



## Population Dynamics of Indian Mole Rat, *Bandicota bengalensis* during Different Growth Stages of Paddy and Wheat Crops in Punjab

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### Abstract

The study was carried out in the fields of village Dhatt, District Ludhiana (Punjab, India) (Ludhiana 30.91°N, 75.85°E). There was pre-dominance of *Bandicota bengalensis* over other rodent species like *Mus booduga* and *Tatera indica*. Total number of live burrow count recorded was maximum during tillering stage and minimum during panicle initiation and dough stages, respectively in both crops. In paddy crop, as the total number of *B. bengalensis* burrows decreases from tillering to pre-harvesting stage there is rise and fall in trap index of *B. bengalensis* but during lean period there is rise in trap index due to increase in *B. bengalensis* burrows due to increase in population build up of this species (mean trap index 8.82). In wheat crop, total number of *B. bengalensis* burrows remain almost same from tillering to lean period stages except dough stage and there is rise and fall in trap index of *B. bengalensis* which was maximum during dough stage and then decreases at pre-harvesting stage and again rises in lean period (mean trap index 7.42). The percentage cut tillers and damage (kg acre<sup>-1</sup>) recorded in paddy and wheat crops were 0.28, 0.46 and 7.93, 11.76, respectively. During panicle initiation, dough and pre-harvesting stages, sex ratio was in favour of females while it was in favour of males in tillering stage, whereas it was vice versa for wheat crop. So, control measures should be done at panicle initiation stage in paddy crop and tillering stage in wheat crop to manage *B. bengalensis* and its damage.

**Keywords:** *Bandicota bengalensis*, paddy crop, wheat crop, growth stages

### 1. Introduction

Rodents are regarded as unwelcome associate of humans as pests since time immemorial. They cause various loss to production systems like agriculture, horticulture and forestry and stored food grains (Amri and Longkumer, 2018; Kaur et al., 2016; Kocher and Parsad, 2003). They have the ability to adapt to a wide variety of habitats (Prashad, 1999). The cause 5-10% damage to agricultural crops at pre-harvest stage (Sharma and Singh, 2017; Babbar et al., 2014). Their role in transmission of various public health diseases like plague, leptospirosis, rat bite fever, leishmaniasis etc are well known (Singla et al., 2015; Singla et al., 2008; Rosa et al., 2007; Singla et al., 2003; Anantharaman 1966, Huq et al., 1985; Khatoun et al., 2004). Out of total 103 rodent species found in India, only over a dozen species are regarded as of economic

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importance. The species of rats and mice inhabiting crop fields in Punjab Indian mole rat are *Bandicota bengalensis*, *Milardia meltada*, *Tatera indica*, Indian bush rat, *Golunda ellioti* Gray, short tailed mole rat, *Nesokia indica* Gray, *Mus musculus*, *Mus booduga* and brown spiny mouse, *Mus platythrix* Bennett. Out of these *B. bengalensis* is prevailing in irrigated and rainfed areas of Punjab (Anonymous, 2018).

In Punjab, rats and mice cause damage of 4.9% in paddy, 6.4% in sugarcane, 3.9% in groundnut, 4.5% in wheat, 5.9% in peas and 10.7% in winter maize (Kaur et al., 2018; Anonymous, 2018; Singh et al., 2017). *B. bengalensis* is a predominant rat of South Asia (Singal and Pasahan, 1993). It is well established in cultivated fields, pasture lands, forests, high mountains, intertidal mangrove zones, semi arid regions and urban areas (Romanach et al., 2005; Malhi and Sheikher, 1986). It is a robust rodent with adults weighing 200-400 g. It has blunt snout with broad muzzle. It can be up to 40 cm long (including the tail) and is considered a pest in the cereal crops and gardens of India and Sri Lanka. Their fur is dark or pale brown dorsally, occasionally blackish, and light to dark grey ventrally. The head-body length is around 250 mm, and the uniformly dark tail is shorter than the head-body length. The diet includes grains, fruits and invertebrates. It destroys cultivated crops in fields. Commonly, it lives in cultivated plains and gardens and is one of the most destructive pests to crops and cultivation. It is nocturnal and fossorial in habit. It digs burrows with characteristic pile of earth around the entrance. The burrow system is extensive and elaborate, consisting of numerous chambers (for breeding, storing food, etc.), galleries and exits or 'bolt-holes', which are covered with loose earth (Sheikher 1990). Males and females usually live in separate burrows (Hussain et al., 2016; Kaur and Singh, 2019). Rodents live in underground burrows established by them. Burrowing is just one of a series of activities such as trampling, wallowing, digging and geophagy that can have tremendous impacts on the landscape (Sheikher and Malhi, 1983; Taylor, 1935; Jacob, 1940; Thorp, 1941; Abaturon, 1972; Hole, 1981; Meadows and Meadows, 1991; Stone and Comerford, 1994; Butler, 1995). Burrows give a stable microclimate and provide small mammal's defense from intense temperature and from predators on the ground surface (Prashad, 1999). Rodents used the burrows for nesting, food storage, hibernating and shelter from predators during their surface activity (Reichman and Smith, 1987). Paddy-wheat is the dominant cropping system of Indo-Gangatic plains of India (Ali et al., 2016). In our present study attempt has been made to study population build up of *B. bengalensis* in paddy-wheat cropping system.

