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Feeding pattern of rodents damaging wheat field in Khanewal, Punjab, Pakistan

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SUMMARY

This study is carried out at District Khanewal, Punjab, Pakistan from December 2018 to May 2019 lengthening over a period of 6 months of winter during which the cultivation of wheat takes place. The feeding habits of the 3 rodent species (*Bandicota bengalensis*, *Millardia meltada* and *Mus* spp.) were observed in order check for the damage these rodent species cause to the agricultural fields, particularly wheat. A total of one 695 specimens were gathered for this experiment including 213 members from *Bandicota bengalensis*, 391 members from *Millardia Meltada* and 91 rodents belonging to *Mus sp.* The rodents were captured on the basis of twice per month traps during the study period. These rodents were collected from the wheat fields of District Khanewal and its nearby areas through snap trap method. After their collection, autopsy was carried out on these animals and their stomachs were preserved in 10% formalin and were later observed to record different type of food these animals have taken. 20 species of plants and some insect species were used as the reference material. The results showed the high dependence of both *Bandicota Bengalensis* and *Millardia meltada* on wheat, as the reproductive part of wheat was specifically preferred (74.7% and 55.1% respectively) by the individuals of these species. The vegetative part of the wheat was also favored by the members of *Bandicota bengalensis* during the pre-flowering (36.4%) and flowering stage (27.9%). However, it was observed that the individuals related to *Mus* spp. showed a changed trend as their major diet portion consisted of insects and wheat was consumed in a much lesser amount as the vegetative parts of the wheat were not at all eaten by these rodents. So, *Bandicota bengalensis* and *Millardia Meltada* were the main culprits damaging the wheat fields and leading to contamination and an overall reduced crop yield.

Keywords: Rodents, Damages, Wheat

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INTRODUCTION

One of the most pressing worldwide concerns in recent years has been ensuring food security for the world's rising population. According to estimates, the

global population would increase by 33% between 2011 and 2050, rising from 7.0 billion to 9.3 billion, causing food demand to increase by about 60% in the same time frame (Alexandratos and Bruinsma, 2012). Nearly half of the world's population growth between 2015 and 2050 is expected to be centred in nine nations, including Pakistan. Agriculture has traditionally been harmed by the feeding and other destructive actions of diverse insect species, resulting in significant losses in agricultural output (Sexton *et al.,* 2007). Furthermore, certain environmental and other changes alter the composition of animal communities, resulting in the loss of native biodiversity resources and possibly increasing the abundances of introduced and generalist species that thrive in urban and rural regions (Bradley and Altizer, 2006). The commensal pest species (particularly rats) that thrive as a result of anthropogenic activity in various regions of the world follow a very identical pattern.

Different species of rodents possess a great threat to the food crops in every country, leading to huge economic losses and serious food shortages (Howard and Marsh 1981). According to a study, 5 to 8 % of wheat is annually spoiled by the rodents (Fulk *et al*., 1980). 34 million tons per year is an estimated value of global loss of stored cereals and rice, chiefly due to the rats. It is noted that nearly 20% of the food crops that are planted for the human consumption are annually eaten up by different rodent species and never reaches the humans and also that almost 10 to 20 kg food is annually eaten up by each rat. Other than eating the food crops, the rodents also deteriorate the food with urine and feces rendering it unhealthy for the consumption of human beings (Sayaboc *et al.,* 1984). One other way in which the rodents damage the stored food is by shedding of their hairs on the stored food leaving it unfit for human use (Hasan, 1989).

Pakistan is an agriculturally diverse country having various climates but there are also a number of rodent species that damage the crops in different parts of the country to a great extent. Even up to 20% loss of stored food of the public sector because of rodents has been recorded in Pakistan (Ahmed *et al*., 1995). As for the wheat, it has been noticed that almost 8% wheat is damaged by the rodents every year (Fulk *et al*., 1980). It has been reported by Greaves *et al*, (1975), that nearly 78% of ration shops have undergone infestation from the rodents in Karachi. While a loss of 0.74 tons / year out of 40 tons have been projected in a single shop on average in Punjab grain market owing to the rodents (Ahmed *et al*., 1995). 400 tons gross annual losses to the business have been recorded. Agricultural restriction studies revealed that the herb grounds were severely damaged in Potohar and the rodents were therefore considered to be the limiting factor for the of acquisition maximum yield (Ali and Iqbal, 1984; Ali *et al.,* 1984). *Benedictine Bengalensis*, *Nesquia Inca*, *Tetra indica*,*MillardiaMeltada*and *Mus sp.* are the five major species of rodents that have been found to cause some serious damage to the crops in Pakistan (Brooks *et al.,* 1988; Hussein et al., 2003).

