Journal of Bioresource Management

Volume 7 | Issue 1 Article 2

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Recommended Citation

Mosvi, A. H., Haider, J., Naseer, A., & Ibrahim, A. (2020). Habitat Utilization of Field Rats in Crop Fields and Adjacent Natural Vegetation in District Rawalpindi, *Journal of Bioresource Management, 7* (1).
DOI: https://doi.org/10.35691/JBM.0202.0116
ISSN: 2309-3854 online
(Received: Feb 20, 2020; Accepted: Mar 6, 2020; Published: Mar 31, 2020)

Habitat Utilization of Field Rats in Crop Fields and Adjacent Natural Vegetation in District Rawalpindi

HABITAT UTILIZATION OF FIELD RATS IN CROP FIELDS AND ADJACENT NATURAL VEGETATION IN DISTRICT RAWALPINDI

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ABSTRACT

Current study was designed to assess habitat utilization of field rats in crop fields and adjacent natural vegetation in District Rawalpindi. The rodents are widely distributed and a serious agricultural pest in Pakistan. Relative abundance of rodent populations changes seasonally under field conditions. The field trials were conducted in district Rawalpindi of the Pothwar area, Pakistan. Wild vegetation plays an important role for providing shelter/cover to the rodent during non-crop season. The dominant wild vegetation recorded from field boundaries were: *Cynodon dactylon, Achyranthes aspera, Aerva javanica Saccharum griffithii, Dactyloctenium aegyptium, Dichanthium annulatum, Desmostachya bipinnata, Imperata cylindrical, Ziziphus nummularia, Sorghum halepense* and *Capparis deciduas*. This vegetation provides shelter and food to rodents when there is no cultivation or at an early stage of crop growth.

Keywords: Habitat, rodents, ecology, bandicoot rat, pest

INTRODUCTION

Rodents (Mammalia) are important components of virtually all the earth's terrestrial ecosystems: important herbivores that aerate the soil by burrowing activities, and assist plant propagation by consuming and disseminating seeds (Tobin and Fall, 2004). Beside this beneficial role, many rodent species come into conflict with human interest due to heavy economic losses, caused by direct damage to cereal crops and fruit orchards (Prakash, 1988).

Pothwar plateau 32° 33' NL and 71° 89' - and 73° 37' E: Ahmad, 1991) covers an area of 1.82 m ha (2.9% of total area of Pakistan: Ali, 2004). Only 0.61 m ha of this plateau is under cultivation (Punjab Barani Commission Report, 1976). It has four administrative districts; Rawalpindi, Attock, Chakwal and Jhelum.

Agricultural land from this area is dependent on rainfall. This region contributes about 10% to the total agricultural production of the country (Ashraf et al., 2007). Soil of this region is low in fertility, deficient in nitrogen, phosphorus and organic matter with pH of 7.5 to 8.5. Dry farming is the dominant land use in Pothwar plateau. Wheat (*Triticum aestivum*) is a major winter crop (November-May) with intercropping of grams, lentils and mustards. Groundnut (*Arachis hypogea*) together with millets forms important crop of the summer (May-October) season (Beg et al., 1985; Ahmad, 1990). The climate of the plateau is semi-arid warm to hot with subtropical winter and monsoon. District Rawalpindi is situated in the Pothwar plateau. It is an important ecological and agricultural area having same agricultural and weather conditions as the other three districts of the plateau.

The agro-ecosystem of Pothwar consists of non-cultivated (scrub forest and

range land) and cultivated croplands. The cropland tract also bear some wild vegetation on the field boundaries, kept undisturbed and intact for conservation of rainwater. In Pothwar plateau, crop field borders are less disturbed habitats than interiors of crop fields, because these borders are not directly exposed to agricultural practices. Hence, they offer year-round stable habitats for rodents by providing incessant resource of food and shelter.

