats usually bite off the tillers near the base, but as long as there are enough remaining plants, it is possible for the plant to compensate for this damage by creating sprouts or re-growing the tillers. However, after the maximum phase of the tiller, there will be a performance penalty: the later the damage, the higher the performance loss [13, 14]. Starting from the middle tiller, the field-rats cause damage to the rice by cutting it at an oblique angle near the base of the tillers. From the booting (reproductive) stage to harvesting, rice is more susceptible to the damage of field-rats.

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It is well known that it is difficult to assess the damage and loss of field-rats to rice on crop and landscape scales, as damage is often irregular [15, 16]. The number of tillers cut by field-rats in rice can be measured, but this does not necessarily translate into yield loss. Damage of field-rats may be easy to see, but vegetative recovery may mask the appearance of crop damage at harvest [6]. Farmers' estimates are subjective and may be very inaccurate. Farmers usually do not notice damage until it is greater than 5-10%.

There are variations of management choices existing to control field-rats in the rice system. These are mainly used to kill animals, but there are some exceptions (for example, habitat management and biological control) [17]. These methods can be divided into physical (trapping, barriers, trap-barrier system, hunting, habitat management and rice bunds [18-23], chemical (acute rodenticides, anticoagulant rodenticide, fumigation and repellents) [24-26], biological control (sterility control, predators, parasites and diseases) [27, 28] and other management strategies (diversionary feeding, electricity, ultrasound and electromagnetism and ecologically based field-rats management) [29]. Farmers frequently try to control field-rats because the number of field-rats is already high, so it is usually too late, so the control time must be fully understood in order to get the most benefit from the reduction yield losses to rice. There are a variety of rodenticides to choose from. These can be broadly classified into acute and anticoagulants. Acute rodenticides are commonly used in the field and anticoagulants are usually not recorded for use in the field (usually used in shops or houses) [17].

Acute rodenticides can cause death within minutes to 24 hours after ingestion. The acute rodenticide widely used by smallholder rice producers is zinc phosphide, brodifacoum and coumetetralyl. It is available in grey or black powder form and must be mixed with the bait substrate. It is typically mixed and coated with cereals, such as broken rice. It has the smell of garlic and is toxic to a variety of field-rats [26].

Therefore, the purpose of this study was to investigate the different rodenticides for the effective control of field-rats in the rice crop at Rice Research Institute, Kala Shah Kaku, Pakistan.

MATERIALS AND METHODS

The present study was conducted in Rice Research Institute, Kala Shah Kaku (31° 43' 17" N Latitude and 74° 16' 14" E Longitude) during 2015. Rice Crop (Basmati-515) was grown on the 1st week of June 2015 to evaluate the effectiveness of different rodenticides against field-rats. The experiment was laid out in a Randomized Complete Block Design (RCBD) with five treatments and four replications (bait stations), in the field measuring 43560 m^2 (1 acre). The crop was transplanted on the 2nd week of July 2015. All the standard agronomic practices were carried out accordingly.

Rodenticides and Preparation of Baits: Four rodenticides were obtained from Entomological Research Institute, Ayub Agriculture Research Institute, Faisalabad, Pakistan. Baits were prepared separately by mixing 25 g of rodenticides in 25 ml edible oil and 950 g crushed wheat. Bait rate for each replication was 10 g of poisoned bait. The detail of treatments is given in Table 1.

Data Recording and Observations: Percentage reduction in rat activity was assessed by measuring rat activity by observing tracking tiles activity and tiller damage activity:

Tracking tiles activity: Pre- and post- treatment field-rats activity census was made by placing 24 tracking tiles each measuring 30×30cm in three transacts. Half of each tile was painted with printing ink to record foot prints. Tile with foot prints was counted positive and expressed as percentage of all tiles placed.

Tiller damage assessment: Tiller damage assessment was counted from three samples (each 1m^2) in which damaged and undamaged tillers were counted. Percentage of damaged tillers was calculated by the formula:

$$\text{Damaged tillers(\%)} = \frac{\text{Tillers cut by field rats}}{\text{Total number of inspected tillers}} \times 100$$

Bait consumption: In each bait station, bait was placed in earthen cups and replenished daily for 5 days. The position of cups was changed daily to avoid position preferences. The post- treatment daily consumption was worked out by weighing the unconsumed baits.

