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Field Establishment and Foraging activity of *Bombus haemorrhoidalis* Smith

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ABSTRACT: Bumble bees are found to be effective pollinators as compared to the honey bees due to their buzz pollination behaviour as well as their ability to work for longer period of time. Keeping this in view, the present study was conducted to evaluate the foraging behaviour of *B. hameorrhoidalis* Smith under shade net house conditions and reported that maximum incoming (1.61) and outgoing activity (1.57) was observed during 0900-1000 hours. Moreover, the foraging activity also varied among different months of the year and recorded maximum incoming (2.10) and outgoing (2.10) activity during October month, while minimum during May.

Keyboards: Bumble bees, Pollinators, month, hours and activity.

INTRODUCTION

One of the major factors responsible for good quality and productivity of agricultural and horticultural crop is pollination for which, a number of insect pollinators *viz.,* honeybees, bumble bees, and solitary bees etc. helps in transferring pollens from one flower to another flower (McGregor, 1976). Out of a number of insect pollinators, bumble bees are the superstar of pollinators also known as teddy bear of insects. Bumble bees are most diverse group of pollinators in temperate regions and only 34 species out of the 250 species are found in tropics (Williams, 1998). The bumble bees are more efficient and reliable pollinators especially under protected conditions (Mackenzie, 2009), helping in high quality fruit production due to their high speed of pollination, buzz behaviour and efficiency at low temperature and sunlight (Paydas *et al.,* 2000). Use of insect pollination within greenhouse, especially bumble bees gave cost effective and attractive substitute of manual pollination (Velthuis and van Doorn 2006). An external and internal environmental condition along with foraging efficiency of bumble bees has an impact on required pollination of various crops. Foraging activity of bumble bees was important to serve as successful pollinators under these greenhouse conditions as compared to honey bees (Wolf and Moritz, 2008).Bumble bees can fly and pollinate flowers under cool conditions due to their thermoregulatory abilities (Corbet, 1995). They have better adaptive qualities for pollen and nectar collection near their hives and preference increases in small patches with flower abundance (Sowig, 1989). Abak *et al.* (2000) conducted a pollination experiment on bumble bees and observed that their activity increased between 9:00 to 11:00 am, the peak activity was observed between 10:00 to 11:00 am then decreased gradually and they stopped between 13:00 to 14:00 pm. They started foraging again in afternoon between 15:00 to 18:00 pm. Spivak (2000) also reported that bumble bees are effective foragers than honey bees because of their ability of buzz pollination.

Bumble bee hang onto flower and buzz it by vibrating their muscles that control flight. Bumble bees are the most efficient pollinators not only for wild plants, but also for pollination services used in outdoor and greenhouse orchards and horticulture. Foraging behaviour studies conducted on four species of bumble bee in England revealed that the high foraging activity occurs at 1000-1100 h. The pollen collection was also high during noon hours (Free, 1955). Hines *et al.* (2007) also studied foraging activity of *B. pullatus* and observed foraging range within 2.6-9.5 bees per minute across different time period, with the highest activity in the morning (07:00-10:00 am). Pollen collection was also highest from 07:00 -10:00 am and declined throughout rest of the day, while the foraging rate for nectar foragers remained relatively constant. The percent of incoming foragers that carried pollen in a sample period ranged from 2.4 to 44.2 per cent. There was no significant relationship between ambient temperature and number of all foragers. Foraging trips lasted from 30-70.5 minutes, with a mean of 51 and a median of 49.5 minutes. Kashyap (2007) recorded maximum bumble bee activity during 0600-0700 and 1600-1700 hours while, minimum during 1200-1300 hours. Stelzer and Chittka (2010) reported that bumble bee activity was restricted between 08:00 to 23:00 hours. Thakur (2018) observed the peak incoming and outgoing activity during 1700-1800h (4.63 bumble

bees/five min) and 0900-1000h (4.73 bumble bees/five min), respectively and minimum during 1300-1400h. Nayak (2018) also reported maximum activity during 1600-1700h while minimum during 1300-1400h.

