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Field Evaluation of Trap Barrier Systems for Sustainable Management of House Mouse (*Mus musculus*) in Rice (*Oryza sativa*) Agro-ecosystems

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ABSTRACT

The *Mus musculus* (house mouse) belongs to one of the world's most widespread animal order rodentia and family muridiae. House mouse is a very active rodent specie as compared to their smaller size. House mouse is cosmopolitan in nature spread throughout the world, found in various human-made habitats. This paper provides information about the assessment

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of the TBS of *Mus musculus* on rice (*Oryza sativa*) crop was consecutively conducted for five months (February to June). Observations were made in Student's Farm's rightly considered as the agriculture hub of the University Campus. From the snap trap from day the one 20 ± 0.26 , from the glue station 13 ± 0.24 , from glue sticks 13 ± 0.24 and from steal traps 6 ± 0.22 were recorded of the house mouse population. Overall, 52 ± 0.28 house mice were Captured on the first day of observation. Ironically this trend was maintain with some exceptions throughout the length of this study. Hardly any surveillance was available to the existing food sources at the Student's Farm's and the such, not only the rodent damage but also, Ave- fauna would be densely destroying the final products of the crops. It was concluded that the TBS is more profitable, environmentally, friendly and also without imposing any stress on and the occurring crops and to maintain crop sustainability of the ecosystems

Keywords—

1. Introduction

Rodents are one of the world's most common threats to crops. (Meerburg *et al.*, 2008). *Mus musculus* inhabit a wide variety of habitats, eat variety of food and survive successfully even in worst conditions. Unlike other insects and vertebrate pests, rodents are difficult to observe because of their secretive and nocturnal behavior. Cuong *et al.* (2002) They are notorious for their faster rates of reproduction, their ability to gnaw and destroy food, and damage infrastructure. (Meerburg *et al.*, 2008). House mouse remains a crucial concern for humans. For hundreds of years, they have been damaging stored grain, crops, and house infrastructures and are a cause of deadly human diseases. (Brown *et al.*, 2017) The house mouse (*Mus musculus*) has become deadly destructive vertebrate pests in rural and urban situations, causing extensive damage to crops, house infrastructures, and stored grain. (Kanwal *et al.*, 2016). Rodents survive and will reproduce easily in rice paddies and the nearby areas. At night, they are often interested in seeking food, searching for mates, and also covering the field. (Pujiastuti *et al.*, 2018).

The effects of damage by house mice persist even after the elimination of rodents. Undoubtedly, the ability of house mice to cause damage in a variety of cultivation with adequate humidity and reduced crop production across different habitats around the world. (Kanwal *et al.*, 2016). The *Mus musculus* firstly founded in Asia, but presently it is a metropolitan rodent that is nowadays adapted and spread around the world and present in all areas where human beings are present. (Adduci *et al.*, 2019). The origin of the house mouse is Palearctic region, but due to significant interaction with mankind became widely distributed all around the world. Currently, house mouse present in all regions where human beings are present. *Mus musculus* inhibit a broad variety of man-made habitats. Manzoor *et al.* (2018) Mice typically build dens in humid areas, near the food sources and water such as boundary lines of rocks, dams, irrigation and small hills, to reduce hostile conditions. (Pujiastuti *et al.*, 2018). Rodents have diverse impacts on crops and stored food, as nearly all crops are target to rodent invasion. In recent decades, in developing and developed countries, rodent pests in agriculture have become increasingly attractive. (Fayenuwo *et al.*, 2007). Agricultural fields and farmlands are homogeneous ecosystems because only few species of crop dominate the vegetation. For greater production farmers are trying to improve water availability and increase soil fertility. In turn, food supplies are increased not just for humans beings but also

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for rodent pests.(Shenkut et al., 2006). Rice is a vital food product used as the principal diet in many places in the world. Rice (*Oryza sativa*) among the world's three leading food crops, with the other two being maize (corn) and wheat, provides about 42 percent of the caloric intake needed worldwide. (Mulungu *et al.*, 2020). The damage inflicted by rodent pests is possible to identify from sliced rice rods (form 45°) and have leftover trunk components that are not sliced off. In the paddy vegetative stage, 11-176 stems each night may be destroyed by rats. Their potential for devastation rises to 24-246 rice stalks each night during pregnancy (Pujiastuti et al., 2018). Mice can destroy growing rice fields entirely and often prevent the cultivation where otherwise should be cultivated. Rodent outbreaks document to cause significant food shortages and crop damage in rice-growing areas due to the impact of sowing crops at physically mature stages (Mulungu et al., 2020). At all stages, from planting to fruiting and harvesting, rodents can destroy rice. Rodents may destroy the seedling or seed just after sowing, which corresponds to the complete elimination of the plant. Instantly tillers have grown, rodents mostly bite off the tillers near the root, but ample plant remains. (Brown *et al.*, 2017). At the pre-flowering phase, house mouse (*Mus musculus*) is more common in rice fields. However, in later stages, their numbers continuously decline but remain constant through subsequent periods. Close to their burrow network, plant sample reveals that they appear to eat only grains of rice. (Sarwar., 2015). In the past, much of the prevention methods used at the time were decentralized With technical development and population increases, some improvements have been taken place. At current, rodent control methods can be divided into two simple approaches: non-lethal and lethal.(Mulungu et al., 2020). Physical control methods are likely to be the most effective technique used by farmers to control rodent pests in developing countries. (Singleton et al., 1999). For the control of rodents in agricultural areas, a trap barrier system (TBS) is commonly used all around the world. TBS consisting of a physical protective border is used to control rodent movement.(Wang et al., 2017). Physical approaches have been increasingly known as successful in minimizing the influence of rodents in post-harvest stores and in intensive livestock processing. (Singleton et al., 1999). TBS is also coupled with live-multiple capture cages to monitor rodents in rice crops. Standard TBSs are built as a rectangular structure around the crops on the concept that rodents are lured to the confined trap-crop (TC) which greatly increases the number of rodents caught (Wang et al., 2017). One particular type of barrier is the Community Trap Barrier System (CTBS) or the Trap Barrier System (TBS). The early use of traps plus fencing was in Malaysia, where rodent colonies were established in the fallow areas adjacent to the rice crop. This method has been changed to incorporate a trap crop (also known as a bait crop) cultivated about 2–3 weeks before the adjacent fields, therefore marginally more desirable than surrounding lands (Brown et al., 2017). Community-based trapping barrier device aims at preventing rodent depredation using environmentally sustainable approaches through the involvement of growers (Kanwal et al., 2016).