## 2. Materials and Methods

The study was carried out in the fields of village Dhatt, District Ludhiana, Punjab, India (Ludhiana 30.91°N, 75.85°E) during 2016-17. The main crops grown in this area were wheat, paddy, maize, bajra and vegetables etc. Population

dynamics of *B. bengalensis* was studied in selected field areas having different crops in soil by trapping method for the whole year. Trapping was carried out at monthly interval for consecutive three trap nights from selected field areas. Various other species of rodents like *T. indica*, *M. meltada* and *M. booduga* were also trapped along with *B. bengalensis*. There were three replications each having one acre area. Sixteen wooden traps acre<sup>-1</sup> were used for trapping rats. Traps were placed in selected areas near the burrow openings. The number of burrows of different rodent species (acre<sup>-1</sup>) was also recorded from fields from where trapping was done to observe the pre-dominance of rodent species. Since most of rodents being nocturnal, the burrows were plugged with soil, late in the evening and freshly re-opened burrows on next day were counted as live burrows.

The population was counted by calculating trap index (Singla et al., 2015):

$$\text{Trap index (\%)} = \frac{\text{Total no. of species trapped}}{\text{Total no. of traps} \times \text{trap nights}} \times 100$$

The trapped species were analyzed to record other parameters like number and kind of species trapped, sex (male or female) and body weight of species trapped (g).

Assessments of rodent damage at pre-harvest stage of different field crops were recorded. Rodent damage (acre<sup>-1</sup>) was assessed by taking five samples of 1m<sup>2</sup> per field of one acre in two diagonal lines to cover center as well as all the four geographical sides of a field as given by Singla and Babbar (2010). In each sample, total number of tillers and tillers cut by rodents were counted.

$$\text{Damage (\%)} = \frac{\text{Average number of cut tillers/m}^2}{\text{Total number of tillers/m}^2} \times 100$$

### 2.1. Statistical analysis

The data of burrow count and trap index were given as mean with standard error (SE).

## 3. Results and Discussion

The trap index of different species of rodents captured along with *B. bengalensis* during trapping at different stages of paddy and wheat crops in the year 2016-17 was recorded. In paddy crop, total number of live burrow count recorded during tillering, panicle initiation, dough, pre-harvesting stages and lean period were 19.5±2.45, 14.5±1.89, 15.8±2.50, 15.5±2.76 and 18.5±3.50, respectively (Table 1). In our study, there was pre-dominance of *B. bengalensis* over *M. musculus* and *T. indica*. Total number of live burrow count recorded was maximum during tillering stage (19.5±2.45) and minimum during panicle initiation stage (14.5±1.89). Total number of live burrow count during panicle initiation, dough, pre-harvesting stages and lean period recorded were 25.6, 18.9, 20.5 and 5.12% lower as compared to tillering stage. There were other species like *T. indica*, *M. booduga* and *M. musculus*

were also trapped along with *B. bengalensis*. Total trap index (%) (including all rodent species) in different stages of paddy during tillering, panicle initiation, dough, pre-harvesting and lean period recorded was 10.00±1.98, 13.38±2.88, 17.00±3.06, 2.00±0.55 and 12.50±2.05, respectively having maximum in dough stage and minimum during pre-harvesting stage. The mean trap index (%) of all the trapped species throughout the year was recorded to be 10.97±2.25. Total trap index (%) during tillering, panicle initiation, pre-harvesting stages and

lean period recorded was 41.17, 21.29, 88.23 and 26.47% lower as compared to dough stage.

