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BURROW STRUCTURE OF LESSER BANDICOOT RAT, *BANDICOTA BENGALENSIS* DURING DIFFERENT STAGES OF RICE CROP IN PUNJAB

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ABSTRACT : Rodents are major vertebrate pests of agricultural crops during pre- and post-harvest stages. Among them, bandicoot rat, *Bandicota bengalensis,* a predominant species inhabiting irrigated fields is a potential pest on agricultural crops. Burrows of *B. bengalensis* were excavated during each stage of rice crop and studied at selected village. The number of burrows excavated ranged from 15-20 from different locations. The results concluded that the length of burrow increases whereas depth decreases from tillering stage to lean period of rice crop. Higher mean value of length (189.34cm) and lower of depth (53.53cm) was recorded when mean soil temperature (^{0}C) and soil moisture (%) observed were 15.00 and 23.01, whereas lower length (163.60cm) and higher depth (76.84cm) was recorded when mean soil temperature and soil moisture (%) were 30.65 and 17.08, respectively to make the burrow environment optimum for their survival. The number of open ends was highest during tillering stage and blind ends at dough stage where as both were lowest during lean period. The length and breadth of open ends ranges from 6.71 to 7.90cm and 7.11 to 8.75cm, respectively. The average number of nest chambers of excavated burrows was higher during pre-harvesting stage and lower during tillering stage of rice crop. Our study will help in development of policies that include strategies for rodent pest management i.e., for placing poison baits in burrows so that the rodent damage to crops may be reduced to a minimum level and farm income of farmer may be increased.

Key words : *Bandicota bengalensis*, burrow excavation, Lesser bandicoot rat, rice crop, rice stages.

INTRODUCTION

Rodents comprise the largest and most successful group of mammals worldwide. They are pests in agriculture, horticulture, forestry, animal and human dwellings and rural and urban storage facilities in India. Their habitat, distribution, profusion and economic significance vary in different seasons, crops and geographical regions of the country. They cause direct damage by feeding and indirect damage by spoilage, contamination and hoarding during pre and post-harvest crop stages (Babbar *et al*, 2014). They have the ability to adapt to a wide variety of habitats (Parshad, 1999). Rodents belong to order '*Rodentia*' of class mammalia. In India, there are 103 species of rodents belonging to 4 families and 46 genera out of which family muridae is represented by 56 species. Among them, 13 species are prevailing ones requiring attention, of which the lesser bandicoot rat, *Bandicota bengalensis* (Gray and Hardwicke) is vital in irrigated crop fields (Anonymous, 2017). *B. bengalensis* is a predominant rat of South Asia. It is well established in cultivated fields, pasture lands, forests, high mountains, intertidal mangrove zones, semi arid regions and urban areas. It is a robust rodent with adults weighing 200-400g with blunt snout and broad muzzle and having length of 40cm. 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 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. Males and females usually live in separate burrows (Sagar and Bindra, 1973).