1.1 Hypothesis:

Present research hypothesized that the introduction of trap barrier system in commercially important rice crops will reduce damage profiles of house mouse (*Mus musculus*) and also increase crop sustainability.

1.2 Aims and objectives:

1. To record information on the damage profiles of house mouse (*Mus musculus*) for the

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rice crop.

2. To check the reduction in rice crop yield due to damage by the house mouse (*Mus musculus*) .
3. To assess the impact of trap barrier system to reduce depredations of house mouse in the rice crop.
4. To increase the rice production by controlling the *Mus musculus* using physical trap barriers in the selected site.

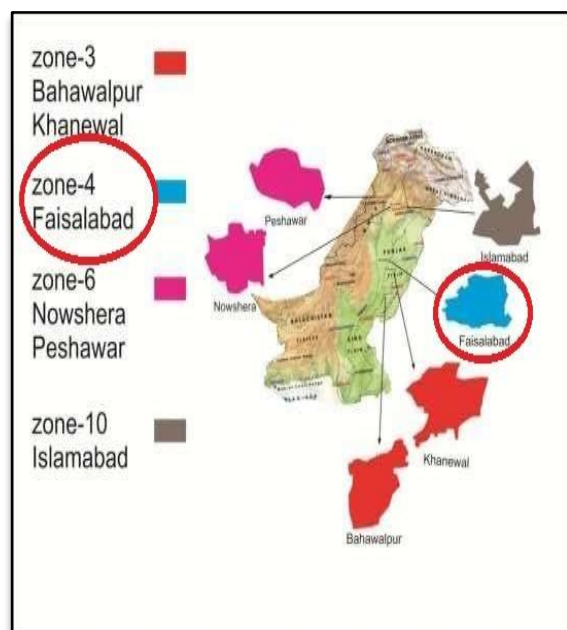
2. Material and Method

This study which was focused on the effect of trap barrier system to reduce the damage profile of house mouse in rice crops.

2.1 Selection of sites

This study was conducted using the trap barrier System at Student's Farms, agro-ecosystem in the University Campus.

Fig 1: Selected Agro-ecological zone of Pakistan



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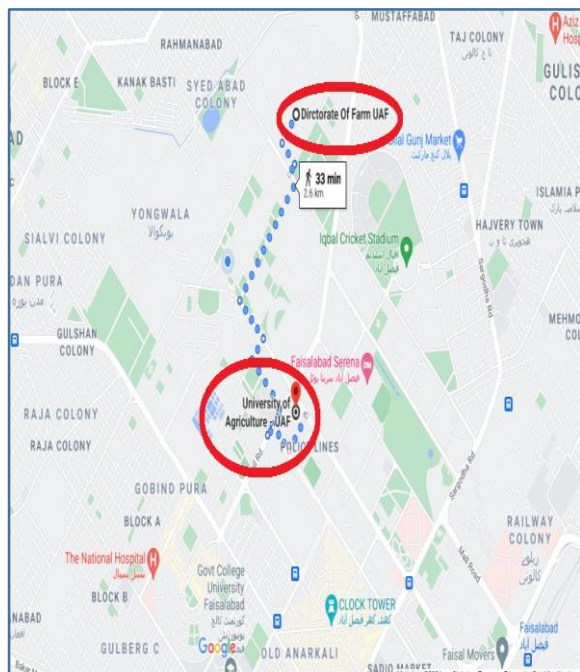
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This sites remains thickly occupied by variety of crops, largely experimental in nature, for the student community. Overall, this region is largely canal-irrigated and as such, rodent populations are present in good number. This region comprises also some other economically important crops, like wheat, maize, sorghum and also fodders besides the various fruit orchids.

Fig 2: Trap barriers installed in selected rice fields

2.2 Methods

The trap barrier System (TBS) is rather scanty in its use in Pakistan. Nonetheless, has been used in many other countries. It came of age in Australia in (2000) and subsequently was used



in other countries like Thailand, Philippines China, Indonesia and South Korea. Its use to inhibit the rodent pests with the incorporation of ecologically acceptable methods has been pivotal. In this study, One arc rice crop randomly selected in the well crop populated Student's Farms. This habitat comprises sufficiently large landscapes and is influenced by Department of Agronomy. The rice crop was barrier installed which was of recyclable polyethylene sheets. They were supported by wooden bamboos of intermediate length to maintain the tensile strength of poly-ethylene sheets.

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Fig: 3 Trap Barrier installed in selected rice field at research site

The barrier was installed around the two rice crops on the some of dimensions at the site. The barrier was kept above the Fig 1: Selected sites for present research work in Faisalabad surface (50cm) and also was provided with the four outlets with the incorporation of the lose and moisten soil attract the rodents. In this barrier system, five traps viz glue stations, glue sticks, self-locking, simple steal traps and snap traps were placed towards the four corners of the field. At each corner, the five traps were placed in double numbers such that, there were ten traps present at each corner of rice crop. In all, there were 40 traps placed in the barrier treated rice crop.

