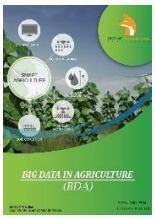
ZIBELINE INTERNATIONAL™ PUBLISHING

ISSN: 2682-7786 (Online)
CODEN: BDAIDR

Big Data in Agriculture (BDA)

DOI: http://doi.org/10.26480/bda.02.2022.54.57



RESEARCH ARTICLE

STUDY OF FORAGING BEHAVIOR OF *APIS CERANA* DURING SUMMER IN SUNDARBAZAR, LAMJUNG, NEPAL

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ARTICLE DETAILS

Article History:

Received 25 June2022
Accepted 27 July 2022
Available online 19 August 2022

ABSTRACT

Apis cerana forages for around 10 hours/day, starting early in the morning and ending late at night. A study was undertaken in an apiary in Sundarbazar, from March-May 2021 to measure the foraging activity. At 8a.m, 11a.m, 1p.m, and 4p.m, number of bees leaving and entering hives with and without pollen for a minute in four different beehives were recorded. According to the observation, there was a significant difference in bee behavior (P0.01) between the time treatments. Pollen-carrying bees entered the hive in greater numbers at 1 p.m, 11 a.m, which was statistically equal to 4 p.m, and least at 8 a.m. Similarly, at 1 p.m., the number of bee leaving and entering the hive without pollen was much greater, followed by 11 a.m. which was statistically equivalent to 4 p.m, and 8 a.m, which had the least. The highest mean value of bee movement was found in May.

KEYWORDS

Beehives, Forage, Pollen, Honey.

1. INTRODUCTION

A honey bee is a eusocial flying insect within the genus Apis of the bee clade, all native to Eurasia. They are known for their construction of perennial colonial nests from wax, the large size of their colonies, and surplus production and storage of honey, distinguishing their hives as a prized foraging target of many animals, including honey badgers, bears, and human hunter-gatherers. Honeybees are the most significant social insect and because of their honey production and pollination activities, they are also recognized as economically valuable insects (Lawal and Banjo, 2010). Honey, bee wax, royal jelly, pollen, propolis, and bee venom are all produced by honeybees. They are economically significant because they generate honey and bee wax in addition to serving as major pollinators for a variety of agricultural and horticultural crops. Honeybee pollination increases agricultural productivity, enhances seed and fruit quality, and allows heterosis to be taken advantage of. Honeybees come in a variety of species but the four most common are *Apis florae, Apis dorsata, Apis cerana*, and *Apis mellifera*. Bees are foraging generalists who may forage from a variety of floral sources.

Apis cerana occurs across the south and southeastern Asia up to Russia in the north. Its natural distribution extends to Japan and stretches as far west as Afghanistan. Similar to *Apis mellifera,* there are many subspecies of *Apis cerana*. These subspecies tolerate a wide range of temperatures from cold, temperate, to tropical ecosystems. *Apis cerana* is an important bee to beekeepers in Asia, especially in poor communities. There are initiatives to teach beekeeping as a long-term employment opportunity in these communities. *Apis cerana* is kept by beekeepers in diverse mountainous areas that can be difficult to reach. Yet *Apis cerana* can thrive in these areas as they are adapted for the environment. There can be up to 60,000 sterile female worker bees, several hundred male drones, and one queen in a single colony. Drones fertilize the queen, the queen lays the eggs (about 1,500 each day) and worker bees feed and care for the brood. Worker bees also clean the hive, forage for food, store it and look after the larvae and queen (Bishop, 2005). Adult bees in the colony forage 25% of the time and store food 20% of the time (Dreller et al., 1999). (Seeley, 1989).

Foraging is the process of the acquisition of food by the bees from the flowering plants within their flight range in the form of nectar or pollen. Foraging is the act of looking for food in the wild. It is the collection of mechanisms by which organisms obtain energy and nutrients, whether the food is consumed immediately (feeding), saved for later consumption (hoarding), or donated to others (provisioning).