Statistical Analysis: The data was subjected to analysis of variance (ANOVA) using Statistix software (version 8.1) (Tallahassee, FL). The means were separated by Tukey's HSD test.

Table 1: Rodenticides use in the experiment along with bate rate (g)

Brand name	Active ingredient	Bate rate (g)
Hit-Rat 80% WP	Zinc phosphide	10
Ractophos 80% WP		
Klerat 0.005 WB	Brodifacoum	
Racumin-57	Coumetetralyl	
Control	-	-

RESULTS

The main effect of rodenticide treated baits on all evaluated damage variables because of field-rats was highly significant (Pre-field-rats activity: F = 1.39, df = 4/19; Post-field-rats activity: F = 153.51, df = 4/19; field-rats reduction activity: F = 183.53, df = 4/19; tiller damage reduction at flowering and ripening stage: F = 295.9 and 58.12, df = 4/19; Percentage of bait consumption rate at flowering and ripening stage: F = 28.27 and 10.99, df = 4/19) (Table 2).

Mean comparisons among percentage of reduction activity of field-rats showed that pre-field-rats activity was almost the same for all the rodenticide treated baits including control. Maximum post-field-rats activity (5.50±1.44) was observed due to baits treated with Racumin-57 while minimum post-field-rats activity (2.75 ± 0.63) was observed due to baits treated with Hit-Rat 80% WP. Percentage of field-rats reduction activity was almost similar for all the rodenticide treated baits. Maximum field-rats reduction activity (89.10 ± 2.64%) was observed due to baits treated with Hit-Rat 80% WP while minimum field-rats reduction activity (80.64 ± 5.42%) was observed due to baits treated with Racumin-57 (Fig. 1).

Mean comparisons among percentage of tiller damage reduction by field-rats showed that tiller damage reduction at flowering stage of rice crop was almost the same due to all the rodenticide treated baits while a variation in tiller damage reduction at ripening stage of rice crop due to all the rodenticide treated baits was observed. Maximum tiller damage reduction at flowering stage (87.58 ± 3.06%) was observed due to baits treated with Hit-Rat 80% WP while minimum tiller damage reduction at flowering stage (81.07 ± 3.92%) was observed due to baits treated with Racumin-57. Maximum tiller damage reduction at ripening stage (83.98 ± 3.61%) was observed due to baits treated with Ractophos 80% WP while minimum tiller damage reduction at ripening stage (68.82 ± 7.83%) was observed due to baits treated with Racumin-57 (Fig. 2).

Table 2: Effects of rodenticide treated baits in relation to all assessed damaging variables when field-rats exposed to different baits.

Variables	df	F
Pre-field-rats activity		1.39
Post-field-rats activity		153.51
Percentage of field-rats reduction activity		183.53
Percentage of tiller damage reduction by field-rats at flowering stage	4, 19	295.9
Percentage of tiller damage reduction by field-rats at ripening stage		58.12
Percentage of bait consumption rate by field-rats at flowering stage		28.27
Percentage of bait consumption rate by field-rats at ripening stage		10.99