All the traps were provided with suitable baits which consistence of the small bread immersed in oil, figs and grains at the top base of the traps. All the traps were carefully placed in the one arc rice crop fields were re-examined in the following morning to see the number of house mice entrapped inside the

Fig: 4 Identified *Mus musculus* burrow

trap barrier crop. For comparison, an adjacent rice crop was also used with the same number of traps for *Mus musculus*. Finally, at the end of this study period, which was conducted for the period of 120 days that is, throughout February to May, trap success ratio index (TSRI) was computed out with the formula:

No of rodents capture per trap night $\times 100$

No of traps per trap placed

weekly observation were conducted successfully through the length of study period.

Statistic Analysis:

The Study was statistically analyzed by incorporating the Statistic soft were (Mini-tab version) and the correlation- regression analysis (Scattered plot) for analysis and interpretation of results (Steel *et al.*, 1993).

3. Results and Discussion

Observation regarding the affect of trap barrier system to reduce the damage profile of house mouse with respect to rice crop was conducted with the use of the ecologically acceptable Trap Barrier System (TBS). Observations were critically made on the rice crop which were one acre dimension.

The house mouse is unquestionably one of the serious rodent pest and Cause sensitive damage not only in the outdoor condition, but also the indoor Surrounding. For this study, the barrier system was installed using the recyclable poly-ethylene sheets which were kept straight with the help of bamboo sticks and incorporated with five trap types viz glue stick, glue station, self locking, simple steal trap and snap trap. All the five traps which were placed around the four corners were provided with suitable baits to attract the house mouse.

Table 1 provide the information of the number of house mouse which were captured on the daily bases. Ironically on the day one, number of house mice which were captured with the different traps were 20, 13, 13, 6 and the overall number of captured mice were 52. Of all these, the standard errors ± 0.26 , ± 0.24 , ± 0.24 ± 0.23 and ± 0.27 respectively (Table 3.1; Fig3.1). Considering the tables through out this study, with the traps applied to the adjacent controlled or non-treated rice crops, it was evident that number of mice were again captured periodically, but the maximum emphases was focused on TBS with maximum captures towards the four corners of the rice field which further indicated that the barrier system remain fairly effective in the capture of house mice. (See Tables 3.2 to 3.4; Fig 3.3 to 3.8). Moreover, it was further elucidated that, the house occurs not in fair abundance not only in the rice crop, but also among crops indicating its potential to depredate on the food sources. It was evident from the data that *Mus musculus* remains prolific in it's depredatory patterns in the outdoor environment particularly on the rice crop. Not only the rice crop is affected by house mouse, but also the other food crops and sources are largely implicated.

On the daily bases, the number of mice which were captured with five types of traps which were placed towards the four corners of the field, incidence and percentage of *Mus musculus* remain fairly high owing to the effectiveness of the traps barrier system.

This system, therefore, implicates that the ecologically based rodent management can be more useful as compared to the incorporation of chemicals Like the rodenticides.

Rodent management is not easy and requires patience and perseverance. Trap Barrier System (TBS) has provided useful measures to reduce the population of not only of the house mouse but also of the large rodents (Mulungu *et al.*, 2015 a,b)

Majority of the farmers suffer hectically in response to the damage done by the rodents and small mammals on the differential growth stage of crops. The patterns remains palpable throughout the World and their population become more intensified in the presence of moisture

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like canal irrigation system. Therefore, the rice crop is much more preferred by house mouse due to the well moistened conditions and are able to cause the damage during its differential growth stages cause economic losses (Leirs *et al.*, 1994; Mulungu *et al.*, 2014).

Perhaps the house mouse prefer also to breed in the well moistened rice crops and can even cause the outbreaks in many instances (Linn, 1991; Leirs *et al.*, 1995) There is not doubt that as evidence from data of the present studies, rice was on of the predilicted. crop for the *Mus musculus* and also might be for or other rodent pests.

As also reported by work (Stuart *et al.*, 2011) rice can be also severely affected by two rodent species viz *Rattus rattus* and *Nesokia indica* respectively. Nonetheless, mice was profusely captured by using all the incorporated traps and of these, snap trap proved effective then the other three trap types.

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Table 3.1 Number of the house mouse captured by using four types of traps from one acre rice field at Student's Farms, agro-ecosystem in the University Campus in February

Days	Types of rodent traps with numbers of <i>Mus musculus</i> captured per daily visits to rice crop				Overall
	Snap-trap	Glue station	Glue sticks	Steel traps	
1	4	2	0	1	7
2	4	2	0	0	6
3	2	1	1	0	4
4	1	0	2	0	3
5	0	0	2	1	3
6	1	1	1	2	5
7	2	1	0	1	4
8	0	2	1	0	3
9	1	0	2	0	3
10	2	1	1	0	4
11	2	2	1	0	5
12	1	1	0	1	3
Total	20	13	13	6	52
Average	1.667	1.083	0.917	0.500	4.167
± SE	0.263	0.246	0.246	0.236	0.274

Table: 3.1.1 Analysis of Variance of data collected in February

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
<i>Regression</i>	1	347.2598	347.2598	14.87787	0.003175
<i>Residual</i>	10	233.4069	23.34069		
<i>Total</i>	11	580.6667			

Table: 3.1.2: Disruptive statistics of data collected in February

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
<i>Intercept</i>	5.499166	2.057389	2.672885	0.023376	0.915017	10.08332	0.915017	10.08332