Benefits mediated by foragers, according to including the deposition of nitrogen (in feces) on plants during visits (Mishra et al., 2013). The average monthly production rate of bee frass by a 5000-bee colony was determined to be between 2.27 and 2.69 g nitrogen. Forager bees can also spread bio-control agents like *Erwinia herbicola* Eh252 of fire blight onto apple blooms and nashi flowers (Cornish et al. 1998). Honey bee foraging behavior is influenced by some factors. Nectar foragers collect information about the hive's nectar supplies from their nestmates (Dreller et al., 1999). They use the availability of food storers to determine the nutritional health of the hive and then change the quality of nectar they bring back to meet the demands of the colony (Seeley, 1989). Pollen foragers, on the other hand, calculate pollen demands in the hive by assessing the amount of brood pheromone (a progeny indicator), the amount of pollen already stored in the hive, the space available for further pollen stores, and the the accessible resources in the environment (Pankiw et al., 1998). *Apis cerana,* like *Apis mellifera,* builds many parallel combs in dark cavities and cervices with a constant spacing between them called 'bee space,' as proven by Langstroth (1853). Honey is stored in the upper portion of the comb, followed by pollen, and brood is reared in the center, like in other Apis species. However, because of their proclivity to flee and move, this possess a challenge (Akratanakul, 1976; Otis, 1990; Smith et al.,2000). They also

Quick Response Code	Access this article online	
	Website: www.bigdatainagriculture.com.my	DOI: 10.26480/bda.02.2022.54.57

Cite The Article: Prabin. K. Poudel, Binaya Baral, Richa Shah, Rajkumar K.C, N.B Singh (2022). Study of Foraging Behavior of *Apis Cerana* During Summer in Sundarbazar, Lamjung, Nepal *Big Data in Agriculture, 4(2): 54-57.*

had high swarming rates, and poor honey storage and were more susceptible to Thai sacbrood sickness, according to (Rutner, 1988; Wongsiri et al., 1996a).

The population of A. cerana in high altitude regions is declining due to a variety of factors including widespread inclusion and promotion of A. mellifera species by the public and private sectors through development intrusion, changes in their habitat and biodiversity, non-judicious pesticide use, disease and parasite attacks and so on (ICIMOD, 2001). When two or more bee species compete for the same pollen and nectar supplies, it has been observed that the presence of A. mellifera dislocated and reduced the number of A. cerana individuals in the area. A. mellifera also carries more pollen, is less aggressive, and produces more honey than A. cerana, the native bee. For beekeepers that want to lose their colonies as little as possible, it is less prone to swarming (FAO, 1986). To learn more about bee foraging activities, more research is needed. The study was carried out to determine the exact foraging pattern of bees during the summer season. With these, we set the objective to study the experience of the farmer with the foraging behavior of A. cerana I summer.

2. Research Methodology

An experiment was conducted in the apiary of Sundarbazar municipality of Lamjung district, Nepal from March 4, 2021, to May 28, 2021, to know the foraging behavior of honeybees under natural conditions in single factor Randomized Complete Block Design (RCBD). At different time intervals on a weekday, four-time treatments, namely 8:00 am as T1, 11:00 am as T2, 1:00 pm as T3, and 4:00 pm as T4 were chosen as treatments (T). The number of *Apis cerana* bees entering the hive each minute with and without pollen load, as well as the number of bees leaving the hive at the same time, were all recorded. These measurements were obtained four times during the day, at 8:00 a.m., 11:00 a.m., 1:00 p.m., and 4:00 p.m., at various stages of flowering. The acquired data was then collated, tabulated, and transformed as needed before being subjected to analysis of variance and significance testing at the 5% level. Word processing was done with Microsoft Word 2013, data entry, tables, and graphs were done with Excel 2013 and statistical analysis was done with SPSS and Gen stat. Duncan was used to separating the differences between treatments at the 0.05 probability level.