Trap index (%) of *B. bengalensis* during tillering, panicle initiation, dough, pre-harvesting stages and lean period recorded was 5.0±1.44, 11.6±2.05, 13.0±3.55, 2.0±0.98 and 12.5±3.44, respectively (Table 1). Trap index (%) of *B. bengalensis* was recorded to be maximum in dough stage (13.0±3.55) while minimum in pre-harvesting stage (2.0±0.98). In paddy crop, as the total number of *B. bengalensis* burrows

Table 1: Trap index (%), cut tillers (%), damage (kg acre<sup>-1</sup>) and different parameters of trapped *B. bengalensis* in different stages of paddy crop (Mean±SE)

Sl. No.	Stages of crop	Total no. of burrow count acre <sup>-1</sup>	Total trap index (%)	Trap index (%) of <i>B. bengalensis</i>	Sex ratio (male: female) of <i>B. bengalensis</i>	Weight of <i>B. bengalensis</i> (g) (min-max)		Average weight (g)	Cut tillers (%)	Damage (kg acre <sup>-1</sup> )
						male	female			
1.	Tillering	19.50± 2.45	10.00± 1.98	5.00± 1.44	1:0.33	212.0-300.0	190.0	229.50± 2.76	-	-
2.	Panicle initiation	14.50± 1.89	13.38± 2.88	11.60± 2.05	1:2.25	211.0-319.0	110.0-303.0	236.90± 3.05	-	-
3.	Dough	15.80± 2.50	17.00± 3.06	13.00± 3.55	1:2.25	80.0-250.0	56.0-268.0	155.30± 3.87	-	-
4.	Pre-harvesting	15.50± 2.76	2.00± 0.55	2.00± 0.98	0:1	0	250.0-280.0	265.00± 2.56	0.46± 0.04	11.76± 0.71
5.	Lean	18.50± 3.50	12.50± 2.05	12.50± 3.44	1:1	100.0-302.0	89.0-256.0	180.80± 3.09	-	-
6.	Mean	16.76± 0.85	10.97± 2.25	8.82± 2.00	-	-	-	-	-	-

SE=Standard error

decreases from tillering to pre-harvesting stage there is rise and fall in trap index but during lean period there is rise in trap index due to increase in *B. bengalensis* burrows (Figure 1). Trap index (%) of *B. bengalensis* during tillering, panicle initiation, pre-harvesting stages and lean period recorded was 61.5, 10.76, 84.6 and 3.84%, respectively lower as compared to dough stage. *B. bengalensis* achieved high rate of reproduction by producing many large litters during the months when paddy crop was maturing and ripening (Fulk et al., 1981). The sex ratio (male: female) of trapped *B. bengalensis* recorded during tillering, panicle initiation, dough, pre-harvesting stages and lean period recorded was 1:0.33, 1:2.25, 1:2.25, 0:1 and 1:1, respectively. During panicle initiation, dough and pre-harvesting stages, sex ratio was in favour of females while it was in favour of males in tillering stage, whereas in lean period sex ratio remains constant for both sexes. The weight (g) of trapped *B. bengalensis* male during tillering, panicle initiation, dough stages and lean period ranged from 212-300, 211-319, 80-250 and 100-302, respectively whereas weight of females ranges from 0-190, 110-303, 56-268, 250-280 and 89-256, respectively.

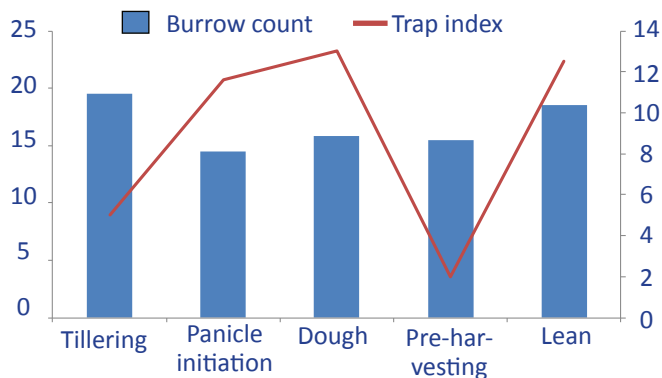


Figure 1: Relationship of trap index (%) and number of burrow count of *B. bengalensis* during different stages of paddy crop