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<i>Regression</i>	0.380489	0.098644	3.857184	0.003175	0.160696	0.600282	0.160696	0.600282
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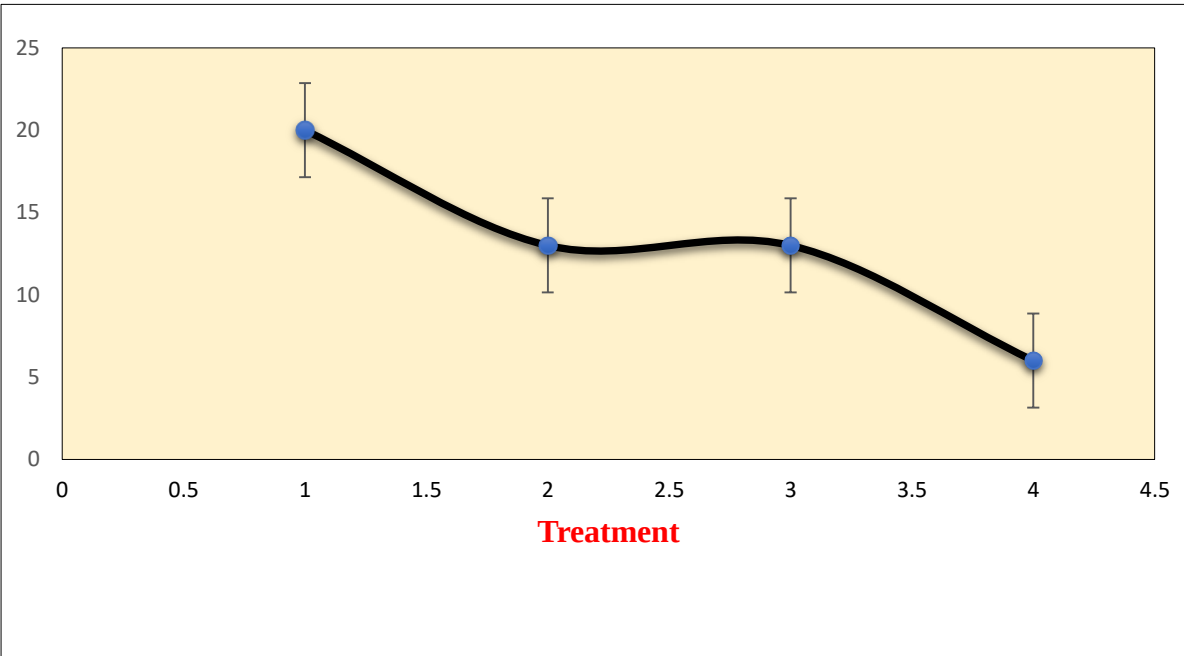


Fig 3.1 Scatter plot of of house mouse captured by using four types of traps from one acre rice field in February

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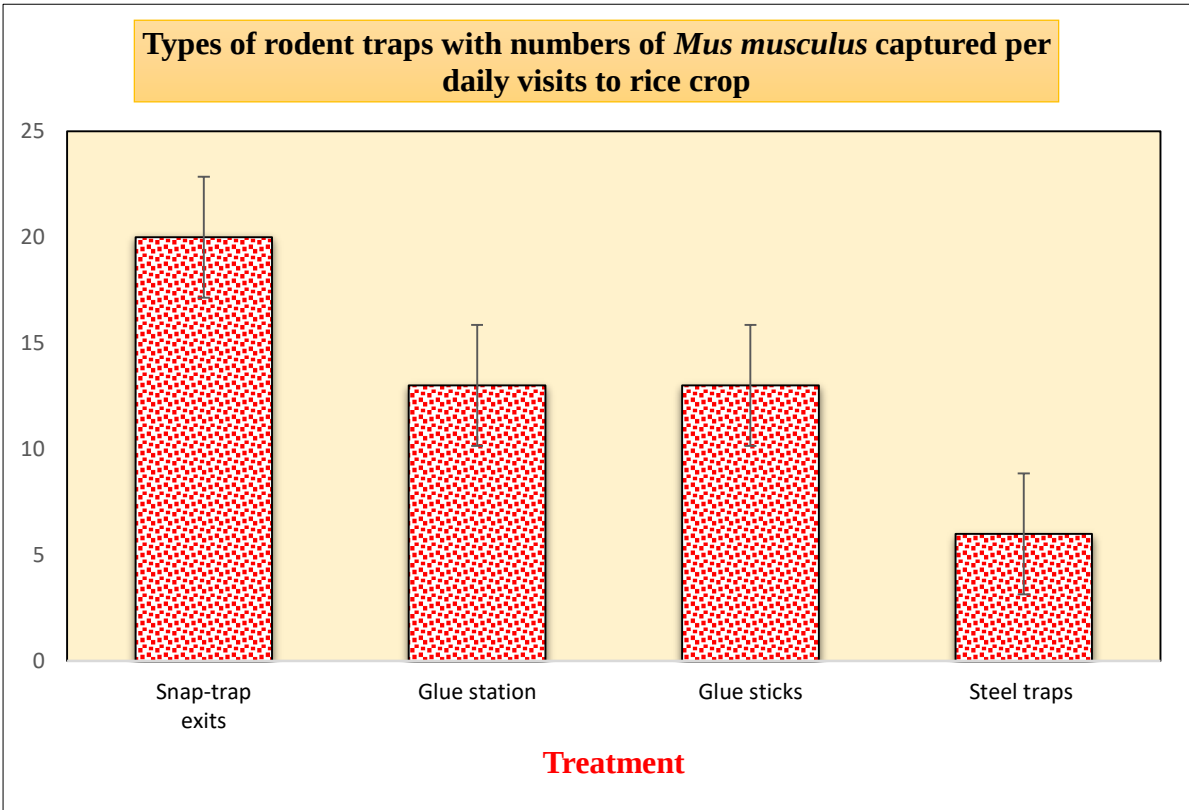