April (13.5) followed by May (8.8), and lowest in March (3.68). In May, the number of bees exiting the hives was found to be highest at 1:00 pm (58.43), followed by 11:00 am (29.18) which was statistically equal to 8:00 am (20.37) and the lowest mean value was recorded at 4:00 pm (8.81). Similarly, the number of bees departing the hives was found to be higher around 1:00 pm (44.18) than at 11:00 am (32.31) for April. During March, the lowest mean value was 3.68 at 4:00 p.m and the highest at 1:00 pm (37.87). The result revealed that there is the minimum movement of bees during 8:00 am and the maximum bee leaving the hives in mid-day time i.e. 1:00 pm in all 3 months. Similar findings were stated by in Manitoba, Canada. It's also found that the species have peak activity in the afternoon between 1300 to 1500 h and decline steadily (Pernal and Currie, 2010; Joshi and Joshi 2010). Was also found the bees to be least active in the morning hours (Pudasaini and Thapa, 2014). Either also observed peak foraging activity of A. cerana between 1300-1400 hrs on mustard bloom (Mishra et al. 1988).

3. Results and Discussion

3.1 Bees Movement Leaving The Hives

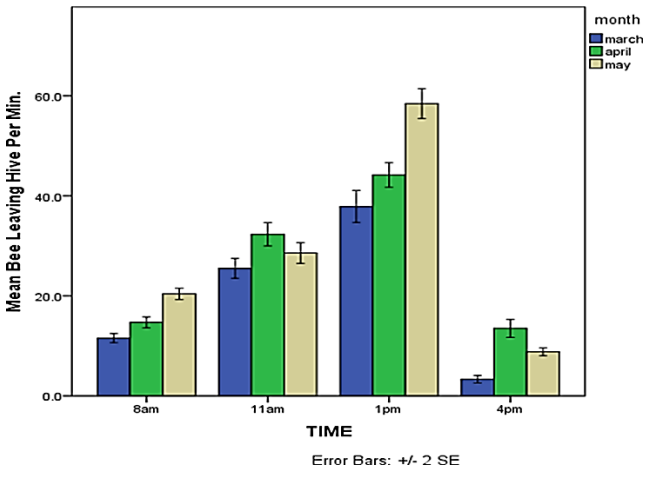

Figure 1: Number of bees leaving the hives in different months

From the analysis, there was a significant difference (P<0.01) in the number of bees departing the hives at different times during the month. The highest mean value of bees departing the hives at 8 a.m. was found in May, followed by 14.68 in April and the lowest mean value was recorded in March. Similarly, the highest mean value at 11 a.m. was discovered in April, at 32.31, and was followed by May, at 29.18. The highest mean value of bees leaving the hives at the peak of foraging activity, 1 pm, was 58.43 in May, followed by 44.18 in April. At 4 p.m., pollen movement was highest in April (13.5) followed by May (8.8), and lowest in March (3.68). In May, the number of bees exiting the hives was found to be highest at 1:00 pm (58.43), followed by 11:00 am (29.18) which was statistically equal to 8:00 am (20.37) and the lowest mean value was recorded at 4:00 pm (8.81). Similarly, the number of bees departing the hives was found to be higher around 1:00 pm (44.18) than at 11:00 am (32.31) for April. During March, the lowest mean value was 3.68 at 4:00 p.m and the highest at 1:00 pm (37.87). The result revealed that there is the minimum movement of bees during 8:00 am and the maximum bee leaving the hives in mid-day time i.e. 1:00 pm in all 3 months. Similar findings were stated by in Manitoba, Canada(Pernal and Currie, 2010). also found that the species have peak activity in the afternoon between 1300 to 1500 h and decline steadily(Joshi and Joshi, 2010). It also found the bees to be least active in the morning hours (Pudasaini and Thapa , 2014). Either also observed peak foraging activity of A. cerana between 1300-1400 hrs on mustard bloom (Mishra et al., 1988).