Burrows are used by rodents for nesting, food storage, hibernating and shelter from predators during their surface activity (Reichman and Smith, 1987; Kinlaw, 1999) along with nesting, food storage and hibernating and provide rodents with shelter from predators during their surface activity (King, 1984; Reichman and Smith, 1987; Kinlaw, 1999). Burrowing is just one of a series of activities such as trampling, wallowing, digging and geophagy that can have tremendous impacts on the landscape (Meadows and Meadows, 1991; Stone and Comerford, 1994; Butler, 1995). Various abiotic factors such as climate and topography affect the animal activity (Porter *et al*, 2002). Biotic factors such as food and mate availability influence both times and places for the activity of rodents (Johnson *et al*, 2001; Clark *et al*, 2002). Subterranean rodents burrow through the soil, consuming above and below ground plant material (Huntlyand Inouye, 1988). Burrowing activity is affected by both the physical characteristics of the soil and the availability of food (Romanach, 2003). Generally, most desert rodents escape heat imposed by solar radiation and high soil and air temperature by remaining below ground in burrows during heat of the day (Ghobrial andNour, 1975; Kucheruk, 1983). Burrowing rodents live in different habitats by forming simple and shallow to deep and complex network of tunnels with variable numbers of surface opening (Barnett andPrakash, 1975; Bindra and Sagar, 1975; Begall and Gallardo, 2000; Dubey, 2001; Kocher and Parshad, 2003). The length, depth, surface opening, chambers of burrows may be affected by soil quality (Rejasekharan and Dharmaraju, 1975) food availability and colony size (Begall and Gallardo, 2000). Studies on the burrowing habit of rodent pests are required to understand their social organization and behaviour of dominance (Barnet and Prakash, 1975; Prakash and Mathur, 1987). They also help to distinguish rodents from other burrowing animals for population estimation, placing poison baits and physical control (Neelanarayanan *et al*, 1996). Rice and wheat crops comprise 80.0% of total cereal production and are serious to food security for tremendously increasing population, and have vital role in our economy and country trade (Khan *et al*, 2003; Anonymous, 2005). But unfortunately, our food crops are in unremitting menace due to a boost in populations of insect pests and rodents. Khan and Razvi (2000) reported that *B. bengalensis* is the most widespread in distribution; it causes serious economic losses to growing crops such as rice, wheat, sugarcane and groundnuts. To reduce rodent damage to crops and to secure our health, it is necessary to know biology and ecology of rodents, so that a satisfactory and scientific plan for their management in the fields can be made. In the present study, an attempt has been made to describe burrow structure of *B. bengalensis*under different growth stages of rice crop in sandy-loam soil of Punjab (India). Our study will help indevelopment of policies that include the strategies for rodent management i.e., for placing poison baits in burrows so that the rodent damage to different field and vegetable crops may be reduced to minimum level which will lead to saving of food grains.

MATERIALS AND METHODS

The materials and methods of the study are illustrated in brief as under :

Selection of area and burrows

The study was carried out in the rice fields of village Dhatt, District Ludhiana (Punjab) (Ludhiana 300 54'N, 750 51'E) and laboratory experiments were carried out in the Departments of Zoology and Soil Science, P.A.U, Ludhiana. The village contains sandy-loam soil. The main crops grown in this area were wheat, rice and fodder crops like barseem, maize and bajra. For excavation, 1-2 days old fresh burrows of *B. bengalensis* species were selected in different stages of rice crop of selected village. The number of burrows excavated in each stage of rice crop ranged from 15 to 20 from different field locations of selected village. Observations were recorded on the basis of different stages of rice crop. The different stages of rice crop under study were tillering, panicle initiation, dough, pre-harvesting and lean period. The excavations of burrows were done from the area around the fields of rice crop.

Determination of Burrow parameters

The burrows of *B. bengalensis* were studied by excavation and identified visually by their structure and nature of burrow entrance as suggested by Barnett and Prakash (1975) and Neelanarayanan *et al* (1996). Thereafter, the burrows were dug out with the help of spade and different burrow and soil parameters were recorded during excavation of each burrow like length and breadth of open ends (cm), number of open ends, number of blind ends (if any) and total number of branches of each burrow were counted, length and depth of excavated burrow (cm), number of nest chambers, length and breadth of nest chambers, weight of food hoarded (grams),were recorded. All the measurements were taken using measuring tape (cm).