Fig 3.2: Graphical Representation of house mouse captured by using four types of traps from one acre rice field in February

Table 3.2: Number of the house mouse (*Mus musculus*) captured by using four types of traps from one acre rice field at Student's Farms, agro-ecosystem in the University Campus in March

Days	Types of rodent traps with numbers of <i>Mus musculus</i> captured per daily visits to rice crop				Overall
	Snap-trap	Glue station	Glue sticks	Steel traps	
1	2	3	2	0	7
2	0	0	3	2	5
3	2	2	2	0	6
4	1	0	3	0	4
5	1	0	3	1	5
6	3	0	0	2	5
7	4	1	1	2	8
8	2	1	0	1	4

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9	0	0	0	0	0
10	0	3	2	4	9
11	1	0	0	1	2
12	2	0	0	0	2
Total	18	10	16	13	57
Average	1.500	0.833	1.333	1.083	4.750
± SE	0.422	0.353	0.429	0.429	0.920

Table 3.2.1: Analysis of Variance of data collected in March

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
<i>Regression</i>	1	80.08333	80.08333	1.5998	0.234612
<i>Residual</i>	10	500.5833	50.05833		
<i>Total</i>	11	580.6667			

Table 3.2.2: Disruptive statistics of data collected in March

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
<i>Intercept</i>	16.5	4.567016	3.612862	0.004746	6.324053	26.67595	6.324053	26.67595
<i>Regression</i>	-2.58333	2.042432	-1.26483	0.234612	-7.13416	1.967488	-7.13416	1.967488

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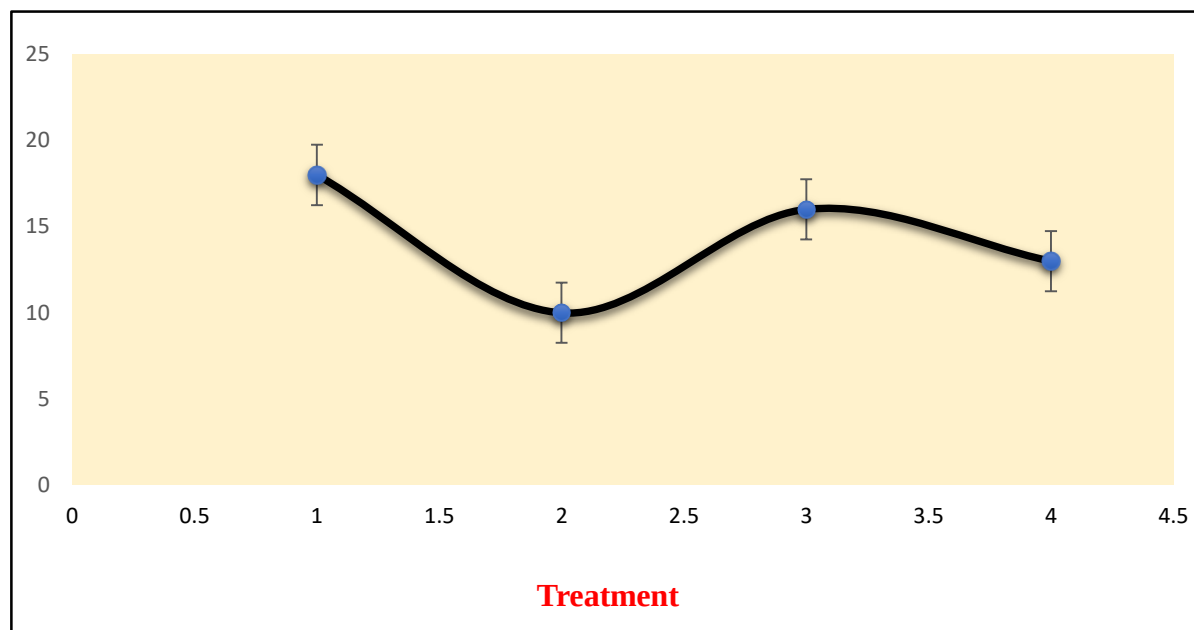


Fig 3.3: Scatter plot of of house mouse captured by using four types of traps from one acre rice field in March

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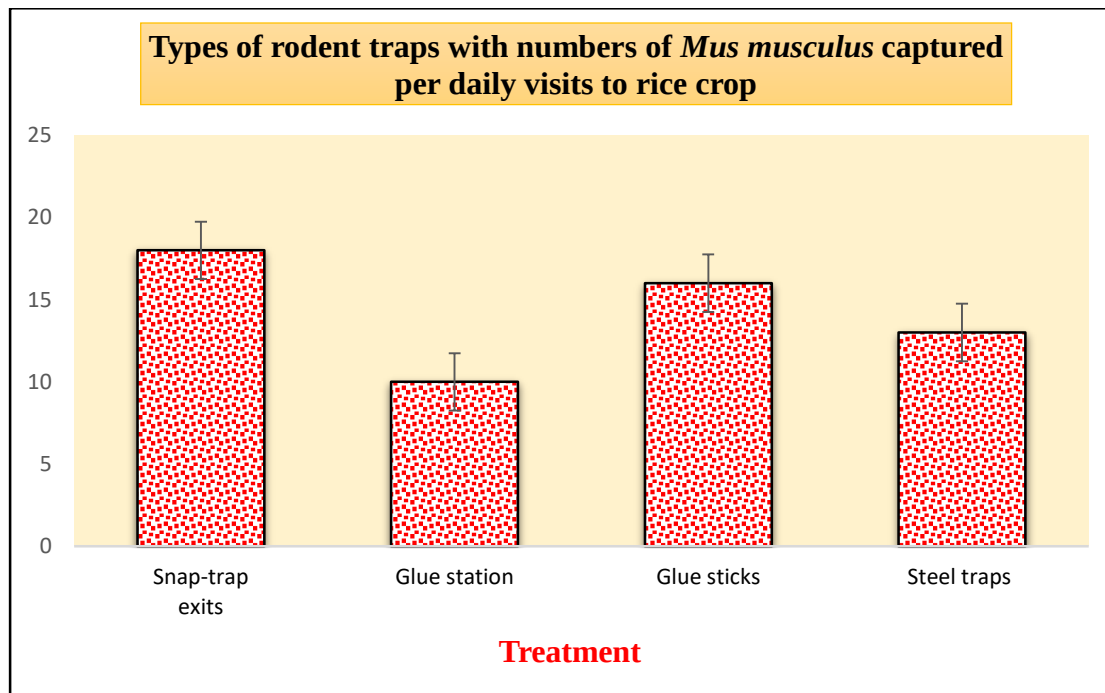


