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BURROW OPENING PATTERN OF *BANDICOTA BENGALENSIS* DURING DIFFERENT GROWTH STAGES OF PADDY AND WHEAT CROPS IN PUNJAB

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ABSTRACT
The present study was conducted to observe the dimensions and orientation pattern of burrow opening dig by lesser bandicot rat, *Bandicota bengalensis* during different growth stages of paddy and wheat crop *i.e.*, tillering, panicle initiation, dough, pre-harvesting and lean period under Punjab conditions at two selected villages Dhatt and Boparai, District Ludhiana, Punjab (300 54'N, 750 51'E). Fresh burrows (1-2 days old) of *B. bengalensis* (120 burrows/each stage of crop) were selected from/near paddy and wheat crop fields at different locations of selected villages. Study revealed that mean number of open ends (1.98-3.60), length of open ends (6.57-7.87) and breadth of open ends (7.10-8.78) of burrows do not differ from each other during different growth stages of paddy and wheat crops. Interestingly, during different growth stages of paddy and wheat crops *B. bandicota* changes the orientation of its burrows. In paddy crop, during tillering and panicle initiation stages (summer months) when there is high atmospheric temperature the orientation of burrows was towards North-West/South-West directions whereas during pre-harvesting and lean period stages when atmospheric temperature decreases, the orientation of burrows changes towards North-East direction. Similarly, in wheat crop, during tillering, panicle initiation and dough stages (winter months) when atmospheric temperature is low the orientation of burrows remain towards North-East/South-East whereas during pre-harvesting and lean period (summer months) it moves its orientation towards North-West/South-West directions due to rise in atmospheric temperature. So, by changing its orientation the burrows get sufficient sunlight during winter season and minimum during summer months to keep their internal burrow environment optimum for the survival of them and their young ones.

KEY WORDS: Lesser bandicot rat, *Bandicota bengalensis*, burrow orientation, growth stages

INTRODUCTION

Rodent infestation in irrigated agricultural crop fields result in 5-10% damage from tilering to harvest stages (Kaur and Singh, 2019; Kaur *et al*., 2016; Babbar *et al*., 2014). Among the rodent pest species, lesser bandicoot rat, *Bandicota bengalensis* (Gray) is known to be predominant pest in irrigated fields (Roy, 1974). It is a solitary rat and occupies a single burrow system (Kocher and Parsad 2003; Dubey, 2001; Begall and Gallardo, 2000; Greaves *et al.*, 1975). Its agonistic behaviour help in spatial distribution in irrigated fields. The burrow systems are complex and usually on the bunds. Burrow openings are closed with a heap of soil except during the harvest season (Chakraborthy, 1975; Bindra and Sagar, 1975). 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 rodents are required to understand their social organization and behaviour of dominance (Prakash and Mathur, 1987; Barnet and Prakash, 1975). They also help to distinguish rodents from other burrowing animals for population estimation, placing poison baits and physical control (Neelanarayanan *et al.*, 1996). Burrows are presumably used for sleeping at night, napping during the day, parturition and litter rearing (Ebensperger *et al.*, 2006; Reichman and Smith, 1987). Orientation of burrow openings of rodents was found to be not randomly distributed and seems to be related to environmental factors such as sunlight and prevalent direction of cold winds (Kay and Whitford, 1978; Best, 1982; Baumgardner, 1991). Various functions of burrows are associated with their complex structure represented by a number of functionally different chambers like nest chambers or food chambers connected by a main tunnel system (Shenbrot *et al.*, 2002).

Less complex burrows could be distinguished from main burrows by their location close to the foraging area where animals can hide when threatened (Armitage, 1988, Branch *et al*., 1994). The higher numbers of open ends were important for animals to hide more quickly from predators (Ebensperger and Bozinovic, 2000). Burrows were also used to avoid extreme temperatures and predators; moreover, air moisture in the burrows is higher than environmental moisture as suggested by Torres *et al.* (2003), Shenbrot *et al.* (2002), Ebensperger (2001), Ebensperger and Bozinovic (2000) and Hickman (1977). Influence of biotic and abiotic factors on the structure of burrows has been studied by many workers (Kaur and Singh, 2019; Sharma and Singh, 2018; Taraborelli *et al.*, 2008). Large number of open ends and higher development of main and satellite burrows is likely related to higher risk of predation. Burrows function as shelter from the environment since temperature in the galleries is lower than atmospheric soil temperature during the hottest time of the day. Due to gallery inclination the sun goes deeper into the tunnels in the coldest season (winter) than in the warmest one (summer) (Carneiro and Rocha, 2013; Ceresoli and Fernandez, 2012). Subterranean rodents burrow through the soil, consuming above and below-ground plant material (Huntly and Inouye, 1988). Soil type is also an important factor, determining the distribution, abundance and diversity of plant and animal species. The importance of soil properties in rodent population ecology has been demonstrated in several studies (Yeboah and Akyeampong, 2001; Ajayi and Tewe, 1978; Booth, 1960). The present study was initiated to study the pattern in which the rodent *B. bengalensis* makes the orientation of its burrow opening during the different growth stages (tillering, panicle initiation, dough, pre-harvesting and lean period) of both paddy and wheat crops in Punjab conditions.