Robert (1997) reported occurrence of seven rodents species from pothwar plateau; the lesser bandicoot rat (*Bandicota bengalensis*), the short-tailed mole rat (*Nesokia indica*), the indian gerbil (*Tatera indica*), the soft fur mole rat (*Millardia meltada*), the deseart jird (*Meriones hurrianae*), the bush rat (*Golunda ellioti*) and Mus species. A report by Hussain et al. (2003) revealed occurrence of five rodent species; the Indian gerbil (*Tatera indica*), the lesser bandicoot rat (*Bandicota bengalensis*), Mus species, the short-tailed mole rat (*Nesokia indica*), and the bush rat (*Golunda ellioti*). The rodent species in the crop fields of Pothwar plateau inflict 4-10% losses to the standing field crops (mainly wheat and groundnut) at their various growth stages (Fulk et al., 1980; Brooks et al., 1988).

Wild vegetation bordering the crop fields provides food and shelter to these rodents during the non-crop seasons and thus integrated management of rodent populations on crop-field borders during the non-crop seasons could prohibit them from establishing themselves in the crops; thereby reducing the crop losses with low inputs and high returns. This study was designed to investigate seasonal habitat use by rodent pest species in crop ecosystem of Rawalpindi district of Pothwar plateau and use of this information in controlling the rodents by employing appropriate management techniques.

MATERIAL AND METHOD

Study Area

The study was undertaken between April 2015 and August 2016 in four major field crops (wheat, groundnut, millet and maize) at different growth stages (sowing, tillering/flowering and maturity/harvesting), in harvested fields and fallow non-crop fields at five selected study sites of district Rawalpindi, Pothwar plateau, Pakistan. The area consists of cultivated flatlands, inter-spread with network of rainwater gullies "nallas", undulated dry lands have containing extensively thorn forests and wetlands. The weather is hot in summer whereas dry and cold in winter. The average annual rainfall is 114.3 cm. In summer, sometimes the maximum temperature soars to 46.5° C , while it drops to a minimum of -3.9º C in the winter (Rashid et al., 2015). The major cereal crops of the study area include wheat (*Triticum aestivum*), groundnut (*Arachis hypogea*), maize (*Zea mays*) and millet (*Pennisetum typhoides*) (Nosheen et al., 2008).