Fig 3.4: Graphical Representation of house mouse captured by using four types of traps from one acre rice field on the 6th day of March

Table 3.3: Number of the house mouse (*Mus musculus*) captured by using four types of traps from one acre rice field at Student's Farms, agro-ecosystem in the University Campus in April

Days	Types of rodent traps with numbers of <i>Mus musculus</i> captured per daily visits to rice crop				Overall
	Snap-trap	Glue station	Glue sticks	Steel traps	
1	1	1	1	1	4
2	3	1	0	1	4
3	2	0	1	2	5
4	1	0	0	0	1
5	1	3	0	1	5
6	0	3	1	1	5
7	2	2	2	1	7
8	0	3	1	3	7
9	3	1	0	0	4
10	3	0	1	3	7
11	1	1	0	0	2
12	1	2	2	0	5
Total	18	17	9	13	57
Average	1.500	1.417	0.750	1.083	4.750
± SE	0.358	0.423	0.263	0.399	0.681

Table 3.3.1: Analysis of Variance of data collected in April

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
<i>Regression</i>	1	11.34752	11.34752	0.199317	0.664785
<i>Residual</i>	10	569.3191	56.93191		
<i>Total</i>	11	580.6667			

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Table 3.3.2: Disruptive statistics of data collected in April

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
<i>Intercept</i>	13.31915	4.952694	2.689274	0.022728	2.283859	24.35444	2.283859	24.35444
<i>Regression</i>	-0.42553	0.953146	-0.44645	0.664785	-2.54927	1.698211	-2.54927	1.698211

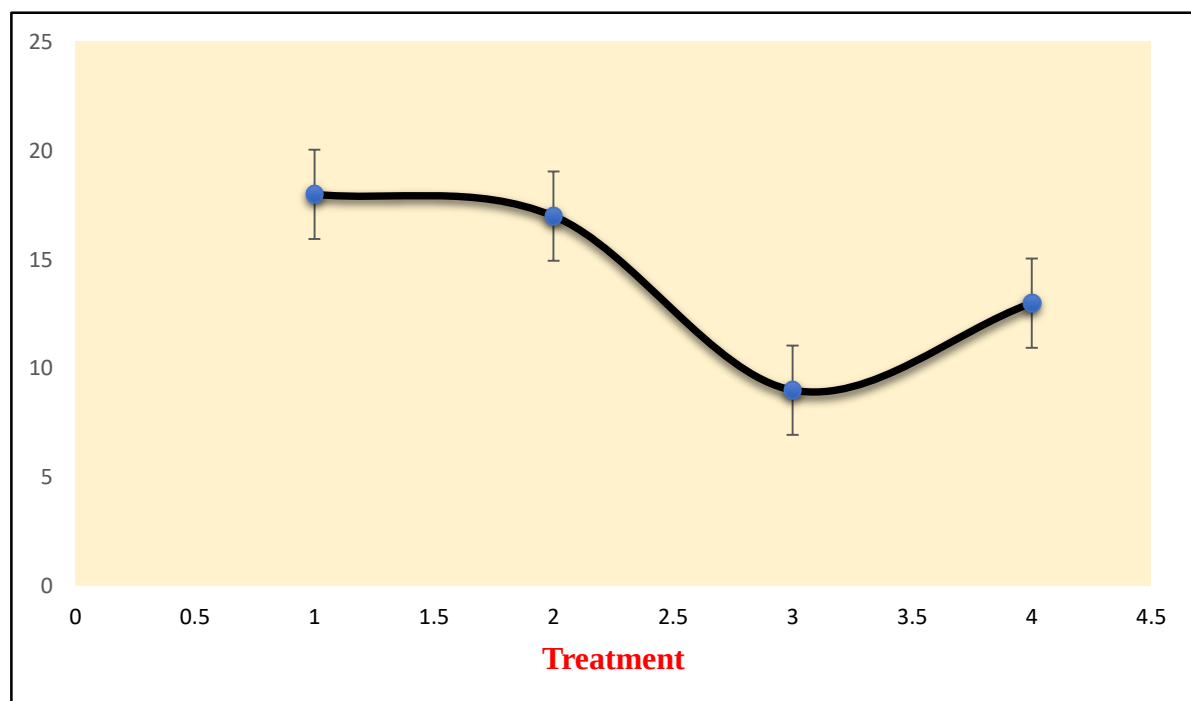


Fig 3.5: Scatter plot of of house mouse captured by using four types of traps from one acre rice field in April