Lack of knowledge about feeding habits of main rodent species in Pakistan is a major factor involved in this huge loss. Scientific research and knowledge about the feeding preferences of these rodent species can be very

beneficial in protecting our agricultural products from this problem and it also helps us to know about their habits during different seasons of the year. Awareness of the diets utilized by species is the foundation for their community and habitat management. Diet research also helps to know about the diet of pests in the rice / wheat area during various seasons of the year. By looking at the severity of the epidemic, it is essential that rodent management must be stepped up. However, recently our agricultural system has made some attempts to cope with these pests but still the major issue remains the lack of proper awareness and the result of different practices on the environment.

Anticoagulant rodenticides (fluticasone and chromatin) and acetaminophenide (zinc phosphide) can be effectively used to manage ground damage rodents. Mixed zinc phosphide (2%), brodifacium and bromidivolone (0,005%) also proves to be effective in controlling the damage caused by rodents. It has been suggested that, anera's combined bromifacim has the potential to further enhance beta-acceptance, followed by bromidolone and zinc, against the rodents in the fields of Pakistan (Pervez *et al.,* 2005).

MATERIALS AND METHOD

SELECTION OF AREA TO BE STUDIED

- This study is carried out at the wheat cultivation areas in District Khanewal, Punjab, Pakistan and its nearby areas.
- The sowing of the wheat is carried out during late October and early November, depending upon the availability of irrigation water and then, the crop is harvested in April.

COLLECTION OF RATS SAMPLE

Rats were collected from different areas of wheat cultivation in District Khanewal by using snap traps.

Rats were collected from three trapping schedules

- Regular bi-monthly Trapping has been carried by the researcher from December 2018 to May 2019.
- Kill trap survey of Khanewal wheat fields conducted.
- Trapping by animal hunters.

TRAP SUCCESS RATIO OF EACH SPECIES WAS CALCULATED AS:

$$\frac{\textbf{Number of animal species A}}{\textbf{Number of total animals of all species}} \textbf{ X 100}$$

- Species identification, body weight, sex, condition of vagina (perforate or imperforate), condition of the uterus (embryo count scar count, nulliparous or estrous), position of testes (scrotal or abdominal), condition of the cauda epididymis (tubules visible or not visible), were recorded for each specimen captured.

- Data was recorded on the autopsy sheet after autopsy was carried out in order to check for the internal organs condition.
- The stomachs of these captured rats were removed as soon as they were collected and placed in small vials containing 10% formalin. Each bottle was labeled with a reference number, date and place of collection and name of the species.
- Stomach samples were grouped according to the developing stages of the wheat crops. According to the developing, stages of the rice crops stage (from transplanting to earliest flowering), stage 2 (from flowering to early grain hardening), stage 3 (From grain hardening to the harvest) and stage 4 (a month after the harvest).

COLLECTION OF REFERENCE MATERIALS

- Twenty different species of plants were collected from Khanewal District and placed in 10% formalin and was used as reference material.
- These plants were identified by personals of the Botany Department, University of Agriculture, Faisalabad and Herbarium sheets were also used for identification.
- Insects and snails were also included in the reference collection.
- The animals were preserved in 10% formalin until reference slides could be prepared.

FINDING THE DAMAGE DUE TO RODENTS

- Percentage of total damage has been estimated by finding rodents abundance, diet and stomach capacity (Fulk et al., 1980).
- *Bandicoots* have a stomach capacity 8.2 times than that of *Mus sp.* and *Millardia* have 4.6 times greater than *Mus* spp. (Fulk el al., 1980).