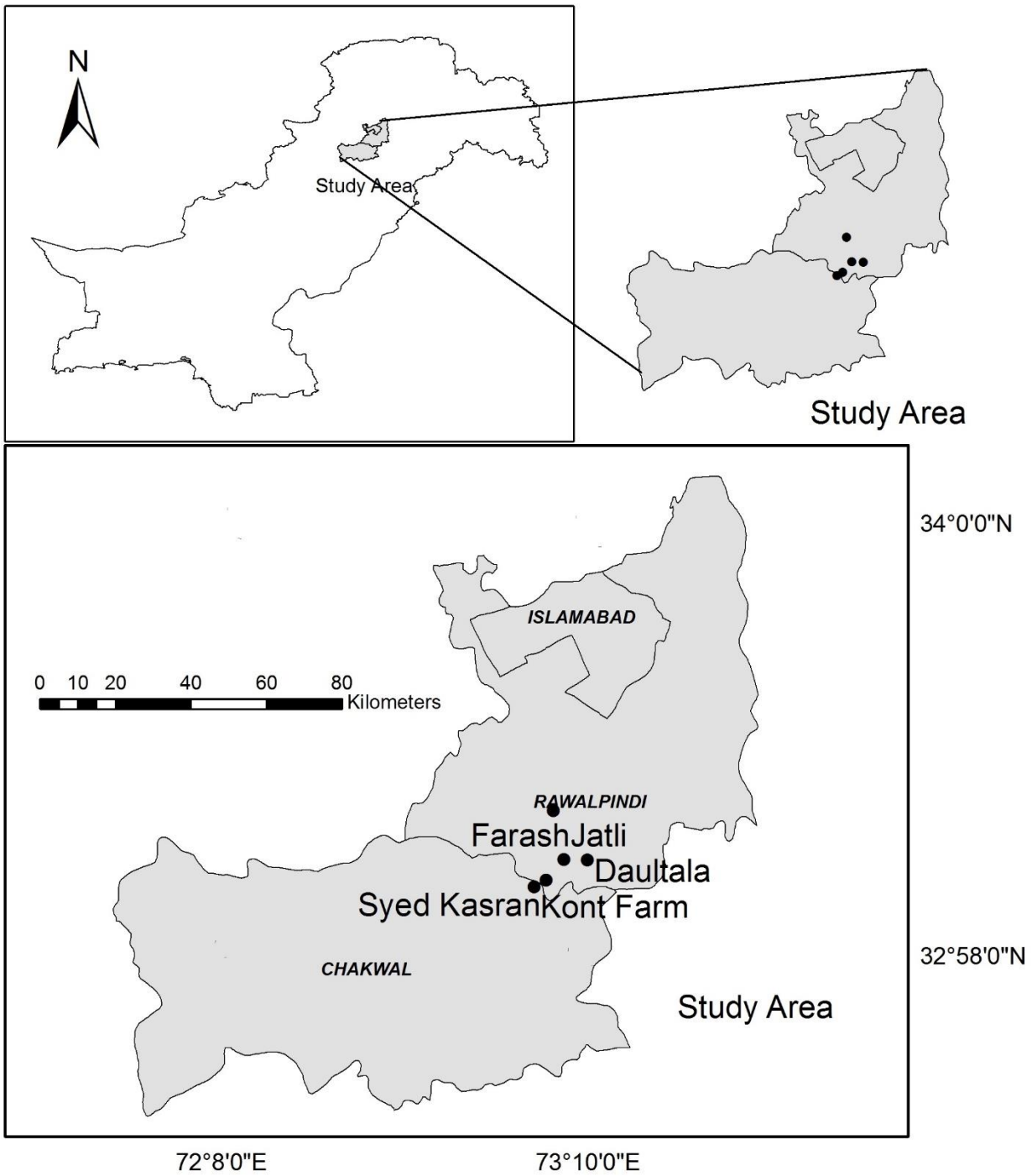

Fig. 1: Map of five study sites selected in district Rawalpindi of Pothwar plateau, Pakistan

Methodology

Burrows of different rodent species were distinguished by their shape and size of the entrances along with other characteristics (Husain et al., 2016). In all five study sites, three rodent species: lesser bandicoot rat, (*Bandicota bengalensis*), short-tailed mole rat (*Nesokia indica*) and Indian gerbil (*Tatera indica*) were recorded. The burrow of the bandicoot rat was characterized by the larger soil particles, visible burrow openings, and visual runways, crop cutting residues scattered around within the area, and spindle-shaped fecal droppings. Main difference between burrow of the short-tailed mole rat and bandicoot rat is that the short-tailed mole rat pushes smaller soil particles out of their burrow and mix these soil particles with capsule-shaped fecal droppings (Brooks et al., 1988). The burrows of the Indian gerbil were straightforward containing single surface opening having no soil mounds near the burrow openings (Jain et al., 1993).

In the study area, active burrows were identified that supported fresh digging, foot tracks, damage to the nearby crop plants and most significantly the fecal droppings. These were numbered and each opening was closed with the nearby excavated soil. Next morning, number of the freshly re-opened burrows was counted. Vegetation around the burrow openings was recorded. The systems with one or more reopened burrows were designated active.

The relationship of rodent abundance with border-vegetation (cover and diversity) and border-structure variables was evaluated. Vegetation censuses were conducted using a 1 m^2 quadrat centred over the burrow site (Dueser and Shugart, 1978; Simone et al., 2012). Vegetation analysis on 10 active burrows was surveyed at each site. Variables recorded in each quadrat was total vegetation cover, stratum cover (Stratum 1: plants below 10 cm; Stratum 2: plants between 10 and 30 cm; and Stratum 3: plants taller than 30 cm) and canopy of each plant species. Presence of seeds (if any) was recorded for each vegetation stratum.

Vegetation diversity at the crop field borders was estimated by Shannon-Wiener diversity index (*H*'), richness (*S*, total number of plant species) and evenness (*E*, relative apportionment of abundance among the present species) following Magurran (1991). For calculating relative density, relative frequency and relative cover the following formulae were used:

i. Density

Density relates to the number of plants rooted within each quadrate. The sum of the individuals per species was calculated for the total area sampled.