The weight of *B. bengalensis* was maximum during panicle initiation stage (303 g for female) and minimum during dough stage (105 g for male). Average weight (g) of *B. bengalensis* during tillering, panicle initiation, dough, pre-harvesting stages and lean period recorded was 229.5±2.76, 236.9±3.05, 155.3±3.87, 265±2.56 and 180.8±3.09, respectively. It was maximum during pre-harvesting stage (265g) while minimum

in dough stage (119.56 g) as shown in (Table 1). The % cut tillers and damage (kg acre<sup>-1</sup>) recorded in paddy crop were 0.46±0.04 and 11.76±0.71, respectively. Beg et al., (2010) reported that except for the wheat fields, the house mouse was predominant in the fields of all the crops; its average trap success in the various crops ranged from 3.1 to 6.7%. The average trap success varied from 0.9 to 5.9%; among its better populated crops were sugarcane (5.9%), fodder (3.6%), and cotton (3.2%). In bandicoot rat, the trap success ranged from 0.1% (in the cotton fields) to 5.0% (in the sugarcane fields). The trap success for the bandicoot rat in the wheat-paddy system was somewhat more than what it was recorded for

the wheat-sugarcane crops, while the opposite was true for the house mouse (*Rattus rattus*) and the soft furred field rat (*M. melstada*) populations (Durr-i-Shahwar et al., 1999 and Beg et al., 2010).

In wheat crop, total number of live burrow count recorded during tillering, panicle initiation, dough, pre-harvesting stages and lean period recorded were 19.6±2.69, 19.2±1.19, 12.6±1.50, 18.5±2.85 and 19.0±2.57, respectively (Table 2). In our study, there was pre-dominance of *B. bengalensis* over *M. musculus* and *T. indica*. Total number of live burrow count was maximum during tillering (19.5±2.69) and minimum during dough stage (12.6±1.50). Total number of live burrow count

Table 2: Trap index (%), cut tillers (%), damage (kg acre<sup>-1</sup>) and different parameters of trapped *B. bengalensis* in different stages of wheat crop

Sl. No.	Stages of crop	Total no. of burrow count acre <sup>-1</sup>	Total trap index (%)	Trap index (%) of <i>B. bengalensis</i>	Sex ratio (male: female) of <i>B. bengalensis</i>	Weight of <i>B. bengalensis</i> (g) (min-max)		Average weight (g)	Cut tillers (%)	Damage (kg acre <sup>-1</sup> )
						male	female			
1.	Tillering	19.60±2.69	11.25±1.28	6.25±1.40	1:1.5	110.0-190.0	80.0-130.0	128.00±2.09	-	-
2.	Panicle initiation	19.20±1.19	3.75±3.88	3.75±3.05	1:0.5	140.0-179.0	81.0	133.30±3.98	-	-
3.	Dough	12.60±1.50	17.00±3.06	13.90±1.55	1:0	180.0-220.0	0	201.20±2.58	-	-
4.	Pre-harvesting	18.50±2.85	2.00±0.55	2.90±1.18	0:1	0	180.0-192.0	186.00±3.80	0.28±0.09	7.93±0.99
5.	Lean	19.00±2.57	13.40±1.98	10.30±2.23	1:0.5	85.0-250.0	80.0-210.0	175.40±3.40	-	-
6.	Mean	17.76±1.16	9.48±2.55	7.42±1.84	-	-	-	-	-	-

SE=Standard error

during panicle initiation, dough, pre-harvesting stages and lean period recorded were 2.04, 35.7, 5.61 and 3.06% lower as compared to tillering stage. Like paddy crop, there were other species like *T. indica*, *M. booduga* and *M. musculus* and *M. melstada* were also trapped along with the *B. bengalensis* in wheat crop. Total trap index (%) including all rodent species in different stages of wheat during tillering, panicle initiation, dough, pre-harvesting stages and lean period recorded was 11.25±1.28, 3.75±3.88, 17.00±3.06, 2.00±0.55 and 13.40±1.98, respectively having maximum in dough stage and minimum during pre-harvesting stage (Table 2). The mean total trap index (%) of all the trapped species throughout the year was recorded to be 9.48±2.55. Total trap index (%) during tillering, panicle initiation, pre-harvesting stages and lean period recorded was 33.8, 77.9, 88.2 and 21.1% lower as compared to dough stage.

