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EVALUATION OF DIFFERENT FOOD BAITS BY USING TRAPS FOR THE CONTROL OF LESSER BANDICOOT RAT (*Bandicota bengalensis*) IN FIELD CROPS OF POTHWAR PLATEAU, PAKISTAN

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ABSTRACT

The lesser bandicoot rat (*Bandicota bengalensis*) is a widely distributed and serious agricultural pest in Pakistan. It has wide adaptation with rice-wheat-sugarcane cropping systems of Punjab, Sindh and Khyber Pakhtunkhwa provinces and wheat-groundnut cropping system of the Pothwar area, thus inflicting heavy losses to these crops. Comparative efficacies of four food baits (onion, guava, potato and peanut butter smeared bread/Chapatti) were tested in multiple feeding tests for snap/kill trapping of this rodent species in the Pothwar Plateau between October 2013 to July 2014 at the sowing, tillering, flowering and maturity stages of wheat, groundnut and millet crops. The results revealed that guava was the most preferred bait for the rat species as compared to the other three. Among relative efficacies of all four tested baits: guava scoring the highest trapping success (16.94 ± 1.42 percent), followed by peanut butter, potato and onion (10.52 ± 1.30, 7.82 ± 1.21 and 4.5 ± 1.10 percent) respectively. Crop stage/season-wise highest trapping success was achieved at maturity stages of the crop. Moreover, the maturity stage of wheat crop coincided with spring breeding season and maturity stages of millet and groundnut matched with monsoon/autumn breeding peak of the lesser bandicoot rat in the Pothwar area. Preferred order among four baits tested was guava > peanut butter > potato > onion.

Key word: *Bandicota bengalensis*, food baits, traps, efficacy, Pothwar.
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INTRODUCTION

The lesser bandicoot rat (*Bandicota bengalensis)* is one of the most abundant rodent pests in crop fields of Pakistan. It is also a serious problem of wheat throughout southern and southeastern Asia. Pakistan has two isolated populations of this rat, one throughout central and northern Punjab and in the southern part of Khyber Pakhtunkhwa province, and the other in the southern Sindh (Smiet *et al.*, 1978; Roberts, 1997). Losses to standing crops in Pakistan from bandicoot rat damage have been estimated at 6-19% in rice (Greaves *et al.*, 1975; Fulk, 1977; Fulk *et al.*, 1980; Khan, 1987), 2-7.5% in wheat (Beg *et al.*, 1977; Beg *et al.*, 1978; Fulk *et al.*, 1980; Ahmad *et al.*, 1986), 7-11% in sugarcane (Fulk *et al.*, 1980; Beg *et al.*, 1985), and 3-5% in groundnut (Roberts, 1981; Brooks *et al.*, 1988). This rat species is also a major issue in the poultry sector too; it damages the floor and weakens the structure by extensive burrowing and also attacks the young birds (Roy *et al.*, 1987). It is a medium sized dark brownish-grey in color, coarse-furred rat with nearly bare tail, slightly shorter than the head and tail. Burrowing rat also hoards a large quantity of food in its burrows (Parrack, 1969; Roy, 1974). Murid rodents accumulate food in under-ground chambers, scattered surface caches, or both. Among small mammals, the most thoroughly studied hoarder is the lesser bandicoot rat, a serious agricultural pest in southern Asia from Pakistan to Indonesia (Fulk, 1977; Maqbool *et al.*, 2011). The reproductive cycle of *B. bengalensis* corresponds with the harvesting stage of the crop and moderate temperature and photoperiod. In Pothwar area, the breeding season extended from March to October with secession in breeding in June. These two periods of breeding activity separated by a long period of reproductive inactivity from October to March (Hussain *et al.*, 1994; Hussain *et al.*, 2002).

The success of any rodent control efforts through live or kill traps depends upon attraction of bait used in the trap and, quantity and quality of food available in the nature because the bait used in a trap has to compete with the food available to the animal in the wild. The effectiveness of bait depends on its attractiveness to the rodent in order of taste and palatability to the target species. The use of anticoagulant and acute rodenticides, for the control of rodents requires higher operational cost (Khan and Mian, 2008), although they are more effective method, but they have little selectivity and poor efficacy (Prakash and Ghosh, 1992), as all the rodent species often exhibit shyness for such chemicals (Sterner, 1994).