Relative density = Total number of individuals of a species x 100/Total number of all individuals of all species

ii. Frequency

It relates to the percentage of total quadrates that contain at least one rooted individual of a species.

Relative frequency = Frequency of a species x 100/ Total frequency value of all species

iii. Cover

It is the percentage of quadrate area beneath the canopy of a given species. Area occupied by the aerial projections of the plants in different strata was calculated.

Relative cover = Cover of individuals of a species x 100/ Total cover of all individuals of all species

iv. Importance Value Index (IVI)

Data for density, frequency and cover were recorded and importance value of each species was calculated as follows:
Importance Value = Relative Density + Relative Frequency + Relative Cover.

RESULTS AND DISCUSSION

The number of shrubs and herb/grass species recorded at the field boundaries on each rodent burrow entrance during the summer season at 5 selected study sites at district Rawalpindi in agro-ecosystem of Pothwar plateau are presented in Table 1. The wild vegetation was recorded for the burrows of three rodent species; the lesser bandicoot rat (*Bandicota bengalensis*), the short-tailed mole rat (*Nesokia indica*) and the Indian gerbil (*Tatera indica*) during summer season corresponding to different agricultural practices of the area.

A total of 26 plant species (9 shrubs and 17 herbs/grass) were recorded over 51 burrows of bandicoot rat which presumably provide shelter/cover and food during summer season. The shrubs given with IVI comprised of *Achyranthes aspera* (6.0), *Artemisia dubia* (16.7), *Aerva javanica* (11.6), *Calotropis procera* (14.0) and *Cannabis sativa* (5.50). The three herbs/grass species scoring highest importance value index (IVI) were *Cynodon dactylon* (42.2) followed by *Imperata cylindrical* (37.3) and *Saccharm spontaneum* (32.6), while the lowest IVI (1.8) was recorded for *Eragrostis cilianensis*.

A total of 30 burrows of *Nesokia indica* were selected to record vegetation coverage during summer season at field edges. The flora comprised of seven shrubs and 11 herbs/grass species (Table 1). The shrubs included *Artemisia dubia* (15.3), *Aerva javanica* (11.6), *Achyranthes aspera* (3.4.2), *Carthamus oxycantha* (9.42), *Cannabis sativa* (3.32) and *Ziziphus nummularia* (2.22). A detail of the 11 herbs/grasses species is given in Table 1. Three species having the higher IVI were *Cynodon dactylon* (IVI = 41.9), *Desmostachya bipinnata* (IVI = 37.0) and *Saccharum griffithii* (IVI = 31.1). While the lowest IVI (3.22) was recorded for *Chrozophora tinctoria* (Table 1).

Twenty-six burrows of *Tatera indica* were observed during this study. The herbaceous flora occurring over the burrows of this rat during summer season comprised of 18 plant species included 6 shrubs and 12 herbs/grasses (Table 1). IVI estimated for shrubs was: *Achyranthes aspera* (34.2), *Artemisia dubia* (13.4), *Calotropis procera* (12.7), *Aerva javanica* (11.9), *Capparis deciduas* (10.2) and *Carthamus oxycantha* (7.0) (Table 1). IVIs estimated for the three dominant herbs/grasses were; 37.2 for *Desmostachya bipinnata*, 27.5 for *Cynodon dactylon* and 28.1 for *Saccharum griffithii. Eclipta prostrata* was the least occurring grass species with IVI value of 1.90 only.

A total of 24 plant species were recorded around the 46 burrow entrances of *Bandicota bengalensis* on field edges during autumn season. These included 8 shrubs and 16 herbs/grass species (Table 1). The Importance Value Index (IVI) of the recorded shrubs were; *Aerva javanica* (11.4), *Artemisia dubia* (11.1), *Carthamus oxycantha* (6.4), *Capparis decidua* (5.4), *Calotropis procera* (5.0), *Achyranthes aspera* (2.7) and *Cannabis sativa* (3.23). A detail of 18 herbs/grasses species is given in (Table 4.17). Three species having the highest Importance Value Index (IVI) were *Desmostachya bipinnata* (56.2) followed by *Dichanthium annulatum* (52.3) and *Saccharm griffithii* (38.4) and while the lowest IVI (3.61) was recorded for *Rumex dentatus*.