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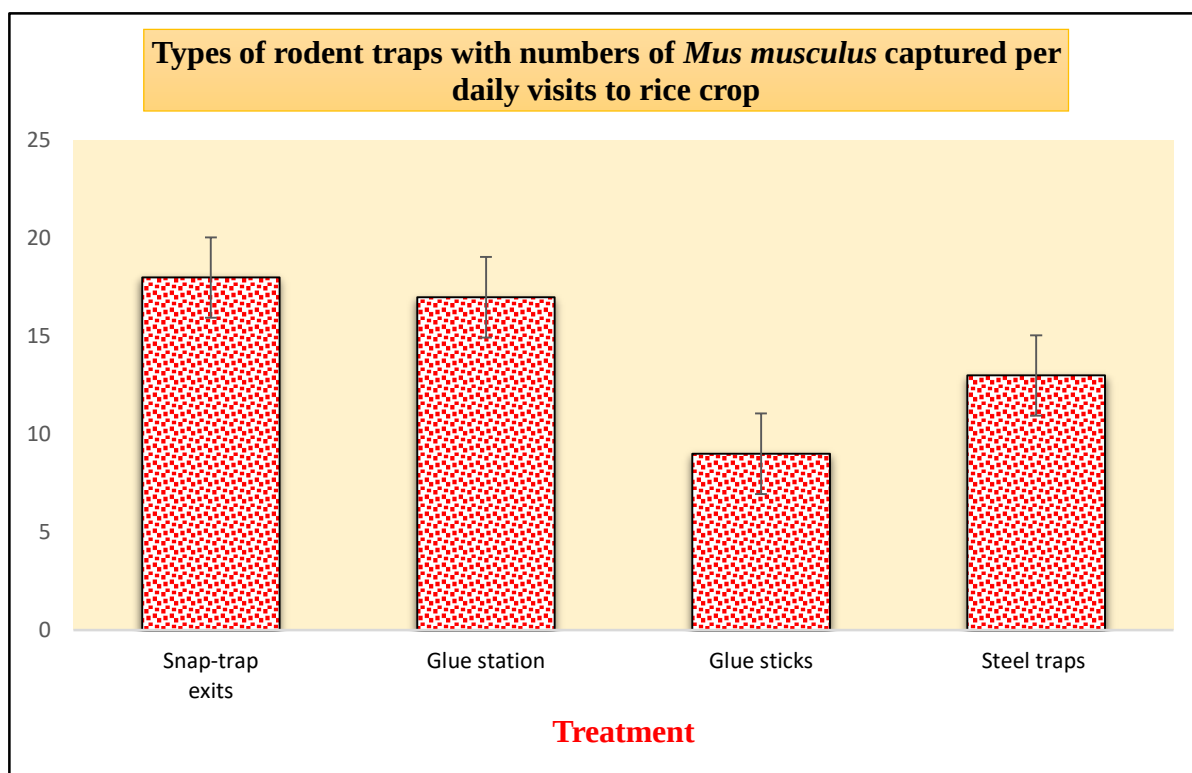
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Fig 3.6: Graphical Representation of house mouse captured by using four types of traps from one acre rice field in April

Table 3.4: Number of the house mouse (*Mus musculus*) captured by using four types of traps from one acre rice field at Student's Farms, agro-ecosystem in the University Campus in May

Days	Types of rodent traps with numbers of <i>Mus musculus</i> captured per daily visits to rice crop				Overall
	Snap-trap	Glue station	Glue sticks	Steel traps	
1	2	2	10	1	15
2	3	0	0	1	15
3	2	2	0	0	4
4	1	0	0	0	1

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5	2	0	3	1	6
6	0	2	0	1	3
7	1	1	1	0	3
8	1	1	2	2	6
9	0	0	2	2	4
10	0	1	1	4	6
11	3	0	0	0	3
12	1	0	1	3	5
Total	16	9	20	15	60
Average	1.333	0.750	1.667	1.250	5.000
± SE	0.331	0.274	0.351	0.473	0.554

Table 3.3.1: Analysis of Variance of data collected in May

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
<i>Regression</i>	1	276.3522	276.3522	9.081138	0.01304
<i>Residual</i>	10	304.3145	30.43145		
<i>Total</i>	11	580.6667			

Table 3.3.2: Disruptive statistics of data collected on 10th day of May

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0 %	Upper 95.0 %
<i>Intercept</i>	17.06425	2.480447	6.879506	4.3E-05	11.53747	22.59103	11.53747	22.59103
<i>Regression</i>	-0.29264	0.097111	-3.01349	0.01304	-0.50902	0.07627	-0.50902	0.07627

