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MANAGING THE DAMAGE OF HOUSE RAT (*Rattus rattus* Cab.) AGAINST RICE (*Oryza sativa* Linn.) WITH THE TRAP BARRIER SYSTEM IN AN IRRIGATED FARMLAND OF FAISALABAD, PAKISTAN

Madeeha Kanwal*, Hammad Ahmad Khan and Muhammad Javed

Departments of Zoology, Wildlife and Fisheries and Entomology, University of Agriculture, Faisalabad, Pakistan.
***Corresponding author's e-mail: druafhammd@yahoo.com**

The house rat (*Rattus rattus*) of the order 'rodentia' and family 'muridae', is one of the major vertebrate pests of agriculture and stored grains, inhabiting the main agro-ecosystems of the world. In Pakistan, damage has also been reported on a variety of economically important crops and stored grains. In an agricultural complex of University of Agriculture, Faisalabad comprising the canal irrigated plantations, infestations of house rat was assessed under the controlled and treated (trap barrier) situation for the mature stage of rice (*Oryza sativa* L.), to assess the inhibited damage. Seemingly, for the one acre control plot, house rat depredations remained high (16.27±0.49), while in the trap barrier phase, there was a considerable decline (2.89±0.24) with respect to the rat damage. Average trap success ratios (TSRs) in the unprotected conditions, were fairly intensive (101.67±3.06), but were significantly reduced (18.08±1.47) in the trap barrier applied rice plot. The present results indicated that, implications of ecologically based rodent management strategies provided dividends on a small landscape, but may also be beneficial over multiple cropping systems, on both agricultural and horticultural food sources, not only throughout the region of Central Punjab, but also over throughout Pakistan, to maintain crop sustainability, without serious impacts on the productivity of agro-ecosystems.
Keywords: House rat, rodents damage, stored grains, pest management, trap barrier system.

INTRODUCTION

Rodents are unquestionably serious vertebrate pests to affect the sustainable agricultural systems, stored grains and carrier of zoonotic diseases throughout the world (Gillespie, 1985; Marsh, 1998; Rao and Crockett, 2003). Losses caused by them vary from crop to crop with seasonal fluctuations in different agro-ally important crops climatic conditions of the world (Singh and Gajader, 2014). Majority of the work done on rodents has focused on their relative assessment around various economic crops abundance around economically important crops. Few attempts have been made to determine their damage profiles and crop management (Hone, 1994). Invariably, the rodents prove destructive to the sustainability of crops among all habitats, and in an integrated pest management, costs and benefits of the farmers mainly rely on the effectiveness of pest management measures in suitable ecological conditions, which requires to be exploited for better and ecological friendly control (Fiedler 1994; Stenseth *et al*., 2003; Singleton *et al*., 2005).

In Pakistan, rodents have long been regarded as a major predicament to reduce agricultural production in terms of crop quality and yield (Ahmed *et al.,* 1990; Ahmad and Bhutta, 2005). Throughout the region of Central Punjab, predominant agricultural practices have been extended on various crops which suffer due to the severe impacts of various small mammals (Ahmed *et al.*, 1995; Avery *et al.,* 1995; Abbas, 2003; Khan *et al.,* 2011; Ahmad *et al*., 2012 a,b). Apparently, existence of suitable ecological conditions viz. sufficient foraging and feeding, moisture and protection among thick crop vegetation, have augmented population of different rodents and birds' over the last several decades, to establish their permanent burrowing and roosting systems close to the food sources. This has resulted in their frequent visitations throughout the day to a variety of crops without being exhausted (Hussain *et al.*, 2003; Khan and Beg, 1998; Khan *et al.,* 2004; Ahmad *et al.,* 2011; 2012 a,b).