MATERIALS AND METHODS

Selection of Area

The study was carried out in the fields of villages Dhatt and Boparai, District Ludhiana (Punjab) (300 54'N, 750 51'E), during 2015-16. The main crops grown in these villages were wheat, paddy, maize, bajra and vegetables *etc.*

Selection of burrows

The burrows of *Bandicota bengalensis* were studied and identified visually by their structure and nature of burrow entrance as suggested by Neelanarayanan *et al.* (1996). Burrow openings are closed with a heap of soil except during the harvest season (Chakraborthy, 1975). To record data, 1-2 days old fresh burrows of *B. bengalensis* species (120 burrows in each stage of crop) were selected during different growth stages of paddy and wheat crops from different field locations of selected villages. Different growth stages of paddy and wheat crop under study were tillering, panicle initiation, dough, pre-harvesting and lean period.

Burrows parameters

Orientation of burrows *i.e*., North, South, East and West were recorded with the help of compass. Before taking data for dimensions of burrow openings (length and breadth), the soil surface litter was removed thoroughly with hands and measurement was taken with the help of a measuring tape.

RESULTS AND DISCUSSION

Number and dimensions of open ends

The mean number of open ends of different *B. bandicota* burrows recorded during all the stages (tillering, panicle initiation, dough, pre-harvesting and lean period) of paddy crop ranged from 1.98 ±0.41 to 3.60 ±0.58 whereas in wheat crop it ranged from 2.03 ±0.17 to 2.79 ±0.27 (Table 1). Among both crops, it was lowest during lean period and highest during dough stage of paddy crop. In paddy crop, mean length (cm) and breadth (cm) of open ends ranged from 7.04 ±0.28 to 7.87 ±0.4 and 7.10 ±0.61 to 8.78 ±0.41, respectively. In wheat crop, mean length and breadth of open ends ranged from 6.57 ±0.48 to 7.68 ±0.46 and 7.13 ±0.46 to 8.14 ±0.60, respectively (Table 1). Little variability was recorded in number, length and breadth pattern of *B. bandicota* burrows during different growth stages of both wheat and paddy crops. The analysis of variance shows significant difference between the values. Some authors like Ubi (1975), Malhi and Sheikhar (1984) revealed that the number of surface openings of *B. bengalensis* ranges from 2.0-10.0, *M. booduga* (1.0-3.0), *T. indica* (1.0-3.0). Diameter (cm) of surface opening ranged from 4.40-10.40 in *B. bengalensis*, 2.20-3.40 of *M. booduga* and 3.50-8.30 in *T. indica* that supports our results.

TABLE 1: Mean number, length and breadth of open ends of *B. bengalensis* burrows during different growth stages of paddy and wheat crops

S. no.	Stages of crop	Paddy crop (Mean in cm)			Wheat crop (Mean in cm)		
		Number of open ends	Length of open ends	Breadth of open ends	Number of open ends	Length of open ends	Breadth of open ends
1	Tillering	2.24±0.39	7.80±0.32	7.92±0.24	2.21±0.31	6.79±0.22	7.13±0.46
2	Panicle initiation	2.52±0.31	7.87±0.41	8.78±0.41	2.53±0.22	6.90±0.36	7.29±0.28
3	Dough	3.60±0.58	7.31±0.52	7.72±0.20	2.79±0.27	6.57±0.48	7.68±0.60
4	Pre-harvesting	2.49±0.27	7.34±0.39	7.10±0.61	2.61±0.20	7.66±0.87	7.80±0.49
5	Lean period	1.98±0.41	7.04±0.28	7.19±0.36	2.03±0.17	7.68±0.46	8.14±0.60

Values are Mean±SE, No sign represents non-significant difference between the values.