Determination of soil parameters

The soil parameters examined were soil textures, soil moisture, soil temperature, soil pH, electrical conductivity (EC), particle density (Dp), bulk density (Db) and organic carbon (OC). Soil samples were collected from soil of excavated burrows at different depths i.e. from zero, one and two feet. For this, the surface litter or vegetation was removed and then a deep pit was dug out and the vertical side of pit was marked at zero, one and two feet deep from the surface. Uniform slices of soil samples were taken out separately with the help of spade. These soil samples were packed in cloth bags and related information like time, location, date, crop, depth, sample number was labelled with the help of marker. Soil texture was determined by the sense of touch in the fields. The methods used were feel method, ball formation, stickiness, ribbon formation method as suggested by Mehra (2014). Gravimetric method (Prihar and Sandhu, 1968) was used for the determination of soil moisture content. Digital soil thermometer (R-Tek™ Shenzhen Tonglixing Technology Co., Ltd. China, Mainland) was used to measure the soil temperature at different depths. Generally soil temperature was measured at 5, 10 and 30cm depths. The thermometer was installed at required depth to record the soil temperature. It takes about 7-10 minutes to record temperature reading of thermometer. To measure pH, potentiometric method (Jackson, 1967) was used. Conductivity meter (Chopra and Kanwar, 1976) was used for the determination of electrical conductivity of soils. Clod saturation method was used in which soil moisture gauge or pycnometer was used for the determination of bulk density of soils (Prihar and Hundal, 1971). PAU soil moisture gauge method was used for determining particle density of soils (Prihar and Sandhu, 1968). Organic carbon in soils was determined by wet digestion method (Walkley and Black, 1934) rapid titration method.

Statistical analysis

Values given in the text are means with their standard error. Comparison of parameters of the burrow systems excavated in different stages of rice crop was made by one-way Annova.

RESULTS AND DISCUSSION

Different characteristics of soil and burrow parameters during burrow excavation in different stages of rice crop like tillering, panicle initiation, dough, pre-harvest and lean period are described as under:

Determination of soil parameters

Various soil samples were taken from different depths viz. zero, one and two feet in soil. Feel method was used to distinguish between the soils. With the feel of fingers, the sandy-loam soil was found to be moderately gritty, easily forming broken ball. The soil adheres slightly and during ribbon formation, the length of ribbon formed (cm) was 1.89±0.10 and it was medium textured (Table 1). At depths of 0, 1 and 2 ft, the pH value recorded was 8.175±0.06, 8.283±0.08 and 8.308±0.06, respectively. The pH value increases as the depth of soil increases. The data revealed that the minimum mean EC value ranges from 0.060 to 0.090and maximum mean value from 0.15 to 0.18 with depth from 0 to 2 ft. As the depth of soil increases, its EC value decreases.The value of organic carbon in soil at depth from 0, 1 and 2 ft recorded was 0.511±0.022, 0.518±0.025 and 0.522±0.026, respectively. This reveals that the organic carbon increases with depth of soil (Table 2). The study revealed that the minimum mean value of bulk density ranges from 1.33 to 1.39 and maximum from 1.44 to 1.56 with depth from 0 to 2 ft. As the depth of soil increases, value of bulk density increases. The value of particle densityat above depths ranged from 2.69±0.002 to 2.74±0.002 (Table 2). As the depth of soil increases, the value of particle density increases.

Determination of soil moisture content (%) and soil temperature (^{0}C)

The average value of soil moisture content (depths 0, 1 and 2 ft) during rice tillering, panicle initiation, dough, pre-harvesting and lean period recorded was 17.08±0.73, 24.66±1.68, 27.08±1.71, 22.07±1.22 and 23.01±1.42, respectively (Table 3). Per cent increase in moisture content during panicle initiation, dough, pre-harvesting and lean period recorded was 44.3, 58.5, 29.2 and 34.7% higher as compared to rice tillering stage. Average soil temperature (^{0}C) of soil at depths of 5, 10 and 30cm duringtillering stage recorded was 29.70±0.50, 30.50±0.44 and 31.75±0.67, respectively, panicle initiation stage 30.20±0.30, 31.50±0.18 and 32.0±0.37, respectively, dough stage 29.40±0.44, 31.45±2.72 and 32.0±0.30, respectively, pre-harvesting stage 20.50±0.66, 22.50±0.62 and 23.0±0.55, respectively and lean period 15.00±1.56, 23.50±0.45 and 16.50±2.04, respectively (Table 4).

Effect of abiotic factors on length/depth of burrows

The burrows of *B. Bengalensis* were characterized with heap of soil around the entrance. The burrow system

Table 1 : Determination of soil texture in different soils.

S. no.	Feel of fingers	Ball formation	Stickiness	Ribbon formation (cm)	Textural class	Textural assessment
1.	Moderately gritty	Forms easily broken ball	Soil adheres slightly	1.89±0.10	Sandy-loam	Medium textured

Table 2 : Different parameters of soil characteristics at various depths of soil during rice crop period.