Rice (*Oryza sativa*), remains one of the significant cereal crops of Pakistan, and is ranked second to that of the wheat (GOP, 2011). Many of the studies have provided information on its growth performance incorporating the selection of sites and appropriate planting dates for better yield to the farmers and elimination of some important ecological factors such as stress of high temperature during reproductive growth stage (Habibullah *et al.* 2007; Safdar *et al.* 2008; Laborte *et al.,* 2012). Benefits of integrated management system at the farmer's level have led to decrease for the depredatory rodents on different agricultural crops without interfering with the natural ecology (Singleton *et al*., 2005). Logically, the effectiveness of variously designed community barrier systems regarding the rice in West Java, Indonesia at varying crop developmental stages there occurred about 58% reduction in terms of rodent damage. Undoubtedly, the barrier system conveniently provides protection to crops through installation of polyethylene sheets around the entire fields

with small openings left at the field corners for installing variously designed traps to snap up the marauding rodents (Singleton *et al.,* 1999). It safeguards the rodent control program based on ecological principals through participation by the farmers (Aplin *et al.,* 2003; Palis *et al.,* 2007; Brown *et al.,* 2005; 2008). It remains pertinent to maintain accuracy for such studies (Morin *et al.,* 2003). Therefore, present studies were hypothesized to reduce the impacts of house rat on the mature stage of rice crop by the incorporation of ecologically based trap barrier system for achieving better production and resultantly inhibited economic losses in a canal irrigated cropland ecosystem of Central Punjab, Pakistan.

MATERIALS AND METHODS

***Study site*:** The city of Faisalabad has a latitude 31°25 north and 73°04 south of Central Punjab. This region is mainly characterized by dry and humid hot summers (42±5°C; May through August), moderate fall and spring (25±3°C; September through October; March and April), and fairly cold winters (2±5°C; November through February). This area harbours with various economically important agricultural and horticultural crops viz. wheat, maize, rice, fodders, sugarcane, sunflower, sorghum, millet, citrus, dates, guava, mango and mulberry. Three main irrigations canals; Jhang branch, Gogera branch and Rakh branch with small water tributaries irrigate mainly the multiple agricultural cropping systems here. A variety of trees *Salamalia malabarica*, *Cedrella toona*, *Terminalia arjuna*, *Ficus bengalnensis*, *Dalbergia sissoo* and *Eucalyptus* species, have also been planted here since the partition of the sub-continent. Over the last many decades, they have been changed into old and tall plantations where enriched faunal diversity thrives under suitable protection. Many of them have been used as permanent roosts and nests by a variety of birds (Beg *et al*., 1995; Ahmad *et al*., 2012).

***Experimental Procedure*:** Present studies to reduce the impacts of rodents' by the incorporation of Trap Barrier System in one acre rice field at the main campus of University of Agriculture, Faisalabad were extended for a period of 20 weeks. Of these, ten remained as control replicate, while the remaining as barrier treated replicate. Before making the observations, a preliminary field survey was made to ascertain the dominant and co-dominant trees (Table 1). Of them, number of existing trees were *Dalbergia sissoo* (12), *Salmalia malabarica* (8), *Ficus bengalensis* (7), *Terminalia arjuna* (7), *Cedrella toona* (5) and *Eugenea cumini* (5). On the roadside, *Tamarix* plantations were predominant. Incidence of house rat (*Rattus rattus*) populations was recorded during the first ten weeks of observations throughout daily evening observations (using the snap traps), and later among the applied trap barrier system (TBS) to determine any of the variations for their relative population abundance. Applied barrier system consisted of fine polyethylene sheets which were hinged around the entire rice crop at 25 cm elevation from the ground. The sheets were kept straight with wooden bamboos which were erected at equal intervals (40 cm) from each other to maintain tensile strength. Four narrow openings (outlets) were left towards the four corners of the rice crop for facilitation to the various rodents entering and leaving in the rice crop. At all these points, single, double and multiple capture traps were placed to snap trap their movement patterns. They were provided with suitable food baits (cereals and fruits) to consume and trapped. As majority of