To overcome the problem associated with consistent use of rodenticide baits and reduce their impact on environment, there is need to evaluate alternate methods for effective control of rodent pests. Such alternate methods are useful in situations when the animals are small in numbers and availability of natural food is in scarcity. Chemical methods are not ecologically sound for rat control. Indiscriminate use of poison creates serious health hazards to human beings and their pet animals and creates environment pollution.

OBJECTIVES

The present study therefore, aimed at evaluating different baits for snap/kill trapping of the bandicoot rat in different

field crops of the Pothwar plateau, Pakistan.

MATERIALS AND METHODS

Study area: The Pothwar area, situated between latitudes 32˚33' and 34˚3' N and longitudes 71˚89' and 73˚37' E, covers a total area of 1.82 million ha, of which only 0.61 million ha are cultivated (PBCR, 1976). Dry farming is the dominant land use. Wheat is a major winter crop (November-May) with intercropping of grams, lentils and mustards. Groundnuts or peanuts (*Arachis hypogaea*) together with millets form two important crops of the summer (May-October) season (Beg *et al.*, 1985; Ahmad, 1990). The climate in the plateau is semi-arid warm to hot with subtropical winter and monsoon.

The current study was undertaken between October 2013 to July 2014 at the sowing, tillering, flowering, maturity stages of wheat, groundnut and millet crops in the Pothwar plateau, Pakistan. The study area included University Research Farm (URF) at Koont, located in Rawalpindi district on Chakwal Road at the borderline of districts Rawalpindi and Chakwal. This area represents typical agro-ecosystem of the Pothwar Plateau. Major crops of this area are wheat, groundnut, maize and millet. The terrain is mainly of undulated and gully in nature, mostly covered with wild (non-crop) vegetation comprising of *Acacia modesta*, *Acacia nilotica*, *Achyranthes aspera*, *Aerva javanica*, *Anagallis arvensis*, *Aristida cyanatha*, *Calotropis procera*, *Capparis deciduas*, *Cynodon dactylon*, *Desmostachya bipinnata*, *Eragrostis cilianensis, Saccharum griffithii*, *Saccharum munja, Rumex dentatus*, *Sorghum halepense, Zizyphus mauritiana*, *Zizyphus nummularia* and *Prosopis juliflora* some of which are more important in providing shelter and food to rodents when there is no cultivation or at an early stage of crop growth.

Trapping: Four different types of food bait materials were used for trapping the bandicoot rats in agro-ecosystem of the study area. The baits included onion, guava, potato and peanut butter smeared piece of chapatti (bread) thereafter called "Peanut Butter" were cut in to small slices of about 3-5 g and equipped on traps. Trapping was carried out at monthly intervals using local made snap / kill traps. Theses traps were made of stamped out sheet metal, they are more effective and easier to set and adjust. Before setting the traps, it was ensured that they were in good working order, that trigger plates work freely and release easily.