S. no.	Depth (feet)	pH	Electrical conductivity (EC) (dS/m)	Organic carbon (%)	Particle density (D_b) (Mg m^{-3})	Bulk density (D_p) (Mg m^{-3})
1.	0	8.175±0.065	0.130±0.016	0.511±0.022	1.37±0.015	2.69±0.002
2.	1	8.283±0.084	0.106±0.014	0.518±0.025	1.41±0.014	2.72±0.003
3.	2	8.308±0.065	0.103±0.017	0.522±0.026	1.44±0.015	2.74±0.002

Table 3 : Soil moisture content (%)in excavated burrows of *B. bengalensis*in different stages of rice crop at village Dhatt, district Ludhiana.

S. no.	Stages	Depth (feet)	Soil moisture content (%)
1	Tillering	0	15.40±1.24
		1	17.35±0.70
		2	18.50±0.92
		Average	**17.08[b]±0.73**
2	Panicle Initiation	0	21.63±1.12
		1	23.75±2.08
		2	28.60±2.24
		Average	**24.66[a]±1.68**
3	Dough	0	24.35±1.15
		1	25.70±0.72
		2	31.21±0.10
		Average	**27.08[a]±1.71**
4	Pre-harvesting	0	19.23±1.25
		1	22.70±0.42
		2	24.30±1.12
		Average	**22.07[ab]±1.22**
5	Lean period	0	20.10±1.24
		1	22.80±2.10
		2	26.12±0.72
		Average	**23.01[a]±1.42**

Values are mean ± SE, a,b shows significant difference in moisture content in different stages of rice crop along the column.

Table 4 : Average soil temperature (^{0}C) at different depths in excavated burrows of *B. bengalensis* during different stages of rice crop.

S. no.	Stages	Soil depths			Average
		5cm	10cm	30cm	
1	Tillering	29.70±0.50	30.50±0.44	31.75±0.67	30.65±0.49
2	Panicle initiation	30.20±0.30	31.50±0.18	32.0±0.37	31.23±0.43
3	Dough	29.40±0.44	31.45±2.72	32.0±0.30	30.95±0.65
4	Pre-harvesting	20.50±0.66	22.50±0.62	23.0±0.55	22.00±0.62
5	Lean period	15.00±1.56	13.50±0.45	16.50±2.04	15.00±0.71

is extensive and elaborate, consisting of numerous chambers (sleeping, storing etc.), galleries and exits holes, which are covered with loose earth. During excavation of burrow, the mean length of burrow during rice tillering, panicle initiation, dough, pre-harvesting stages and lean period recorded was 163.6±2.34, 171.34±2.84, 182.91±3.17, 186.48±3.93 and 189.34±3.27, respectively (Table 5). The depth of burrow varies during different stages of rice crop. The mean depth of burrow during rice tillering, panicle initiation, dough, pre-harvesting stages and lean period recorded was 76.84±2.72, 64.29±3.57, 59.87±2.63, 56.14±4.06, 53.53±2.33, respectively (Table 5). The average depth of burrows during panicle initiation, dough, pre-harvesting stages and lean period was 16.3, 22.0, 26.9 and 30.33%, respectively lower as compared to rice tillering stage.