Keeping in view all these points, present studies were undertaken to investigate the foraging activity of *Bombus haemorrhoidalis* Smith kept under shade net house conditions.

MATERIALS AND METHODS

The experiment was conducted in experimental farm, Bagaur under the Department of Entomology, College of Horticulture, Dr YS Parmar University of Horticulture and Forestry, Nauni-Solan (H.P.) in the first week of June, 2018. Foraging *B. haemorrhoidalis* queens were collected from field during early spring and then brought to laboratory for their in-vitro rearing. These captured queens were kept in wooden domiciles under controlled conditions (25 ± 2ºC temperature and 60 - 65 per cent relative humidity). Proper cleaning and daily feeding of 50 per cent sugar syrup and freshly collected pollens were given to colonies. After the production of first brood *i.e*., at the end of May, 2018these colonies were transferred to field under shade net hose conditions for their establishment and acclimatization. Under field conditions, small wooden boxes consisting of colonies were kept in Langstroth hive, which was kept on iron stand at the centre of the cage. Plastic pipe was also fitted at the entrance for easy movement of bumble bee foragers. The colonies were provided proper feed for first 2-3 days by closing their entrance. After 2-3 days, data on incoming and outgoing bumble bee forgers was noted down. Data recorded on various parameters were analysed statistically with no transformation in R.B.D. design by Gomez and Gomez (1986).

RESULTS AND DISCUSSIONS

Incoming activity of *B. haemorrhoidalis* foragers. Data recorded on incoming activity of bumble bees under shade net house conditions is presented in Table 1. The data showed that bumble bee activity was significantly low during initial months of shifting and development of colonies being 0.37, 0.55, 0.57 bumble bees/five min, respectively in May, June and July. The average activity of bumble bees in the field peaked during October (2.10 bumble bees) followed by September (1.76 bumble bees) which was at par with the activity observed during November (1.59 bumble bees) (Fig. 1).

Table 1: Incoming activity of *B. haemorrhoidalis* at hive entrance under shade net house conditions during 2018.

Months	Incoming bumble bees/ five min					
	0600-0700	0900-1000	1200-1300	1500-1600	1800-1900	Mean
May	0.25	0.49	0.24	0.27	0.62	**0.37**
June	0.52	0.81	0.40	0.35	0.66	**0.55**
July	0.54	0.75	0.49	0.59	0.48	**0.57**
August	1.06	1.71	0.85	0.80	1.03	**1.09**
September	1.75	2.39	1.36	1.55	1.77	**1.76**
October	2.18	2.74	1.76	1.42	2.39	**2.10**
November	1.83	2.33	1.00	1.00	1.78	**1.59**
December	0.97	1.67	0.67	0.56	1.42	**1.06**
Mean	**1.14**	**1.61**	**0.85**	**0.82**	**1.27**	
CD $_{(0.05)}$	Month Day hours Month × Day hours					

The incoming activity of *B. haemorrhoidalis* varied greatly in the months of May to December during different day length. Irrespective of months, the *B. haemorrhoidalis* activity was maximum (1.61 bumble bees) during 0900-1000h followed by activity observed during 1800-1900h (1.27 bumble bees) which was statistically at par with the activity observed during 0600-0700h (1.14 bumble bees). Significantly low incoming activity was observed during 1500-1600h (0.82 bumble bees) and 1200-1300h (0.85 bumble bees) which was statistically at par.

Outgoing activity of *B. haemorrhoidalis* foragers. Data recorded on outgoing activity of *B. haemorrhoidalis* under open field conditions presented in Table 2 revealed that the *B. haemorrhoidalis* activity was significantly low in the months of May, June, July and December being 0.49, 0.58, 0.65 and 0.60 bumble bees/five min, which were statistically same. However, the average outgoing activity of *B. haemorrhoidalis* peaked during the month of October (2.10 bumble bees) (Fig. 1).