Three types of crop fields (wheat, groundnut and millet crops) were selected to evaluate the efficacy of selected baits. During the respective crop season and its growth period, approximately 5.0 ha area of cropland was selected bearing sufficient population of the lesser bandicoot rat burrows and infestation required to test the selected baits. A total of 40 snap / kill traps using all four baits were set at a time in each trapping session for three consecutive nights to test relative efficacies of the selected bait in such a way that it was never repeated in the same fields/areas during the course of study. The baited traps were placed in front of active burrows (burrow system), selected on the basis of observations for presence of the rat species. Some traps were also set on the crop field boundaries under wild vegetation. The identification and activeness of the bandicoot burrows were based on fresh digging, size of soil particles, burrow openings, foot track, damage pattern to the surrounding crop plants and most importantly the fecal droppings. All the four kinds of baited traps were placed together near/on an active burrow system to give a multiple-choice to the animal. It was kept in view that the rodents have free accessibility to the traps and placed under possible cover/vegetation to avoid the non-target animals and save from adverse weather conditions. The dead rats were removed at each morning. Before re-setting the same trap, it was cleaned from blood, flesh or any other contamination. Location of each trap was marked by tying a piece of colored tag/cloth on the nearest tall vegetation/plant. All the traps were operated from dusk to dawn and data were collected in the morning at about sun rise. The trap success of the rat species in different crops was measured during five periods of crop growth stages and at post-harvest stage in the crop fields and fallow fields. Corresponding climatic seasons were defined as: autumn (October, November), winter (December – February), spring (March, April), summer (May, June) and monsoon (July, August) at the sowing, tillering, flowering and maturity stages of wheat, groundnut and millet crops. Descriptive Statistics were performed to calculate means and standard errors of the data using computer software Microsoft Excel 2010. The trapping results for different crops, seasons and baits used were analyzed with Analysis of Variance (ANOVA). Fisher's protected Least Significance Difference (LSD) test was employed to compare mean values at 95% level of significance.

RESULTS

Wheat: Efficacy of different baits for capturing the lesser bandicoot rat at various growth stages of wheat are summarized in (Table 1). Guava as a bait showed highest trapping success at all three stages (sowing, tillering and mature) as well as at post-harvest stage (Table 1), followed by peanut butter but least by onion. Seasonal data showed that guava as bait also scored the highest success in spring, summer and monsoon seasons, while least was scored for onion (Figure 1).

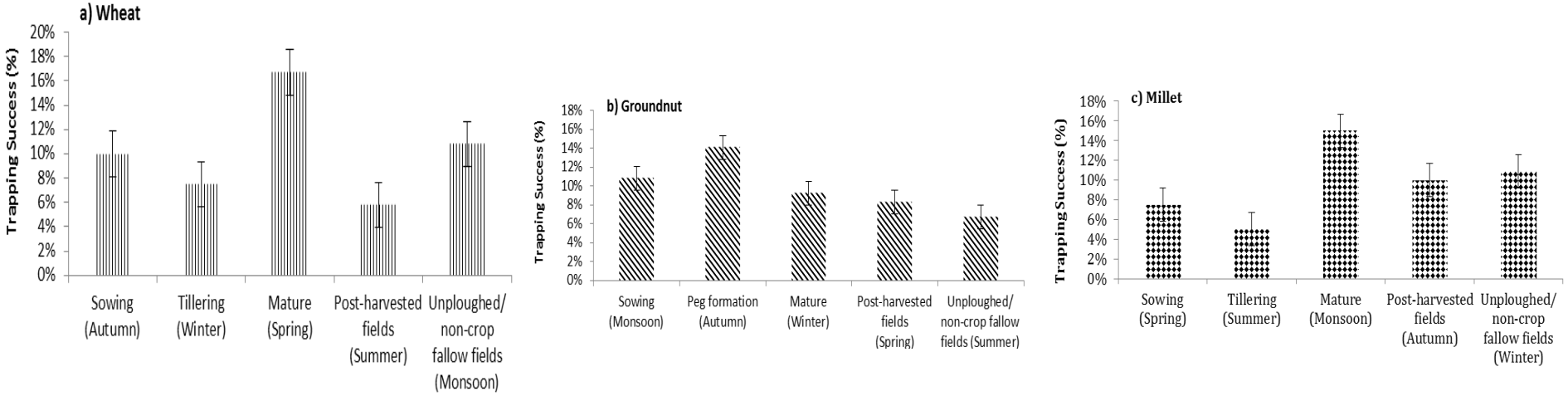
The overall performance of the four bait types tested in the wheat crop season showed trapping success in the descending order: guava > peanut butter > potato > onion. The mean number of lesser bandicoot rat captured using different baits in wheat crop at various stages of growth was significantly different ($F_{3, 16} = 6.495$, $P = 0.004$) from each other (Table 1). Least Significance Difference (LSD) test revealed that the trapping success achieved by guava bait was significantly ($P < 0.05$) higher than rest of the three baits. Although performance of remaining three baits remained in following order: Peanut butter > Potato > Onion but the differences between their trapping successes were non-significant ($P > 0.05$).