The 17 plant species recorded on 38 burrows of *N. indica* included 7 shrubs and 17 herbs/grass species. The estimated IVIs

for shrubs were; *Achyranthes aspera* (10.0), *Aerva javanica* (6.10), *Artemisia dubia* (5.0), *Ziziphus nummularia* (4.5), *Cannabis sativa* (3.52) *Carthamus oxycantha* (2.2) and *Capparis decidua* (1.0). Three grasses/herbs having the highest IVI were *Dichanthium annulatum,* (IVI = 39.0) followed by *Desmostachya bipinnata* (35.2) and *Saccharm griffithii* (IVI = 29.1) while the lowest IVI (2.81) was recorded for *Rumex dentatus*

The numbers of burrows recorded at field edges were n = 16 for *Tatera indica.* The herbaceous flora which provides shelter and food to this rat during autumn season comprised of 15 plant species including six shrub species and nine herbs/grass species (Table 1). The Importance Value Index (IVI) of the recorded shrubs were: *Achyranthes aspera* (5.34), Aerva javanica (4.3), Cynodon dactylon (2.30), and *Carthamus oxycantha* (1.44). Three species of herbs and shrubs having the highest Importance Value Index (IVI) were *Cynodon dactylon,* (37.8) followed by *Desmostachya bipinnata* (21.8) while the lowest IVI (3.35) was recorded for *Cenchrus ciliaris*.

The herbaceous flora occurring on crop field boundaries during winter season covering 34 burrow openings of bandicoot rat comprised of 23 plant species including 13 shrubs having IVI values *viz Achyranthes aspera* (24.0), *Artemisia dubia* (17.2), *Cannabis sativa* (11.8), *Carthamus oxycantha* (11.5), *Avena fatua* (2.1), *Capparis deciduas* (8.53) and *Aerva javanica* (7.4) (Table 1) and 10 grasses/herbs. The IVIs estimated for the three dominant herbs/grasses were: 37.8 for *Cynodon dactylon*, 21.2 for *Desmostachya bipinnata* and 20.5 for *Dactyloctenium aegyptium. Cenchrus ciliaris* was the least occurring grass with IVI value of 3.33 only.

A total of 21 plant species were recorded on field edges during winter season on the burrows of *N. indica*. These included 21 shrubs and 15 herbs/grass species (Table 1). The IVI values of shrubs were; *Achyranthes aspera* (29.4), *Calotropis procera* (8.6), *Capparis deciduas* (9.32), *Carthamus oxycantha* (7.62), *Avena fatua* (3.70) and *Ziziphus nummularia* (3.33). The IVIs estimated for the three dominant herbs/grasses were 81.9 for *Cynodon dactylon,* 62.0 for *Desmostachya bipinnata* and 41.9 for *Medicago polymorpha.* The lowest IVI recorded for *Eragrostis cilianensis* was 1.80.

Eighteen burrows of *Tatera indica* were examined for floral occurrence at field edges. The wild vegetation comprised of 20 plant species including 5 shrubs and 15 herbs/grass species (Table 1). The IVI values of shrubs were: *Achyranthes aspera* (25.0), *Artemisia dubia* (14.4), *Calotropis procera* (7.41) and *Capparis deciduas* (5.8). The IVIs estimated for the three dominant herbs/grasses were 65.5 for *Cynodon dactylon,* 36.5 for *Imperata cylindrical,* and 34.2 for *Saccharm spontaneum.* The lowest IVI recorded for *Solanum surattense* was 1.32.

During spring season, we observed 46 burrows of bandicoot rat for vegetation analysis (Table 1). A total of 23 floral species were recorded consisting of seven shrub species with estimated IVI as follows: *Avena fatua* (21.2), *Achyranthes aspera* (5.6), *Artemisia dubia* (5.33), *Capparis deciduas* (6.2), *Calotropis procera* (7.62) and *Aerva javanica* (2.18). Among the 16 herbs/grass species the IVIs estimated for three dominant species were 54.2 for *Cynodon dactylon* followed by 53.8 for *Saccharum griffithii* and 40.1 for *Dactyloctenium aegyptium*, while the lowest was recorded for *Rumex dentatus* was 1.06.