3.2 Bees Entering The Hives With Pollen

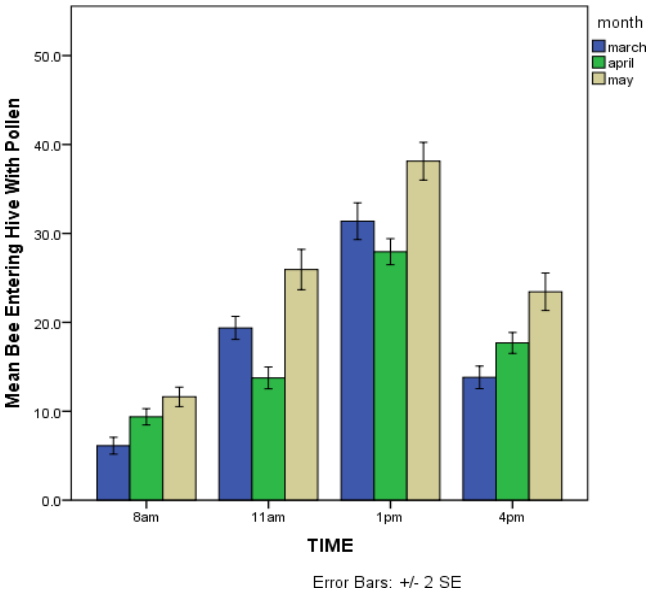

Figure 2: Number of bees entering the hives with pollen in different months

From the analysis, there was a significant difference (P>0.01) in the movement of pollen-carrying bees at different times during different months. In May, the mean value of bee movement with pollen at 8 a.m. was at its highest. Similarly, the highest mean value at 11 a.m. was recorded in May, at 25.93, and was followed by March, at 19.37. The highest mean value of bee movement with pollen was 38.12 in May, followed by March during the peak period of foraging activity of bees, i.e., 1 pm. At 4 p.m., pollen movement was highest in May (23.43), followed by April (19.18), and lowest in March (13.81). In May, the number of pollen-carrying bees was found to be highest at 1:00 p.m., with 38.12 followed by 11:00 a.m. (25.93) which was statistically equal to 4:00 p.m. (23.43) and 8:00 a.m. (11.625). Similarly, throughout April, the number of pollen-carrying bees was found to be highest at 1:00 pm (27.93) followed by 4:00 pm (17.31) which was statistically equal to 11:00 am (13.86) and lowest at 8:00 am (9.37). Similarly, during March, the number of pollen-carrying bees was found to be higher at 1:00 pm (31.37), followed by 11:00 am (19.35) which was statistically comparable to 4:00 pm (16.9). At 8:00 a.m., the number of bees entering the hives carrying pollen was at its lowest (6.125). According to the foraging activity of A. cerana was significantly and positively correlated with temperature which corresponds to my findings (Abrol and Bhat, 1987). It was also discovered that the average hour of foraging was ten hours with the highest period of foraging occurring between 11:30 and 1:00 pm in the middle of the day, followed by 2:30 pm and 4:00 pm. The findings are consistent with those of (Maity et al., 2014).