Groundnut: Performance of four selected baits tested for capturing the lesser bandicoot rat at three growth stages of

Crop stage	Onion			Potato			Guava			Peanut butter			Total		
	Trap success N (%)			Trap success N (%)			Trap success N (%)			Trap success N (%)			Trap success N (%)		
	Wheat	Groundnut	Millet	Wheat	Groundnut	Millet	Wheat	Groundnut	Millet	Wheat	Groundnut	Millet	Wheat	Groundnut	Millet
Sowing	1 (3.33)	3 (10)	1 (3.33)	2 (6.66)	3 (10)	2 (6.66)	6 (20)	5 (16.6)	4 (13.3)	3 (10)	2 (6.66)	2 (6.66)	12 (10)	13 (10.8)	9 (7.5)
Tillering/Peg Formation	1 (3.33)	2 (6.66)	0 (0)	1 (3.33)	3 (10)	1 (3.33)	5 (16.6)	8 (26.6)	3 (10)	2 (6.66)	4 (13.3)	2 (6.66)	9 (7.5)	17 (14.1)	6 (5)
Mature	3 (10)	0 (0)	2 (6.66)	4 (13.3)	2 (6.66)	4 (13.3)	8 (26.6)	6 (20)	6 (20)	5 (16.6)	3 (10)	6 (20)	20 (16.7)	11 (9.2)	18 (15)
Post-harvested field	0 (0)	1 (3.33)	1 (3.33)	2 (6.66)	2 (6.66)	3 (10)	3 (10)	4 (13.3)	5 (16.6)	2 (6.66)	3 (10)	3 (10)	7 (5.8)	10 (8.3)	12 (10)
Un-ploughed/ non-crop fallow fields	2 (6.66)	1 (3.33)	2 (6.66)	3 (10)	1 (3.33)	2 (6.66)	4 (13.3)	5 (16.6)	4 (13.3)	4 (13.3)	1 (3.33)	5 (16.6)	13 (10.8)	8 (6.7)	13 (10.9)
All	7 (4.7)	7 (4.7)	6 (4.0)	12 (8)	11 (7.3)	12 (8.0)	26 (17.3)	28 (18.7)	22 (14.7)	16 (10.7)	13 (8.7)	18 (12.0)			
*Mean ± S.E	1.4 ± 0.51^{CB}	1.4 ± 0.51^{CB}	1.2 ± 0.37^{A}	2.4± 0.51^{CB}	2.2 ±0.37^{CB}	2.4 ± 0.51^{AB}	5.2 ± 0.86^{A}	5.6 ± 0.68^{A}	4.4 ± 0.51^{C}	3.2 ±0.58^{BC}	2.6±0.51^{BC}	3.6 ±0.81^{BC}			

Table 1: Table 1: Trapping success of capturing the lesser bandicoot rat (*Bandicota bengalensis*) at various growth stages of wheat, groundnut and millet crops for three consecutive nights (n =30) using four different kinds of baits.

Figure 1: Cumulative trapping success (%) of all four baits tested in wheat (a), groundnut (b) and millet crops (c) at various growth stages (Mean ± S. E).



the groundnut crop in the Pothwar Plateau, in harvested field and fallow non-crop fields is summarized in Table 1. The guava as bait showed highest trapping success among all baits tested at all stages of growth of the groundnut crop in the study area (Table 1). The highest results were achieved at peg formation stage (26.6%), while least was scored by onion, followed by peanut butter (13.3%), potato bait (10%) and onion could get only 6.7% trapping success at this stage.

In the groundnut harvested fields, when there were no stand and cover of the crop, the bandicoot rat populations had moved under the wild vegetation at the field boundaries, therefore, most of the rats were captured from the field edges. The results showed 13.3% trapping success by guava bait, 10%, 6.7% and 3.33% by peanut butter, potato and onion baits respectively (Table 1). Similarly, maximum trap success was recorded during autumn season in the study area.