Orientation of burrow openings (%)

Fresh burrows (1 to 2 days old) were surveyed at different growing stages of rice and wheat crops and desirable results were obtained. It was observed that as the weather changes, there is change in the direction of surface openings of the *B. bengalensis* burrows. The mean per cent orientation of burrows (%) in rice crop during tillering stage was N-E=9.82 ±1.58, S-E=18.4 ±2.81, S-W=30.28 ±2.55 and N-W=41.5 ±2.05, during panicle initiation stage, N-E=11.68 ±2.05, S-E=13.5 ±1.89, S-W=36.90 ±2.48 and N-W=37.92 ±1.58, during dough stage, N-E=35.10 ±2.18, S-E=20.0 ±1.28, S-W=22.5 ±2.18 and N-W=22.4 ±2.58, during pre-harvesting stage, N-E=33.7 ±1.18, S-E=23.4 ±2.98, S-W=22.75 ±1.48 and N-W=20.2 ±2.08 and during spring season N-E=36.51 ±1.20, S-E=21.16 ±2.50, S-W=18.16 ±2.78 and N-W=24.18 ±3.87 (Fig. 1). During tillering stage, the maximum mean orientation was towards N-W (41.5 ±2.05) followed by S-W (30.28 ±2.55) and minimum towards N-E (9.82 ±1.58) while in panicle initiation stage the maximum mean orientation was towards N-W (37.92 ±1.58) followed by S-W (36.90 ±2.48) and minimum towards N-E (11.68 ±2.05), in dough stage the maximum mean orientation was towards N-E (35.10 ±2.18) followed by S-W (22.5 ±2.18) and minimum towards S-E and N-W, in pre-harvesting stage maximum mean orientation was towards N-E (33.7

±1.18) followed by S-E (23.4 ±2.98) and minimum towards N-W (20.2 ±2.08) and in lean period the maximum mean orientation was towards N-E (36.51 ±2.98) followed by N-W (24.18 ±3.87) while minimum towards S-W (18.16 ±2.78) in rice crop.

During different stages of wheat crop, the mean per cent orientation of burrow (%) during tillering stage recorded was N-E=32.58 ±3.05, S-E=36.42 ±2.58, S-W=13.55 ±2.95 and N-W=17.45 ±3.05, during panicle initiation, N-E=30.58 ±3.58, S-E=33.81 ±2.59, S-W=18.58 ±3.15 and N-W=17.03 ±4.68, during dough stage, N-E=31.78 ±2.48, S-E=29.52 ±3.05, S-W=17.22±4.22 and N-W=21.48 ±2.75, during pre-harvesting stage, N-E=23.05 ±3.58, S-E=13.66 ±4.06, S-W=36.78 ±2.82 and N-W=26.51±3.81 and during lean period, N-E=17.15±1.59, S-E=20.65 ±2.51, S-W=32.15 ±3.58 and N- W=30.05 ±4.05 (Fig. 2).

During tillering stage, the maximum mean orientation was towards S-E (36.42 ±2.58) followed by N-E (32.58 ±3.05) and minimum towards S-W (13.55 ±2.95) while in panicle initiation stage the maximum mean orientation was towards S-E (33.81 ±2.59) followed by N-E (30.58 ±3.58) and minimum towards N-W (17.03±4.68), in dough stage maximum mean orientation was towards N-E (31.78 ±2.48) followed by S-E (29.52 ±3.05) and minimum towards S-W and N-W, in pre-harvesting stage maximum mean orientation was towards S-W (36.78 ±2.82) followed by N-W (26.51 ±3.81) and minimum towards S-E (13.66 ±4.06) and during lean period, the maximum mean orientation was towards S-W (32.15 ±3.58) followed by N-W (30.05 ±4.05) while minimum towards N-E (17.15 ±1.59) in wheat crop. In support to our results, orientation of burrow openings was found to be not randomly distributed and seems to be related to environmental factors such as sunlight and prevalent direction of winds (Kay and Whitford, 1978; Best, 1982; Baumgardner, 1991; Kucheruk, 1983).