3.3 Bees Entering The Hives Without Pollen

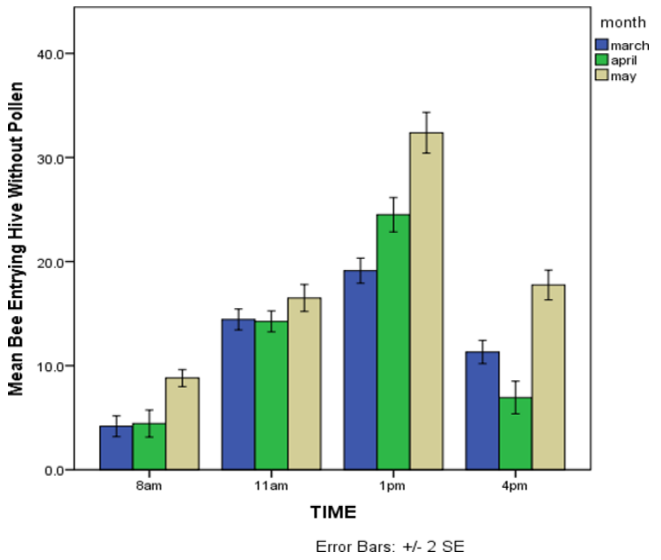

Figure 3: Number of bees entering the hives with pollen in different months

From the analysis, there was a significant difference (P>0.01) in the movement of bees without pollen at different times during different months. In May, the mean value of bee movement without pollen at 8 a.m. was at its highest. Similarly, the highest mean value at 11 a.m. was recorded in May at 16.5 and was followed by March at 14.43. The highest mean value of bee movement without pollen was 32.37 in May, followed by April, during the peak period of foraging activity of bees, i.e. 1 pm. At 4 p.m., pollen movement was highest in May (17.37), followed by March (11.31), and lowest in April (6.93). During May, the number of bees moving without pollen was found to be highest at 1:00 pm (32.37), followed by 4:00 pm (17.75) which was statistically equal to 11:00 am (16.5), and the lowest mean value was seen at 8:00 am (8.81). Similarly, during April, the number of bees moving without pollen was observed to be higher around 1:00 pm (24.5) than at 11:00 am (13.5). At 4:00 p.m., the minimum mean value was 6.93, which was statistically equivalent to 8:00 a.m. (4.43). Similarly, during March, the number of bees moving without pollen was found to be higher at 1:00 pm (19.125) followed by 11:00 am (14.435) which was statistically equal to 4:00 pm (12.31). During March, the number of bees entering the hives with pollen was at its lowest around 8:00 a.m. (4.18). Similar findings were reported by (Dhaliwal and Bhalla, 1980). He observed peak periods of *A. cerana* as 1200 hrs-1400 hrs. On cauliflower in Solan, also reported that foraging behavior was more or less similar in summer (monsoon) and winter with peak activity of outgoing foragers, pollen, and nectar foragers during 1100-1300 (H.P.Holi and Viraktamath, 1997).

4. Conclusion

Studies on the foraging behavior of *A. cerana* indicated that pollen and nectar were collected throughout the year irrespective of floral and climatic conditions and thus exhibited a regular foraging cycle. Temperature plays a major factor in the foraging behavior of bees. Commencing of bee mostly started earlier in a warmer month but in the cold month, the commencing time started lately. In our study, the most feasible time or peak foraging period of honey bees was observed during May followed by April and the least was observed during March. In all three months, maximum bee movement was observed at 1:00 pm and least movement at 8:00 am. The highest percentage of pollen-carrying activity was recorded at the time of 1:00 p.m. The lowest pollen gathering activity was recorded at the time of 8:00 a.m. The forage available at that time was the flower of various plants. The dearth period was March when the minimum activity of bees was observed due to low temperature and poor availability of forage than the other 3 months. The overall, study suggests to the local farmer that the warmer season was the most suitable period for apiculture and similar case were felt by a local farmers with their experience. The bee movement was maximum in those hives directly facing the sun exposure and was least in the hives placed in the shaded portion. During the dearth period, thermal insulation of the hives should be done to increase and maintain the temperature within the hives. Similarly, artificial supplementation of food during the shortage of forage should be done. Flowers should also be planted for improving forage availability during the dearth period.

Limitations of the Research

The research was carried out in only one season and at only one location. Therefore, this experiment should be further verified by conducting similar research at different locations.

The increase in the number of replications could also be done in this research but wasn't carried out due to time constraints.

Suggestions for Further Research

The present investigations should be repeated to confirm the findings. Similar research can be done with more replications and more treatments in the future. The same research could be done at different locations and we can delineate the differences.

Acknowledgements

I am very grateful to my main academic supervisor, Mr. Narendra Bahadur Singh, Assistant Professor, Department of Horticulture and Plant Protection, Institute of Agriculture and Animal Science and for the excellent academic and moral support, he offered to me on the entire document from Proposal write up to the submission of the final thesis write up. I also extend my thanks to my friend Mr. Binaya Baral and my senior Richa Shah for their constructive comments and suggestions throughout the research period. Without their encouragement, assistance, and support, this study would not have been accomplish.

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