A significant difference ($F_{3, 16} = 12.03$, $P = 0.0002$) was found among the performance of four different baits used in capturing the lesser bandicoot rat (*Bandicota bengalensis*) in groundnut crop at various growth stages and fallow fields. Trapping performances by rest of three baits were in the order of success as: Peanut butter > Potato > Onion. The difference in trapping success by these baits from each other was found non-significant ($P > 0.05$) (Table 1; Figure 1).

Millet: Trapping success of the four tested baits for capturing the lesser bandicoot rat in millet crop at various growth stages and at post-harvested stages is presented in Table 1. A similar trend of trapping success was observed in the millet crop also as mentioned in the above two crops. The guava as a bait showed highest trapping success at all stages of the crop, followed by peanut butter. During monsoon season, when millet crop was at maturity stage, highest trapping success (20%) was achieved each by guava and peanut butter, while onion showed least success (Table 1). In the millet field, at post-harvest stage, the trapping success was highest by guava bait (16.6%) followed by both peanut butter and potato baits (10% each).

In un-ploughed/non-crop fallow fields, during winter season, the bandicoot rat was observed to have moved at field boundaries under the wild vegetation, therefore, at this stage most of the trapping was carried out at field boundaries. Highest trapping success (16.6%) was shown by peanut butter, followed by guava (13%).

Analysis of mean number of lesser bandicoot rats trapped by various baits at various growth stages of millet crop showed significant difference ($F_{3, 16} = 5.93$, $P = 0.006$) among the baits tested. Least Significance Difference (LSD) test showed guava as the most preferred bait having trapping success significantly ($P < 0.05$) higher than rest of the three baits. Comparison of other three baits tested did not show any significant difference ($P > 0.05$) from each other in trapping success. However, their relative performance showed order of success as: Peanut butter > Potato > Onion.

Seasonal Variation: During all seasons (spring, summer, monsoon, autumn and winter seasons), highest trapping success was shown by guava followed by peanut butter is summarized in Table 2. The combined trapping success achieved by all the four baits and in all the three crops segregated on seasonal basis revealed the performance of the baits in the order as: guava > peanut butter > potato > onion.

The mean numbers of lesser bandicoot rats captured using four different baits in wheat, groundnut and millet crops at various stages of growth was significantly different ($F_{3, 16} = 17.336$, $P = 0.000$) from each other. Least Significance Difference (LSD) revealed that the trapping success achieved by guava bait was significantly ($P < 0.05$) higher than rest of the three baits (Table 2). Although performance of remaining three baits remained in the order as: Peanut butter > Potato > Onion, but the differences among their trapping successes were non-significant ($P > 0.05$).

Season (months)	Trapping success (%) of baits				
	Guava	Onion	Potato	Peanut butter	All Baits
Autumn (Oct-Nov)	21.2	4.5	8.9	11.2	11.4
Winter (Dec-Jan)	16.7	3.4	5.6	11.2	9.17
Spring (Mar-April)	17.8	5.6	8.9	11.2	10.8
Summer (May-June)	12.3	1.2	4.5	5.6	5.84
Monsoon (July-Aug)	16.7	7.8	11.2	13.4	12.3
*Mean ± S.E	16.94 ± 1.42	4.5 ± 1.10^{A}	7.82 ± 1.21^{AB}	10.52 ± 1.30^{B}	

Table 2: Effect of seasons on trapping success (%) of the lesser bandicoot rat (*Bandicota bengalensis*) in cropping system (wheat, groundnut and millet) of the Pothwar plateau, Pakistan.

*The values superscript by same letters are not significantly ($P > 0.05$) different from each other.

Discussion

The presence of the bandicoot rat at the maturity stages of wheat, groundnut and millet crops is supported by some earlier studies on the Pothwar Plateau (Fulk *et al.*, 1980; Brooks *et al.*, 1988; Hussain *et al.*, 2002; Hussain *et al.*, 2003). The surrounding habitats and seasonal changes of Pothwar plateau influence the bandicoot's abundance in wheat crops. The breeding activity of this rat reaches at peak during spring season, which corresponds with the maturity of wheat crop and moderate temperature and photoperiod (Hussain *et al.*, 2003). During the hot and dry period in summer season, the vegetation cover is less in croplands, most of the rats die due to unfavorable environmental conditions and predation (Siddique and Arshad, 2003).