RESULTS AND DISCUSSION

A total of 695 rodent stomachs were used for the experiment, belonging to 3 different species. 213 stomachs were taken from *Bandicota Bengalensis*, while 391 stomachs belonged to *Millardia Meltada* and 91 stomachs used in this experiment were linked to members of *Mus* spp. (Table 1). In Pakistan and India, these three species along with *Nesokia indica and Tatera indica* are the major agricultural pests (Manzoor *et al.*, 2018) and approaching maturity, their reliance on cereals like rice and wheat increases a lot (Bindra and Sagar, 1977, 1968; Greaves *et al.,* 1977 and Fulk *et al.,* 1980). These rodent specimens were collected during four different stages of wheat crop (Pre-Flowering, Flowering, Seed Hardening and Post-Harvest) from the wheat fields of District Khanewal, Punjab, Pakistan. The variations in the predominance of species in different regions relate to the cropping patterns as *B. bengalensis* is predominant in fields of paddy-wheat rotation, *M. meltada* and *Mus* spp., in cotton- and groundnut-wheat rotations while *B. bengalensis* and *R. meltada* in millet- and maize-wheat rotations (Parshad, 1991). Various form of food was eaten up by these three species of rats i.*e. Bandicota bengalensis*, *Millardia Meltada* and *Mus* spp., during different seasons of the year; however wheat mainly remained as a

preferred diet. However it is noticed that in Lower Sindh, the amount of damage these rodent species cause to the rice is 4 times greater as compared to the rice fields of Punjab (Khokhar, 1985 and 1986). The damage occurs throughout the crop's life cycle, but is particularly severe during the ripening phases (Singh and Saxena, 1989), when rodents, notably B. bengalensis rats, stockpile the panicles in their burrows. In prior investigations, a comparable study for variations in growth phases and species predominance was done in almost exact parallel to the current findings. Rodent damage is rarely consistent throughout time; it varies according on crop phenology. Field rats cause more damage to crops at certain phases of development than at others (Tristiani and Murakami, 1998). It was also noted that after the commencement of short rains, the rodent population density increased. Variations in food supply and plant cover can also be attributed to this shift (Florence, 1996). Suitable conditions would result in large populations that would bypass the typical density-dependent regulation, resulting in population explosion (Pech *et al.,* 1999). Some of mammals especially rodents adopted anthropogenically impacted habitats (Rasheed *et al.*, 2020; Abbasi, 2021; Ijaz and Adil, 2021).

It was observed that the major part of diet of *Bandicota bengalensis* comprised of vegetative part of the wheat during the pre-flowering season in December, while during the flowering stage, the diet pattern changed as the relative frequencies of other identifiable and non-identifiable fragments was seen to be much higher in their stomachs than pre flowering stage and it was almost equal to the amount of vegetative parts of wheat eaten up by these rodents in this stage. However, it can be clearly seen that the amount of reproductive part of the wheat is clearly the highest amongst any other food eaten up by these rodents during both the seed hardening stage and also the post-harvest stage. So, because of very high consumption during the latter two stages of wheat, the mean was the highest for reproductive part of wheat taken up by these rodents. The presence of higher amounts of post-harvest wheat grains in their stomachs directs the utilization of underground food caches by this species through gleaning. There is a habit of storing plentiful food in their burrows by *Bandicots* (Fulk, 1977 and Sagar and Bindra, 1971). In *Bandicota bengalensis* and Mewls, feeding on the grains even after the harvest was shown by researchers such as (Khokhar, 1993; Hussain, 1921; Beg et al., 1977 and Bindra and Sagar, 1971). The bandicoot rat (*B. bengalensis*) was also observed going into the wheat field early in the booting stage and nibbling on wheat plants, however their abundance in the wheat crop peaked in March and April (Siddique and Arshad, 2003).

Though, it was also observed with *Millardia meltada* that the reproductive part of wheat stayed as the mean highest diet used by these rodents but the frequency of consumption of other un-identifiable fragments was also quite a lot as well for this species as compared to the case of *Bandicota bengalensis*, where the major toll was taken up by only the reproductive part of wheat. The un-identifiable fragments were used by these rodents mostly during the pre-flowering stage but during all the latter three stages of flowering, seed hardening and post-harvest, the highest consumed food was the reproductive

part of wheat. Unlike the Bandicots, the members of *Millardia meltada* are not strong burrowers; therefore they either robe Bandicoot's caches or apparently hoard the grains (Fulk *et al.,* 1980). Likewise, in the Philippines, it was founded about these rodents, that even after as late as 8 months post-harvest, they continued to eat wheat. This clearly shows their increased dependence on wheat in the latter stages. Most likely, the surface grains that remained after the post-harvest are also used up by these rodents and especially in Sindh, Pakistan, as the burning of the fields is not normally done there. Data on the abundance, reproduction, diet, and damage index of the soft-furred field rat *M. meltada* were collected in earlier research during the rice and wheat seasons, and it was discovered that the abundance of *M. meltada* remained high during the wheat crop's post-harvest stage. The abundance of *M. meltada* was unaffected by field ploughing. Even when there was no crop in the fields, this species continued to devour wheat grains for a long time, and the damage indices in wheat crops were 28.3 percent (Sood and Prem, 2007). The same thing was discovered in a recent study as well.