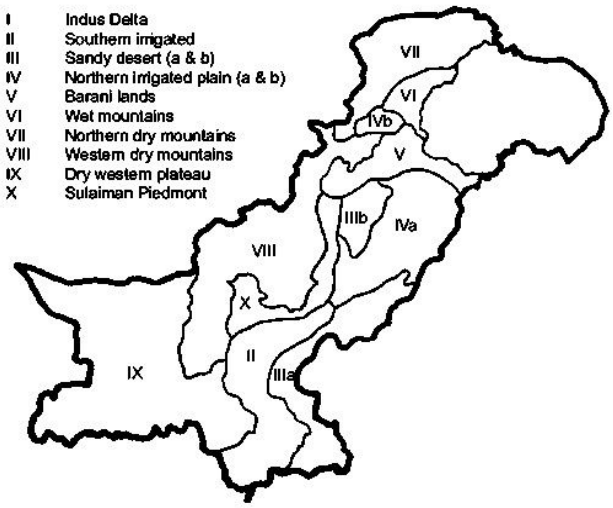

Figure 1. Major Agro-Ecological Zones of Pakistan.

Table 1. Number of dominant and co-dominant trees inhabiting the sampling site in an agricultural complex.

Common name	Scientific name	No. of trees present	Average diameter at breast height (dbh) (cm)	Average height (m)
Simbel	*Salmalia malabarica* (DC)	8	78.5	20
Sheesham	*Dalbergia sissoo* (Rox)	12	75.0	23
Barh	*Ficus bengalensis* (Linn)	7	72.0	21
Arjan	*Terminalia arjuna* (Linn)	7	75.0	21
Toon	*Cedrella toons* (Mel)	5	68.0	17
Jaman	*Eugenea cumini* (Linn)	5	68.0	20
Total		44	436.5	122

the rodents prefer the cereals and fruits, therefore, keeping their importance as food additives, both of these were used. Pre-trapping wherever required was done at least one day before implicating the trap barrier to recognize as point indicators of their occurrence in the rice field. Numerical counts for the house rats were made each morning after the previous evening installed traps. Counts were only made for the *Rattus* species, while the others were not included.

***Statistical analysis*:** The data was statistically analyzed on a micro-computer using the descriptive statistics (Tuckey's test) to interpret the control and treated replicate results meaningfully (Steel *et al.,* 1997).

RESULTS AND DISCUSSION

Results of the present studies indicate that the house rat exhibited enhanced food predilection on the mature stage of rice crop in the unprotected phases, with elevated foraging patterns (16.27±0.49) as compared to the barrier induced situation (2.89±0.24), wherein there was a significant decline in the house rat damage proportions (Table 2). Apparently, the depredatory profiles extended by *Rattus rattus* for the rice crop during all the trap nights was fairly intensive (101.67±3.06) due to no inhibition which came across this rodent pest, but in the trap barrier induced conditions, however, a decreased damage profile based on trap success ratio (18.08±1.47) was recorded (Table 3), describing the effectiveness of trap barrier system. Seemingly, the results sufficiently were the point indicators of the high degree of preference for rice in the mature stage, but introduction of ecologically based trap barrier system remained was a significant safety factor for the crop.

The house rat being a commensal rodent (Brouat *et al*., 2014), has ability to locate for the food even from narrowest ranges, and happens to be an important vertebrate pest of the croplands and indoor situations (Khan *et al*., 2009). It was evident in the present studies that, a considerable damage occurred to the mature stage of rice crop in the unprotected conditions, based on the relative population abundance and invasion during the total trap nights. Seemingly, predominant depredations were recorded during the nocturnal conditions, whereas quiescence prevailed in the diurnal periods, with the rodent preferably averting the daylight and largely restricted its movement patterns. Majority of the damage was recorded on the rice tillers in dry periods in the weekly rat captures. This was also correlated with the elevated trap success ratios (TSRs) during the same durations. Undoubtedly, the trap barrier system (TBS) proved to be important inhibitory factor to minimize the damage which appeared to be prevalent without any obstruction. This also remained valid for the daily rat captures (DRC) of the rice field. As rice is one of the important food crops of Pakistan, sufficing most of the food requirements of the total population, its high crop yield remains significant factor (Memon, 2012). A yet another important factor for expansion of vertebrate pests is their low degree of energy expenditures spent during their frequent visitations to various cropped areas from their burrows and nesting sites throughout the day (Dechant *et al*., 2003; Linz *et al*., 2015). As the agro-ecosystems of Central Punjab are canal irrigated with enriched floral distribution, therefore, ample food opportunities, low temperature fluctuations and sufficient protection against larger predators, exists for various vertebrate pests including the birds and rodents, to augment their populations and to improve the prospect of incessant damage to economical crops, reducing

Table 2. A comparison of house rat captures at the mature stage of rice in the control and treated conditions of an irrigated farmland of Faisalabad, Pakistan.