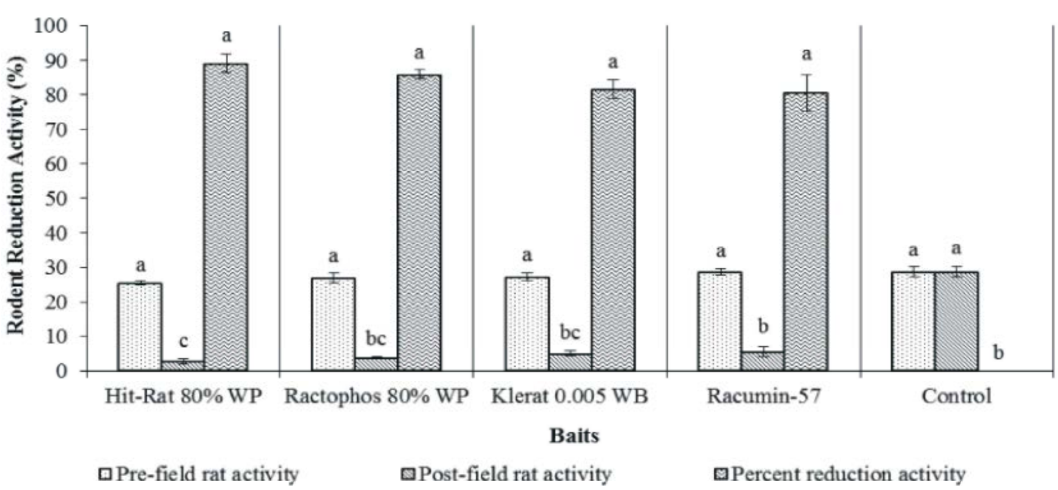

Fig. 1: Percentage of field-rats reduction activity (Mean ± SE, n = 4) due to rodenticide treated baits in rice field crop. Means sharing similar letters for each rodenticide treated bait are significantly different (Tukey HSD at P = 0.05)

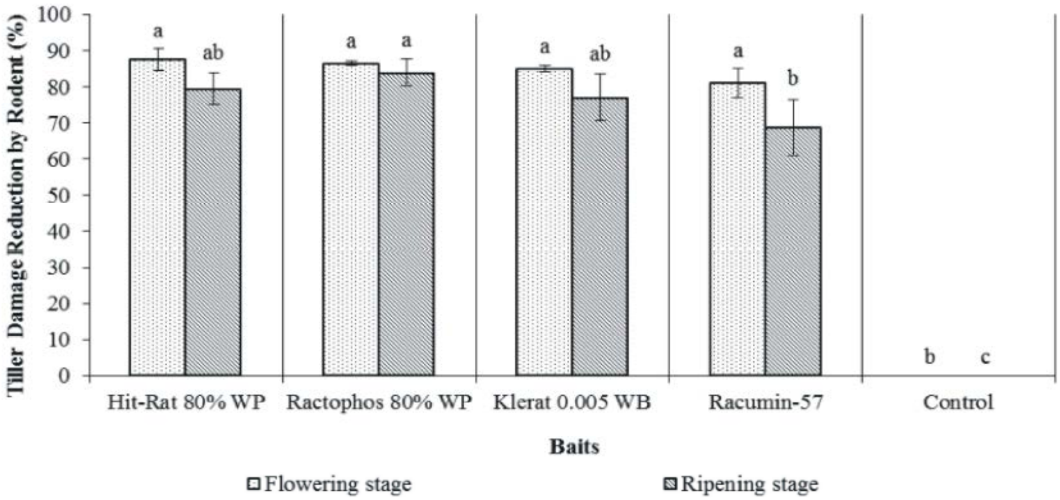

Fig. 2: Percentage of tiller damage reduction by field-rats (Mean ± SE, *n* = 4) due to rodenticide treated baits in rice field crop. Means sharing similar letters for each rodenticide treated bait are significantly different (Tukey HSD at P = 0.05)

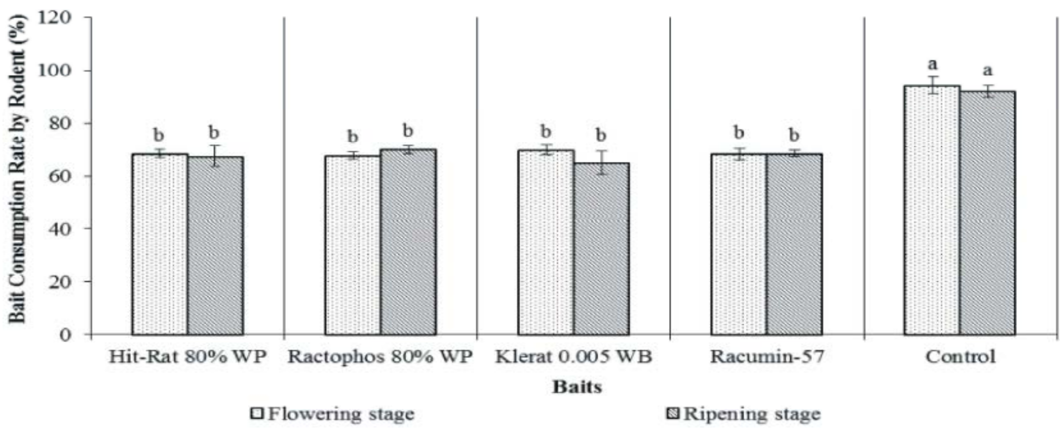

Fig. 3: Percentage of bait consumption rate by field-rats (Mean ± SE, *n* = 4) due to rodenticide treated baits in rice field crop. Means sharing similar letters for each rodenticide treated bait are significantly different (Tukey HSD at P = 0.05)