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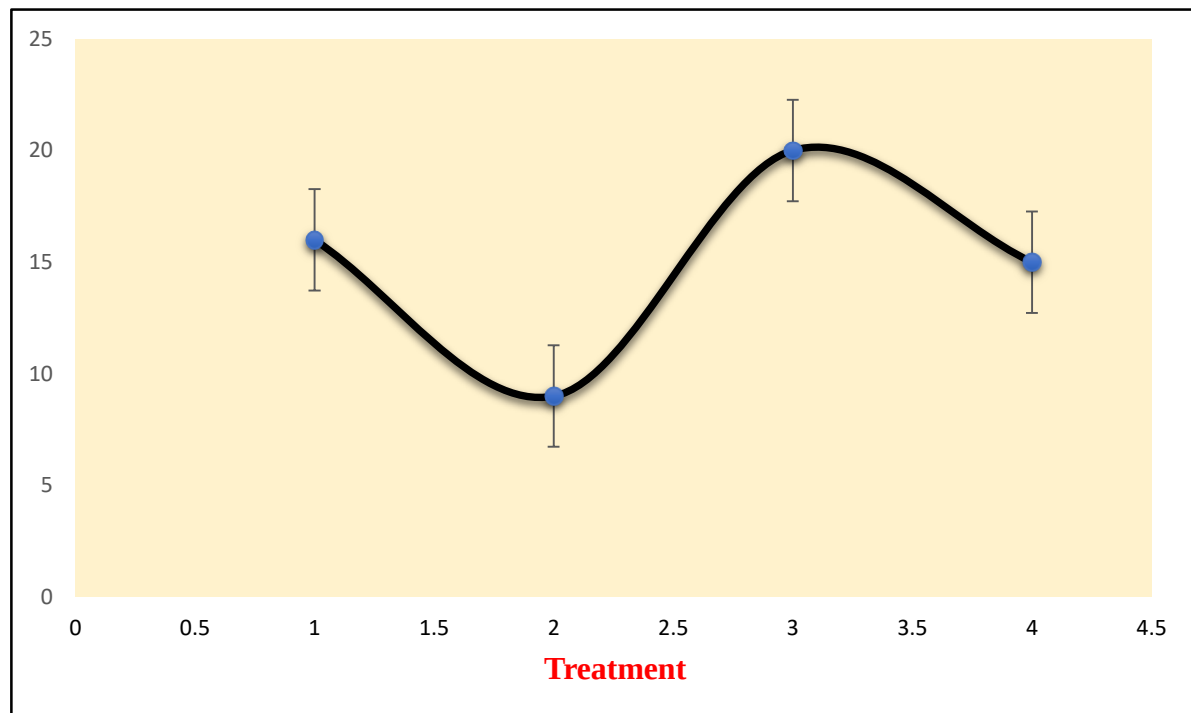


Fig 3.7: Scatter plot of of house mouse captured by using four types of traps from one acre rice field in May

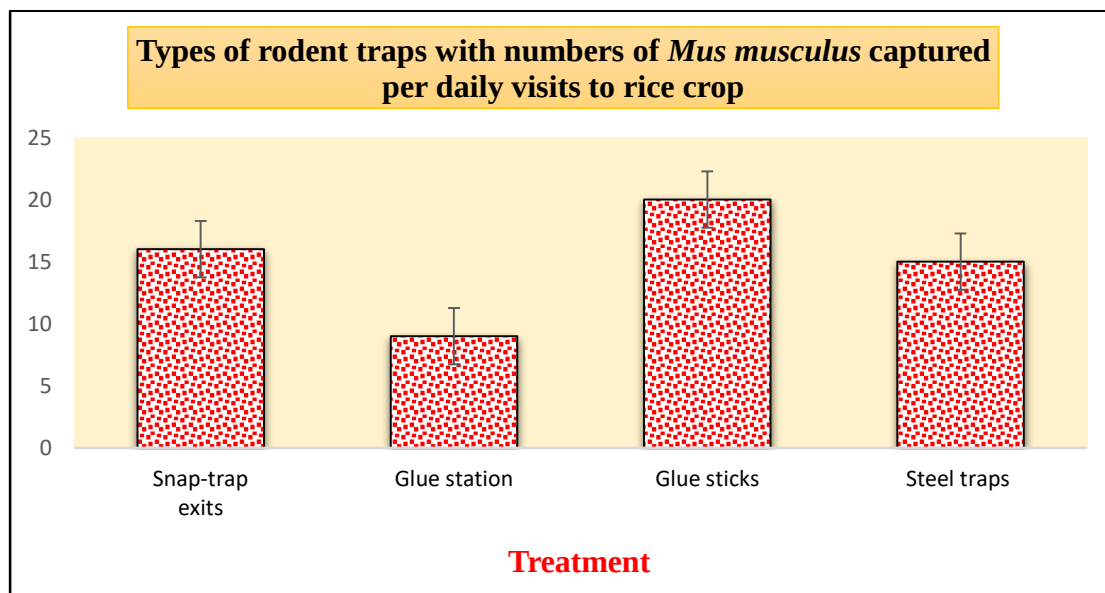


Fig 3.8: Graphical Representation of house mouse captured by using four types of traps from one acre rice field in May

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It is considered highly significant that while managing the *Mus musculus* infestation of rice crop, efforts should be made to critically analyze any tendency of rodents outbreaks and also the proportion of damage which should be less. on the threshold levels (Rennison *et al.*, 2013; Pauling *et al.*, 2009; Uwan *et al.*, 2014; Baldwain *et al.*, 2003; Brown *et al.*, 2006). Rodents are undeniably fairly serious pests of agriculture and important steps should be taken in this regard to save the crop from their pillage to obtain the useful and sustainable final crop products.

4. Conclusion

- ❖ *Mus musculus* is cosmopolitan in its habitat.
- ❖ It squeeze through even from the smallest available room into crops and indoor environment.
- ❖ Rive (*Oryza sativa*) staples food for many nations like that of south east Asia. This crop is frequently visited by the house mouse and inflicts serious economic losses.
- ❖ Favorable environmental conditions, such as enough moisture given mostly by the numerous water streams and canal irrigation system throughout Central Punjab, results in promoting rodent population abundance and agricultural damage to a wide range of crops.
- ❖ Although, several attempts have been made to use the rodenticides for house mouse management in rice crop, but mostly the traditional methods also have proved to be useless for its effective management ecologically friendly TBS is sound and with out implications on ecosystem sustainably. This method has been successfully used in Australia and in many other countries.
- ❖ The Trap Barrier System is a eco-friendly approach provides the farmer a convenient way to efficiently controlling and reducing the impacts of smaller rodents on different crops.
- ❖ In addition to reducing the rodent population, the effective use of the trap barrier system reduces damage profile and improves crop economy.
- ❖ In Pakistan its usage remains rather scanty, but it is important to be incorporated for achieving better targets and results with out jeopardizing agro-ecosystem.

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