In the current study, during spring, the highest trap success was achieved (16.7%), when the mature wheat crops were available, which coincides with peek breeding period of the bandicoot rat (Hussain *et al.*, 1994). At this stage, the crop was providing a good source of food and shelter under which

the rat constructed extensive burrow system. Due to favorable climatic condition and having security under crop shelter, the rat assumed to spend most of its time at surface feeding. The greater surface movement the rat assumed to get greater chances to come in cross with the baited traps which could have resulted in the highest trap success. The second highest trapping success 10.8% was achieved during monsoon and autumn seasons despite of non-wheat season but presumably, better shelter of wild vegetation and climatic factors. The seasonal changes in the rat species population could be correlated with type of crop cover, crop food and climatic factors. A low trapping success recorded in post-harvest and at tillering stage could be related to extreme weather conditions of summer and winter. The drastic reduction in the population of bandicoot rat in winter and summer has also been explained by (Chakraborty, 1992) assuming that it has a natural cycle of fluctuations in population size with growth, peak and decline depending on several biotic and abiotic factors.

Bait preference by rodents depends upon a variety of factors including taste, texture, previous experience of feeding, food item size, palatability, behavioral components, nutritional values and caloric content (Linz *et al.*, 1995). The acceptability of bait plays a vital role in successfully controlling rodent populations. If the bait is not well accepted there will be a poor rodent kill and the whole rodent control operation will be waste. Four food bait materials were used primarily to lure the bandicoot rats. The result of the current study indicated that guava was the most preferred bait item as compared to the other three baits tested. The preference for guava over peanut butter, potato and onion could due to its taste and smell. It can be stated that the smell of the guava marked an attractive taste for the rodents. Moreover, guava is cheap and having the right physical properties and remains available in the study area for major part of the year. The second most preferred baits was peanut butter, the smell of the peanut butter may also have attracted a wide variety of rodents. Peanut butter smeared with chapatti (bread) as bait is attractive, palatable and nourishing foods; it is accepted because it is "tasty" with flavors and soft texture (Mushtaq *et al.*, 2010). It is also assumed that it may fulfill the body needs for proteinic, nutritional and caloric values, but the drawbacks of this bait was that in summer season it was highly infested by ants in the study area which may eat or remove all the bait in one night, that could be a deterrent factor for the rodents. Ants may repel the rats if they are numerous around the trap platform area. Moreover, the peanut butter is an expensive material and not easily available to the farmers at local town/village levels. Potato and onion proved relatively less effective as baits to attract the bandicoot rat. Among these, the potato baits might not have attracted the rats' due to less flavor/aroma and any peculiar taste attractive for the bandicoot rat. Whereas the onion bait presumably did not play any major role in attracting the bandicoot rat, because of its bitter taste and bad smell (Hussain *et al.*, 2003).

CONCLUSION AND RECOMMENDATIONS

Considering the trap success, availability in the local market and cost of the traps, it can be concluded that farmers can use snap or kill traps for controlling rodents in the agro-ecosystem with guava bait. It could be advised that the farmers should periodically carry out rodent trapping at the beginning of each cropping season and during non-breeding seasons of this rodent pest when its populations are low in numbers and restricted under crop boundary vegetation. This could reduce the cost of operation in time and money. The bandicoot population keeps on moving with change in vegetation, crop cultivation and other agricultural operation, for example, ploughing, weeding, removal of crop cache and burning and cutting of wild vegetation. Moreover, the farmers of the Pothwar plateau have small land holdings and are resource deficient. Therefore, it can be recommended that the rodent control operation (by snap trapping) shall be carried out at community level or at least by group of farmers sharing a large segment of agricultural land. This would reduce the operational cost and the rat species may require longer time to re-develop its population.

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