Mean comparisons among percentage of bait consumption rate by field-rats showed that rodenticide treated bait consumption rate by field-rats was almost same at both flowering and ripening stages. Maximum bait consumption rate at flowering stage (69.75 ± 1.89%) was observed due to baits treated with Klerat 0.005 WB while minimum bait consumption rate at flowering stage (67.75 ± 1.25%) was observed due to baits treated with Ractophos 80% WP. Maximum bait consumption rate at ripening stage (70.00 ± 1.58%) was observed due to baits treated with Ractophos 80% WP while minimum bait consumption rate at ripening stage (65.00 ± 4.53%) was observed due to baits treated with Klerat 0.005 WB (Fig. 3).

DISCUSSION

The results of this study show that all tested rodenticide treated baits affect post-field-rats activity, percentage of field-rats reduction activity, percentage of tiller damage reduction by field-rats at flowering and ripening stage and percentage of bait consumption rate by field-rats at flowering and ripening stage in rice crop.

The highest and least post-field-rats activity was observed in Racumin-57 (6.00) and Hit-Rat 80% WP (3.00), respectively. Dissimilar trend of field-rats reduction activity from post-field-rats activity was recorded where maximum and minimum field-rats reduction activity was observed in Hit-Rat 80% WP (89%) and

Racumin-57 (81%), respectively. Post-field-rats activity was inversely proportional to percentage of field-rats reduction activity. Similar results were found in the study of Brown *et al.* [24] where zinc phosphide was tested on populations of house mice in cereal stubble and pasture paddocks. According to this study, significant reduction in the survivorship of mice (24-51%) was recorded due to zinc phosphide baits. Caughley *et al.* [30] also found that ground application of zinc phosphide in crops was generally highly successful and reduced field-rats population up to 95% in chickpea crop. Brown and Singleton [31] reported that Brodifacoum is responsible to reduce the field-rats activity unto 95% in wheat crop.

The highest and least tiller damage reduction by field-rats at flowering stage of rice crop was observed in Hit-Rat 80% WP (88%) and Racumin-57 (82%), respectively; while highest and least tiller damage reduction by field-rats at ripening stage of rice crop was observed in Ractophos 80% WP (84%) and Racumin-57 (69%), respectively. Maximum tiller damage reduction by field-rats was recorded on flowering stage of rice crop as compare to ripening stage in all tested rodenticide treated baits.

The highest and least rodenticide treated bait consumption rate by field-rats at flowering stage of rice crop was observed in Klerat 0.005 WB (70%) and Ractophos 80% WP (68%), respectively. Dissimilar trend of bait consumption rate by field-rats at ripening stage of rice crop from at flowering stage was recorded where maximum and minimum rodenticide treated bait consumption rate by field-rats at ripening stage of rice crop was observed in Ractophos 80% WP (70%) and Klerat 0.005 WB (65%), respectively. Bait consumption rate by field-rats at flowering stage was inversely proportional to bait consumption rate by field-rats at ripening stage. Results are in accordance with the study of Mushtaq *et al*. [32] on Indian crested porcupine (*Hystrix indica*), a large nocturnal field-rats considered a pest in Pakistan, where the consumption of Coumetetralyl (Racumin) treated bait started decreasing gradually in time and by day 12 the amount of consumption was negligible due to a reduction in the number of field-rats in the baited area.

Bait consumption rate by field-rats is high because there may be a chance of unavailability of alternative food. Mutze [33] and Brown *et al.* [34] believe that when alternative food is available to mice, the acceptance of poison baits will be lower, reducing efficacy. The results of Caughley *et al.* [30] also support this. Alternative food supplies were probably not a factor affecting the efficacy of zinc phosphide baiting in this trial.

CONCLUSION

The purpose of the study was to find out the effective rodenticides for the management of field-rats in rice crop at field level. Results of this study indicated that all tested rodenticides are effective for the management of field-rats at field level. Percent crop yield losses may also be reduced by the proper management of field-rats by using these rodenticides with different time interval throughout the rice cropping season.

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