In case of members of *Mus* spp. a clear changed trend was seen in the selection of diet. As these rodents consumed insects as the major part of their diet while the vegetative part of wheat was not at all used up by them during any of the stage of wheat crop. Insects constituted the highest proportion of the diet of these rodents during the initial and last stage of pre-flowering and post-harvest. While during the flowering phase, it was noticed that the relative frequencies of consumed reproductive part of the wheat and insects were the highest and almost the same. Whereas, some other un-identifiable fragments were the highest portion of diet during the seed hardening phase for these rodents. Rodents, particularly Mus spp., might be considered a "indicator species" of environmental degradation because of the negative consequences they have in altered habitats such as urban and/or rural regions (Gomez et al., 2009).

CONCLUSION

The objectives of this work were to evaluate the damage caused by the rodent species on the wheat crop. Three species of rodents (*Bandicota bengalensis*, *Millardia Meltada* and *Mus* spp.) were collected from the wheat fields of District Khanewal and its nearby areas and studied their feeding patterns during this experiment to check for the most damaging species of the rodents to the wheat fields in Punjab, Pakistan. It was found that *Bandicota bengalensis* and *Millardia Meltada* were the main culprits damaging the wheat fields and leading to contamination and an overall reduced crop yield. Both of them favored the reproductive part of wheat (74.7% and 55.1% respectively). Whereas, the members of *Mus sp.* were more inclined towards insects and therefore a very low relative frequency of wheat was recorded in their diet. So, proper steps need to be taken in order to negate the harmful effect of *Bandicota bengalensis* and *Millardia Meltada* on wheat fields, thus increasing overall production.

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Table 1: Identified damages of rodents.

Stages of wheat crop development	Months	No. of stomachs examined	Wheat		Insects (%)	*Scirpus maritimus* (%)	Other identifiable fragments (%)	Unidentifiable fragments (%)
			RP (%)	VP (%)				
Pre-Flowering	December	20, 30, 12	(15.0), (4.5), 0	(36.4), 0, 0	(8.2), (17.4), (13.2)	(5.5), (0.8), (9.7)	(1.5), (0.1), 0	(8.6), (25.4), (5.2)
Flowering	January & February	25,32,05	(1.0), (57.2), (25.7)	(27.9), (2.3), 0	(14.6), (5.1), (25.3)	0, 0, 0	(29.8), (1.0), 0	(26.7), (34.3), (13.8)
Seed Hardening	March	70,111,16	(80.7), (57.0), (3.6)	(2.3), (0.1), 0	(0.4), (12.0), (11.2)	(2.6), (2.0), (2.8)	(7.0), (1.0), (2.1)	(7.2), (21.6), (13.0)
Post-harvest	April & May	98,218,58	(83.3), (57.7), (2.7)	(0.3), 0, 0	(11.2), (7.6), (8.4)	(0.6), (6.6), (4.4)	(1.2), (1.7), (3.0)	(3.3), (25.8), (6.2)
Mean $\pm$ 2 S.D.	6Months	213,391,91	(74.7), (55.1), (5.0)	(5.0), (0.2), 0	(8.2), (9.4), (12.1)	(1.6), (4.0), (4.4)	(3.6), (1.3), (1.8)	(5.4), (25.0), (8.9)

Relative frequency of various food items in 213 stomachs of *Bandicota bengalensis*, 391 stomachs of *Millardia meltada* and 91 stomachs of *Mus* spp.(respectively) collected during four different wheat crop stages (Pre-Flowering, Flowering, Seed Hardening & Post-Harvest) in Wheat fields in Khanewal, Pakistan. (In parenthesis are percentages of fragments observed).

RP = Reproductive Part

VP = Vegetative