The data revealed that the length of burrow was minimum during rice tillering stage while maximum during lean period. A trend of increase in length of burrows was observed from rice tillering stage to lean period. Similarly, the depth of burrow was minimum during lean period and maximum in rice tillering stage. A trend of decrease in depth of burrow was observed from rice tillering stage to lean period. This may be due to the fact that in rice tillering stage during July, there is high temperature outside, whereas it is low during lean period in the month of November-December. So, to keep the environment of the burrow optimum the rat increases the depth and decreases the length of burrow during rice tillering stage and reduces depth and increases length of burrow during lean period. From our study, it is concluded that the length of burrow increases where as its depth decreases as rice crop matures from tillering stage to lean period. Higher valueof length (189.34±3.27cm) and lower of depth (53.53±2.33cm) was recorded 15.00±0.71 and 23.01±1.42 where as lower length (163.60±2.34cm) and higher depth when mean soil temperature (^{0}C) and soil moisture (%) observed were (76.84±2.73cm) was recorded when mean soil temperature and soil moisture (%) were 30.65±0.49 and 17.08±0.73, respectively to make the burrow environment optimum for their survival. The length of burrow is negatively correlated with soil temperature and positively correlated with soil moisture content whereas depth of burrow is positively correlated with soil temperature and negatively correlated with soil moisture content. As per evaluating data in linear model, we got the equations for calculating the relationship between length, depth, soil temperature and soil moisture.

The equation derived is:

Length = 170.419-1.161×soil temperature + 1.688 × soil moisture

Depth = 76.014+0.928× soil temperature-1.667 × soil moisture

This model was statistically significant with R^2 values of 0.89 and 0.95 for length and depth, respectively, where R^2 is coefficient of determination. Sheikher and Malhi (1983) reported maximum length of 2030.0 cm and estimated an area of 50.0 m^2 of burrow system of bandicoot rat. Such variations in burrow structures have

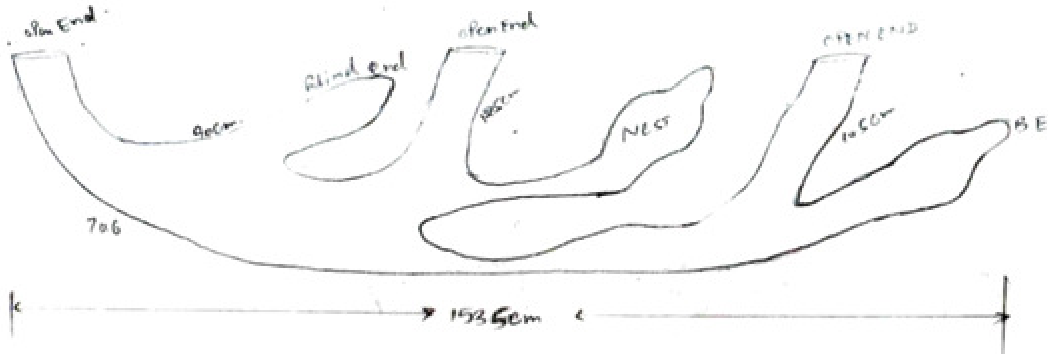

Fig. 1 : *B. bengalensis* burrow in rice crop at lean period.

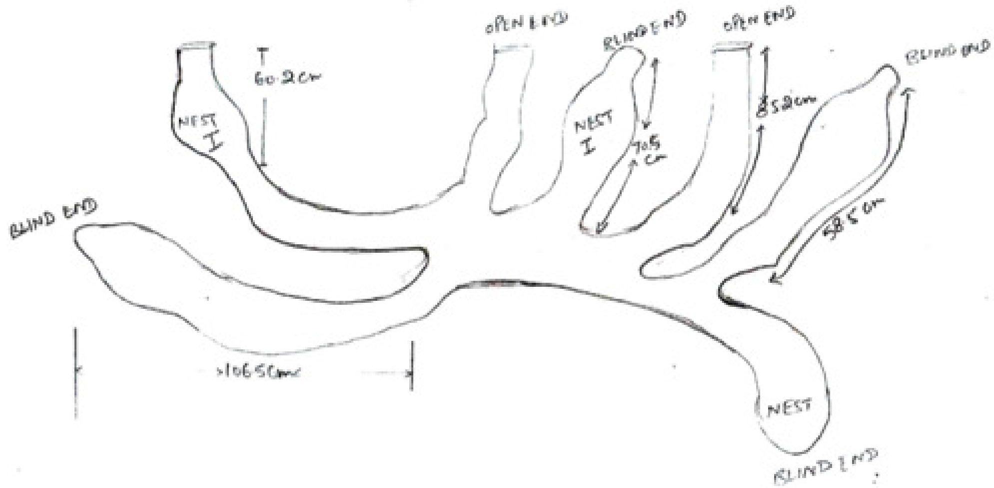

Fig. 2 : *B. bengalensis* burrow in rice crop at dough stage.