Trap index (%) of *B. bengalensis* during tillering, panicle

initiation, dough, pre-harvesting stages and lean period recorded was 6.25±1.40, 3.75±3.05, 13.9±1.55, 2.9±1.18 and 10.3±2.23, respectively. Trap index (%) of *B. bengalensis* was recorded to be maximum in dough stage (13.9±1.55) while minimum in pre-harvesting stage (2.9±1.18). In wheat crop, total number of *B. bengalensis* burrows remain almost same from tillering to lean period stage except dough stage, there is rise and fall in trap index which was maximum during dough stage and then decreases at pre-harvesting stage and again rises in lean period (Figure 2). Trap index (%) of *B. bengalensis* during tillering, panicle initiation, pre-harvesting stages and lean period was recorded to be 55.0, 73, 79.1, 25.8%, respectively lower as compared to dough stage. The sex ratio (male: female) of trapped *B. bengalensis* recorded during tillering, panicle initiation, dough, pre-harvesting stages and lean period of wheat crop recorded was 1:1.5, 1:0.5, 1:0, 0:1 and 1:0.5, respectively (Table 2). During panicle

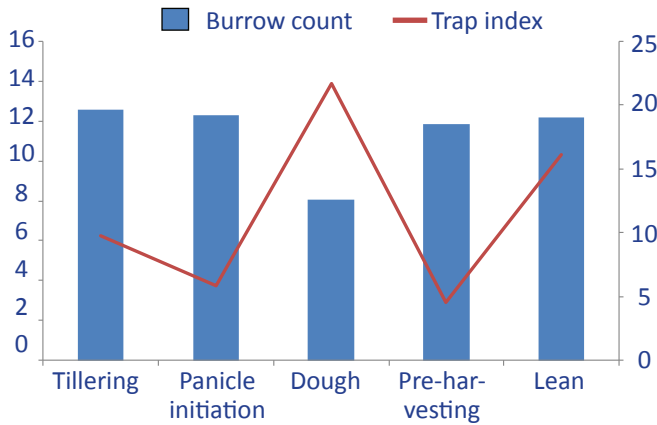


Figure 2: Relationship of trap index (%) and number of burrow count of *B. bengalensis* during different stages of wheat crop

initiation, dough stages and lean period, sex ratio was in favour of males while it was in favour of females in tillering and pre-harvesting stages. In a study by Sharma and Singh (2018) during monsoon, post-monsoon and spring seasons, sex ratio of *T. indica* species was in favour of males while it was in favour of females during winter season, which leads to increase in population during winter season. The weight (g) of trapped *B. bengalensis* male during tillering, panicle initiation, dough stages and lean period ranges from 110-190, 140-179, 180-220 and 85-250, respectively whereas weight of females during tillering, panicle initiation, pre-harvesting stages and lean period ranges from 80-130, 0-81, 180-268 and 80-210, respectively. The weight of *B. bengalensis* was maximum during dough stage (220 g for male) and minimum during tillering stage (80 g for male). Average weight (g) during tillering, panicle initiation, dough, pre-harvesting and lean period was recorded to be  $128.0 \pm 2.09$ ,  $133.3 \pm 3.98$ ,  $201.2 \pm 2.58$ ,  $186.0 \pm 3.80$  and  $180.8 \pm 2.30$ , respectively. It was maximum during dough stage (201.2 g) while minimum in tillering stage (128.0 g) as shown in (Table 2). The % cut tillers and damage ( $\text{kg acre}^{-1}$ ) recorded in wheat crop were  $0.28 \pm 0.09$  and  $7.93 \pm 0.99$ , respectively.

According to Singal and Pasahan (1993) the population of *B. bengalensis* depicted a linear correlation with growth of crop. The population density of *B. bengalensis* was maximum at maturity stage of crop, this peak in the population density may be correlated with the availability of sufficient food and shelter in the crop fields (Sood and Ubi, 1975). This evidence supports our result. In paddy and wheat crop, the population density of *B. bengalensis* was maximum at dough stage. Hence, there was a higher degree of level of damage at the maturity stage as comparison to other growing stages of crop (Kumar and Pasahan, 1992). Sagar and Bindra (1973) and Shekhar (1990) have also noticed in *B. bengalensis* two different breeding seasons i.e. one around March to April and the other around August to September corresponding to the maturity stage of the crops. Thus, periodicity of bandicoot reproduction in wheat crop could be correlated with the availability of food

and shelter, consequent of which more number of young ones were trapped (Sood and Ubi, 1975).

#### 4. Conclusion

There was pre-dominance of *B. bengalensis* over other species. In both crops, as number of *B. bengalensis* burrows decreases there is rise and fall in trap index and it was maximum during dough stage in wheat crop. During panicle initiation, dough and pre-harvesting stages, sex ratio was in favour of females which leads to higher population, while it was in favour of males in tillering stage, whereas it was vice versa for wheat crop.

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