The outgoing activity of *B. haemorrhoidalis* varied greatly in the months of May to December during different day hours. It varied from 0.11 bumble bees (in December during 1500-1600h) to 3.32 bumble bees (in October during 0900-1000h). Irrespective of months, the *B. haemorrhoidalis* activity was maximum (1.57 bumble bees) during 0900-1000h. Significantly low average outgoing activity (0.62 bumble bees) was observed during 1500-1600h.

Table 2: Outgoing activity of *B. haemorrhoidalis* at hive entrance under open field conditions during 2018.

Months	Outgoing bumble bees per five min					
	0600-0700	0900-1000	1200-1300	1500-1600	1800-1900	Mean
May	0.38	0.68	0.40	0.30	0.71	**0.50**
June	0.54	0.86	0.45	0.33	0.71	**0.58**
July	0.55	0.89	0.58	0.49	0.75	**0.65**
August	1.28	1.56	0.98	0.72	1.26	**1.16**
September	1.94	2.79	1.27	1.19	1.68	**1.77**
October	2.11	3.32	1.33	1.09	2.66	**2.10**
November	2.11	1.56	1.56	0.78	1.56	**1.51**
December	0.89	0.89	0.33	0.11	0.78	**0.60**
Mean	**1.22**	**1.57**	**0.86**	**0.62**	**1.26**	
CD $_{(0.05)}$	Month Day hours Month × Day hours					

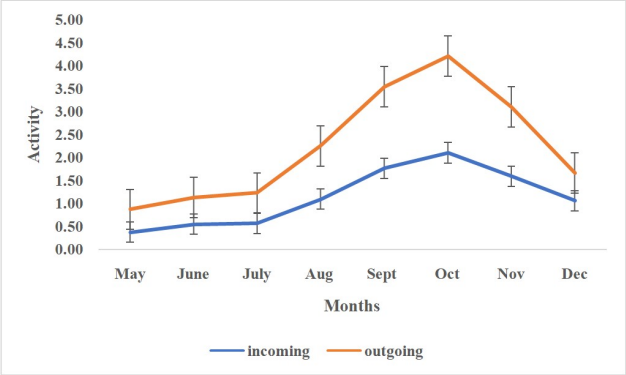

Fig. 1. Incoming and Outgoing activity of *B. haemorrhoidalis* Smith under shade net house conditions.

The results of the present investigations with respect to foraging activity of *B. haemorrhoidalis* under shade net house conditions are in line with the findings of earlier workers (Chauhan *et al.,* 2013; 2014; Thakur, 2018; Nayak, 2018). Chauhan *et al.* (2013; 2014) recorded maximum incoming and outgoing activity of *B. haemorrhoidalis* at hive entrance during 0900-1100h and 1600-1800h and minimum during 1300-1500h.Later, Thakur (2018) observed the peak incoming and outgoing activity during September and October months which was statistically at par. However, the minimum activity was observed in May. According to day hours, the peak *B. haemorrhoidalis* incoming and outgoing activity was observed during 1700-1800h (4.63 bumble bees/five min) and 0900-1000h (4.73 bumble bees/five min), respectively. On the other hand, the minimum activity was reported during 1300-1400h. Nayak (2018) also reported maximum activity during 1600-1700h while minimum during 1300-1400h.

CONCLUSION

Bumble bees have long been recognized as efficient pollinators as compared to honey bees under protected conditions because of their potential of buzz pollination and long working hours. From the present study, it is clear that maximum incoming and outgoing activity of *B. haemorrhoidalis* Smith was observed during the month of October, at 0900-1000 hours.

FUTURE SCOPE

In protected farming, bumble bee use boosted the qualitative and quantitative characteristics of agricultural crops, which also helped to support the world food supply chain. Bumble bees are capable of foraging even under low temperature conditions as well as their ability to buzz pollinate, make more effective and efficient pollinator for commercial crops.

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Conflict of interest. None.

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