been related to physical properties (Reichman and Smith, 1990) and texture of the soil (Shenbrot *et al*, 1997). There is seasonal shift in the rodent population between cultivated crops and non-crop areas (mainly field boundary vegetation) (Hussain *et al*, 2003). Seasonal movement of rats may not allow enough time for the species to construct deep and complicated burrow systems, compared to other environments (Armitage, 2003; Reichman and Smith, 1990; Smith and Gardner, 1985), where burrows are occupied for an extended period and may become progressively longer and deeper.

Open and blind ends of excavated burrows

The number of branches of excavated burrows during different stages ranges from 1.55±0.16 to 3.79±0.03 (Figs. 1 and 2). The mean number of branches of burrows was highest during dough stage and lowest during lean period (Table 6). The average number of open and blind ends of burrows during different stages of rice crop ranges from 1.75±0.24 to 3.51±0.60 and 1.81±0.20 to 2.75±0.42, respectively. The number of open ends was highest during rice tillering stage and lowest during lean period. Similarly, the number of blind ends was highest in dough stage and lowest during lean period. Similar results are recorded by Ubi (1975), Malhi and Sheikhar (1986) that the number of surface openings of *B. bengalensis* ranges from 2-10, *M. booduga* (1-3), *T. indica* (1-3) and number of blind ends observed was 2-18 in *B. bengalensis*, 2-3 in *M. booduga* and 0-4 in *T. indica* that supports our results.

Length and breadth of open ends of excavated burrows

The average length and breadth of open ends (cm) of excavated burrows during different stages of rice crop ranges from 6.71±0.43 to 7.90±0.32 and 7.11±0.58 to 8.75±0.36, respectively (Table 6). The length of open ends was maximum during panicle initiation stage and minimum during dough stage similarly breadth of open ends was maximum during panicle initiation stage and minimum during pre-harvesting stage. Several authors work supports our results. Diameter (cm) of surface opening ranges from 4.40-10.40 in *B. bengalensis*, 2.20-3.40 of *M .booduga* and 3.50-8.30 in *T. indica* (Ubi, 1975; Malhi and Sheikhar, 1986).

Nest chambers in excavated burrows

The average number of nest chambers of burrows during different stages of rice crop ranges from1.45±0.08 to 1.66±0.32 (Table 7). The average number of nest chambers of burrows was higher during pre-harvesting stage and lower during tillering stage. The average length and breadth of burrow nest chamberduring different stages

Table 5 : Length and depth of excavated burrows of *B. bengalensis* during different stages of rice crop.

S. no.	Stages	Length of burrows (cm)	Depth of burrows (cm)
1	Tillering	$163.60^{e}\pm2.34$	$76.84^{a}\pm2.73$
2	Panicle initiation	$171.34^{d}\pm2.84$	$64.29^{b}\pm3.57$
3	Dough	$182.91^{c}\pm3.17$	$59.87^{c}\pm2.63$
4	Pre-harvesting	$186.48^{b}\pm3.93$	$56.14^{d}\pm4.06$
5	Lean period	$189.34^{a}\pm3.27$	$53.53^{e}\pm2.33$
6	**Average**	**178.34±4.36**	**62.13±3.67**

Values are mean±SE. a, b, c, d, e shows significant difference in length and depth of burrows in different stages of rice crop along the column.

Table 6 : Average number of branches, open and blind ends, length/breadth of open ends of excavated burrows of *B. bengalensis*, during different stages of rice crop.