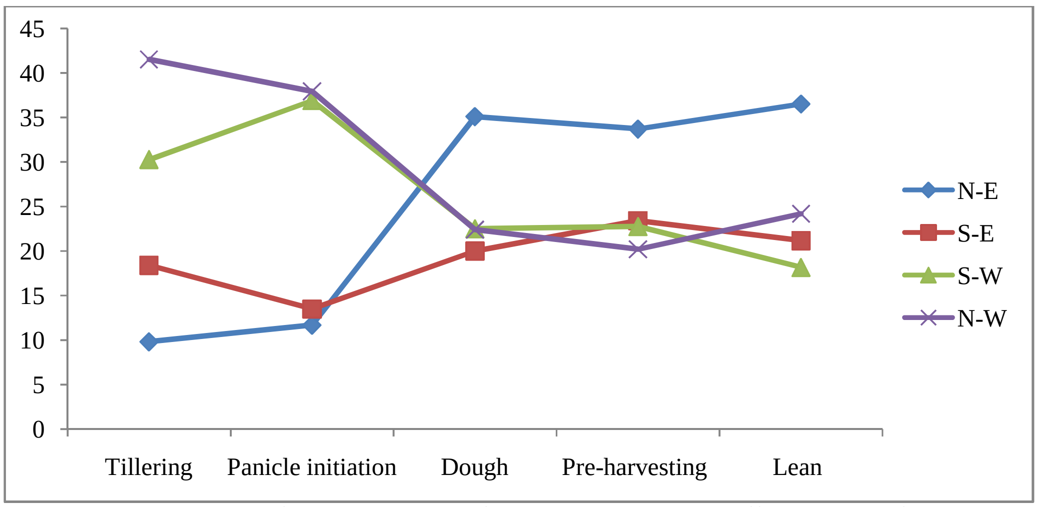

FIGURE 1: Orientation of burrow openings of *B. bengalensis*, during different stages of paddy crop

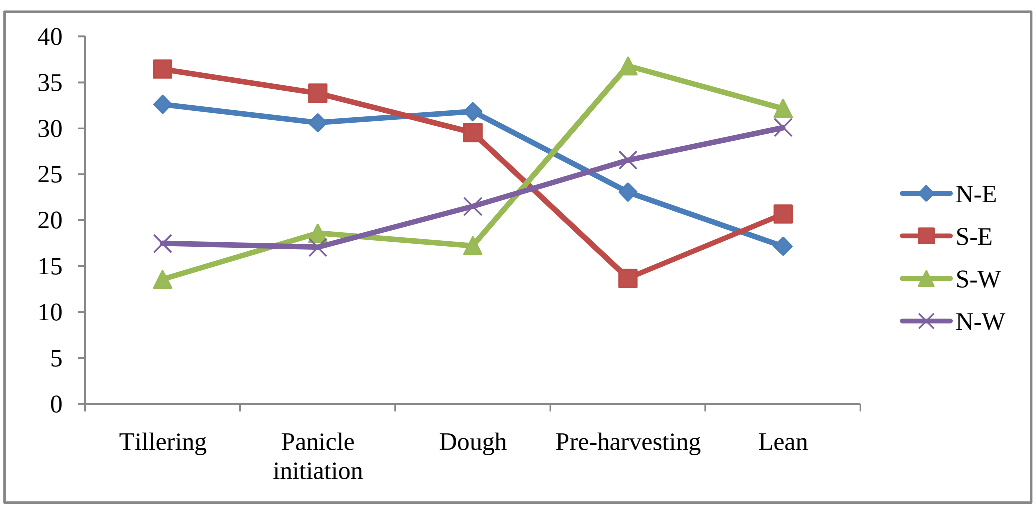

FIGURE 2: Orientation of burrow openings of *B. bengalensis*, during different stages of wheat crop

Present study suggests that mean number of open ends, length of open ends and breadth of open ends of *B. bandicota* burrows do not differ from each other during different growth stages (tillering, panicle initiation, dough, pre-harvesting and lean period) of paddy and wheat crops and little variability was recorded among them. Interestingly, during different growth stages of paddy and wheat crops the rat *B. bandicota* changes the orientation of its burrows. In paddy crop, during tillering and panicle initiation stages (summer months) when there is high atmospheric temperature the orientation of burrows was towards North-West/South-West directions whereas during pre-harvesting and lean period stages when atmospheric temperature decreases, the orientation of burrows changes towards North-East direction. Similarly, in wheat crop, during tillering, panicle initiation and dough stages (winter months) when atmospheric temperature is low the orientation of burrows remain towards North-East/South-East whereas during pre-harvesting and lean period (summer months) it moves its orientation towards North-West/South-West directions due to rise in atmospheric temperature. This is due to the reason that during winter season the sun moves obliquely to the East-West directions, whereas in summer months the sun moves at ~90 degrees of East-West directions. So, by changing its orientation the burrows get sufficient sunlight during winter season and minimum during summer months to keep their internal burrow environment optimum for the survival of them and their young ones.

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