Trap nights	House rats captured without trap barrier system (treated)	House rats captured with trap barrier system (control)	Means
1	15.20±0.80	4.00±0.84	9.60±1.94
2	15.80±1.62	2.60±0.68	9.20±2.35
3	14.60±1.86	2.00±0.89	8.30±2.31
4	13.80±3.68	2.80±0.97	8.30±2.56
5	17.80±1.96	2.60±1.21	10.20±2.76
6	17.40±1.91	4.00±0.95	10.70±2.45
7	16.20±1.50	3.00±0.95	9.60±2.35
8	16.60±1.54	2.20±0.58	9.40±2.52
9	16.80±1.93	2.20±0.66	9.50±2.62
10	17.60±1.29	2.80±0.86	10.20±2.57
11	12.40±1.57	4.00±1.10	8.20±1.67
12	18.00±2.12	3.40±1.29	10.70±2.70
13	18.60±1.69	2.60±1.08	10.60±2.83
14	15.20±2.03	2.40±0.51	8.80±2.35
15	18.00±2.00	2.80±1.36	10.40±2.78
Overall Means	16.27±0.49	2.89±0.24	9.58±0.61

Table 3. Trap success ratio (TSR) for house rat at mature stage of rice crop (treated) in control and TBS conditions in an agricultural farmland of Faisalabad, Pakistan.

Trap Nights	Trap success ratio (TSR) with trap barrier system	Trap success ratio (TSR) without trap barrier system	Means
1	95.00±05.00	25.00±5.23	60.00±12.15
2	98.75±10.16	16.25±4.24	57.50±14.70
3	91.25±11.63	12.50±5.59	51.88±14.47
4	86.25±23.00	17.50±6.06	51.88±16.06
5	111.25±12.25	16.25±7.55	63.75±17.23
6	108.75±11.96	25.00±5.93	66.88±15.31
7	101.25±09.35	18.75±5.93	60.00±14.71
8	103.75±09.60	13.75±3.64	58.75±15.76
9	105.00±12.08	13.75±4.15	59.38±16.36
10	110.00±08.05	17.50±5.38	63.75±16.08
11	77.50±09.80	25.00±6.85	51.25±10.41
12	112.50±13.26	21.25±8.05	66.88±16.88
13	116.25±10.57	16.25±6.73	66.25±17.68
14	95.00±12.72	15.00±3.19	55.00±14.70
15	112.50±12.50	17.50±8.48	65.00±17.36
Overall Means	101.67±03.06	18.08±1.47	59.88±03.82

largely their production and yield (Ahmad *et al*., 1995; Akbar *et al*., 2005; Ali *et al*., 2003; Beg *et al*., 1995; Lathiya *et al*., 2008; Khan *et al*., 2011).

Present studies are in support to the work done for the effectiveness of trap barrier system for rodent management and without exerting any impacts on the sustainability of agricultural systems (Singleton *et al*., 1998; 1999). Integration with the trap barrier system strongly emphasizes on not only reducing the rodent damage, but also on socio-economic benefits in the cultivations of Indonesia, Philippines, Thailand, Vietnam and the delta of Mekong river in China (Brown *et al*., 2006; Davis *et al*., 2004; Singleton *et al*., 1998; 2003; Tuan *et al*., 2003). Although diversity among rodents' damage patterns may be a predicament to reduce their continued damage profiles in wake of favourable ecological conditions in Punjab, but the implications of ecologically based trap barrier system constitutes the perfect basis for their management without altering the productivity of the agro-ecosystems. Undeniably, further investigations would be required to collate its benefits to the farmers and stakeholders.

***Conclusions*:** It appears probable to implicate the ecologically and economically suitable trap barrier system on rice and also other agriculturally important croplands in Central Punjab to achieve their better growth performance and largely inhibit the damage and economic losses against the existing ominous rodent pests, without affecting the crop sustainability.

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