A total of 19 species of wild flora were recorded from field edges during spring season on the burrows of *Nesokia indica*. Six shrub species recorded with IVI value were consisted on *Ziziphus nummularia* (11.4) *Achyranthes aspera* (6.7), *Artemisia dubia*

(5.06), *Avena fatua* (3.55), *Aerva javanica* (2.5) and *Calotropis procera* (1.40) (Table 1). The three top scoring IVIs herbs/grass were *Cynodon dactylon* (62.0), *Saccharum griffithii* (41.9) and *Dichanthium annulatum* (14.8). A member of this having lowest IVI (3.10) was *Chrozophora tinctoria*.

A total of 15 plant species were recorded on the burrows of *T. indica* which included six shrub species and nine herbs/grass species (Table 1). The IVI values of shrubs were: *Achyranthes aspera* (25.0), *Calotropis procera* (7.41), *Carthamus oxycantha* (8.29), and *Artemisia dubia* (14.4). For herbs/grass species highest IVIs were estimated for *Saccharum griffithii* (33.5) followed by *Cynodon dactylon* (32.0) and *Desmostachya bipinnata* (30.4), while the lowest IVI (3.42) was recorded for *Solanum surattense.* Wild plantation on field boundaries provide shelter to all field rat during crop season. As during non-crop season rodent burrows increases on field boundaries and reduces during crop season.

Farmers should periodically carry out rodent trapping at the beginning of each crop season and during non-breeding seasons of this rodent pest when the populations are low in numbers and restricted under crop boundary vegetation, particularly during very hot and cold months. It could be beneficial for the farmers and reduce the operational cost in terms of time and money.

Table 1: Importance value index (IVI) of shrubs and herbs in habitat of three rodent's species during various season in five selected sites of District Rawalpindi

Season	Rodent Species	No. of quadrats/ Burrows	Plant Profile Shrub species								
			A.j	*A.d*	*A.a*	*C.p*	*C.d*	*C.o*	*C.s*	*A.f*	*Z.n*
Summer	*B.b*	51	11.6	16.7	29.7	14.0	18.6	16.2	5.50	-	7.10
	N.i.	40	9.1	15.3	34.2	11.2	-	9.42	3.23	-	2.22
	T.i	26	11.1	13.4	17.6	12.7	-	7.02	-	-	-
Autumn	*B.b*	46	11.4	11.1	5.04	7.60	6.42	3.23	3.24	-	4.65
	N.i.	38	7.12	6.12	17.0	-	2.45	-	3.23	-	3.24
	T.i	16	4.30	-	5.34	-	2.30	1.44	-	-	-
Winter	*B.b*	34	7.44	17.2	24.0	14.7	8.53	11.5	11.8	2.81	-
	N.i.	28	-	12.9	29.4	8.68	9.32	7.62	7.00	3.70	3.33
	T.i	18	-	14.4	25.0	7.41	5.82	8.29	-	-	-
Spring	*B.b*	46	2.18	5.33	5.6	5.52	7.62	-	-	10.2	16.4
	N.i.	24	2.5	5.06	6.7	1.40	-	-	-	3.55	11.4
	T.i	15	-	3.8	5.21	6.54	-	2.81	-	3.40	5.54

A.j = Aerva javanica, A.d = Artemisia dubia, A.a = Achyranthes aspera, C.p = Calotropis procera, C.d = Capparis deciduas, C.o= Carthamus oxycantha, C.s = Cannabis sativa, A.f = Avena fatua, Z.n = Ziziphus nummularia S.g = Saccharum griffithii, D.b = Desmostachya bipinnata, C.d = Cynodon dactylon, D.a = Dichanthium annulatum, M.p = Medicago polymorpha, D.a = Dactyloctenium aegyptium, C.b = Conyza bonariensis, S.h = Sorghum halepense, E.p = Eclipta prostrate, I.c = Imperata cylindrical, D.m = Digera muricata, C.c = Cenchrus ciliaris, A.c = Aristidia Cyanatha, S.s = Saccharm spontaneum, O.c = Oxalis corniculata, R.d = Rumex dentatus, S.s = Solanum surattense, S.n = Solanum nigrum, C.a = Chenopodium album, E.c = Eragrostis cilianensis, C.t = Chrozophora tinctoria.