S. no.	Stages	Average no. of branches	Average no. of open ends	Average no. of blind ends	Average length of open ends (cm)	Average breadth of open ends (cm)
1	Tillering	$2.87^{d}\pm0.02$	$3.51^{c}\pm0.60$	$2.58^{b}\pm0.36$	$7.75^{b}\pm0.29$	$7.91^{b}\pm0.28$
2	Panicle initiation	$3.79^{c}\pm0.03$	$2.48^{b}\pm0.26$	$2.50^{b}\pm0.32$	$7.90^{a}\pm0.32$	$8.75^{a}\pm0.36$
3	Dough	$3.14^{a}\pm0.15$	$2.21^{a}\pm0.41$	$2.75^{a}\pm0.42$	$6.71^{c}\pm0.43$	$7.78^{c}\pm0.27$
4	Pre-harvesting	$3.35^{b}\pm0.35$	$2.06^{b}\pm0.23$	$1.90^{c}\pm0.22$	$7.22^{c}\pm0.35$	$7.11^{e}\pm0.58$
5	Lean period	$1.55^{e}\pm0.16$	$2.00^{d}\pm0.24$	$1.81^{d}\pm0.20$	$7.26^{d}\pm0.33$	$7.21^{d}\pm0.30$
6	**Average**	**2.94±0.33**	**2.45±0.24**	**2.30±0.16**	**7.36±0.10**	**7.75±0.08**

Values are mean±SE, a,b,c,d,e shows significant difference between the values along the column.

Table 7 : Parameters of nest chambers in excavated burrows of *B. bengalensis* during different crop stages of rice crop.

S. no.	Stages	No. of nest chambers	Length of nest chambers (cm)	Breadth of nest chambers (cm)	Area of nest chambers (cm)	Hoarding material
1	Tillering	1.45±0.08	38.08±0.61	30.50±1.82	1305.01±20.75	grass-8gm Bajra ear heads-156gm
2	Panicle initiation	1.49±0.12	35.50±4.62	34.45±3.63	1400.10±50.08	leaves-27gm Grass-34gm
3	Dough	1.55±0.25	32.25±1.94	29.65±2.30	1000.35±78.30	—
4	Pre-harvesting	1.66±0.32	29.15±5.40	27.20±4.46	1125.21±34.70	—
5	Lean period	1.55±0.11	24.85±5.50	25.17±3.40	790.25±61.62	leaves-13gmgrass-28gm

of rice crop ranges from 24.85±5.50 to 38.08±0.61 and 25.17±3.40 to 34.45±3.63, respectively. The length and breadth were maximum during rice tillering and panicle initiationstages, respectively and both minimum during lean period (Table 7). The area of nest chambers during tillering, panicle initiation, dough, pre-harvesting stages and lean period recorded was 1305.01±20.75, 1400.10±50.08, 1000.35±78.30, 1125.21±34.70 and 790.25±61.62, respectively. It was maximum during panicle initiation stage and minimum during lean period. Different hoarding materials were found during excavation like grass, bajra ear heads, leaves in excavated burrow during different crop stages of rice. Burrows of *B. bengalensis* are elaborate interconnected tunnels/galleries having multiple openings, with a nest chamber and more than one food-stroage chambers (Chanda and Garg, 1981; Poche *et al*, 1982; Sheikher and Malhi, 1983; Malhi and Sheikher, 1986). According to Hussain *et al* (2003), the burrows of *B. bengalensis* maximum had four chambers during different stages of crop, which supports our result.Bandicoots in the Garhwal Himalayas (India) hoarded an average of 0.390kg of wheat ear heads per burrow with as much as 2.0kg in one burrow (Sheikher and Malhi, 1983). The food hoarding behaviour of *B. bengalensis* has evolved as a contingency programme ensuring food security for adverse times or for their young ones, without being exposed to predators or fire (Jackson 1966; Burns *et al*, 1989). Some authors like Ubi (1975), Malhi and Sheikhar (1986) had revealed that the number of food chambers in three species *B. bengalensis*, *T. indica* and *M. booduga* were in the range from 2-14, 0-1 and 0-2, respectively. Food hoarded by *B. bengalensis*, *T. indica* and *M.booduga* was reported to be 370g, 260g and 2500g, respectively.

Our study will help in development of policies that include strategies for rodent pest management i.e., for placing poison baits in burrows so that the rodent damage to crops may be reduced to a minimum level and farm income of farmer may be increased which ultimate will lead to food security.

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