...Continued

(IVI)															
Herbs/Grasses															
D.b	*C.d*	D.a	*C.b*	*S.h*	*E.p*	*I.c*	*C.t*	*S.g*	*D.m*	*C.c*	*D.a*	*A.c*	*O.c*	*R.d*	*S.s*	*E.c*
28.2	42.2	41.2	18.1	13.0	9.44	37.3	4.0	22.6	6.46	8.13	47.3	5.67	6.35	6.72	6.81	2.62
37.0	41.9	27.8	21.2	13.5	-	11.6	3.22	31.0	-	11.3	22.7	-	-			9.53
37.2	27.5	23.9	8.10	-	3.85	-	8.62	28.1		-	7.94	-	3.36	5.38	5.21	-
56.2	45.0	52.3	11.2	8.78	5.20	4.02	8.55	38.4	7.50	8.42	13.5	4.76	8.51	3.61	14.8	-
35.2	-	39.0	-	7.01	5.73	9.14	5.12	29.1	6.33	4.47	17.0	3.11	-	2.81		
21.2	37.8	20.5	-	-	-	5.22	-	30.2	-	3.35	19.2	-	6.77	4.20	5.25	-
62.0	81.9	-	15.0	13.2	14.3	8.54	5.73	50.3	4.13	11.5	55.0	2.80	8.80	7.34	-	3.60
40.6	65.5	55.0	5.46	6.08	7.96	22.1	-	35.8	5.02	6.56	45.4	1.45	6.93	5.32	-	2.56
20.4	43.0	43.2	7.82	6.07	7.33	7.12	6.56	20.4	3.25	-	33.5	2.23	3.52	1.66	-	-
32.9	54.2	40.1	9.25	4.70	5.01	11.5	1.28	53.8	7.53	14.1	23.7	7.56	12.5	1.06	7.42	-
30.4	62.0	34.5	6.45	4.62	-	14.5	3.10	41.9	6.21	8.14	14.8	7.54	8.52	-	3.42	-
30.6	32.0	1332	4.38	-	-	2.62	-	33.5	-	3.10	17.5		-	-	1.09	-

A.j = Aerva javanica, A.d = Artemisia dubia, A.a = Achyranthes aspera, C.p = Calotropis procera, C.d = Capparis deciduas, C.o= Carthamus oxycantha, C.s = Cannabis sativa, A.f = Avena fatua, Z.n = Ziziphus nummularia S.g = Saccharum griffithii, D.b = Desmostachya bipinnata, C.d = Cynodon dactylon, D.a = Dichanthium annulatum, M.p = Medicago polymorpha, D.a = Dactyloctenium aegyptium, C.b = Conyza bonariensis, S.h = Sorghum halepense, E.p = Eclipta prostrate, I.c = Imperata cylindrical, D.m = Digera muricata, C.c = Cenchrus ciliaris, A.c = Aristidia Cyanatha, S.s = Saccharm spontaneum, O.c = Oxalis corniculata, R.d = Rumex dentatus, S.s = Solanum surattense, S.n = Solanum nigrum, C.a = Chenopodium album, E.c = Eragrostis cilianensis, C.t = Chrozophora tinctoria.

CONCLUSION

Three rodent species; the lesser bandicoot rat, short-tailed mole rat and Indian gerbil *Tatera indica* were recorded. A total of 15 plant species were recorded on the burrows of *T. indica* which included six shrub species and nine herbs/grass species. A total of 24 plant species were recorded around the 46 burrow entrances of *B. bengalensis* on field edges. These included 8 shrubs and 16 herbs/grass species. A total of 19 species of wild flora were recorded from field edges on the burrows of *Nesokia indica*. Six shrub species recorded. Current study suggests that in non-crop season, vegetation on field boundary provides food and shelter to rodents.

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