RESEARCH ARTICLE

FORAGING BEHAVIOR OF EUROPEAN HONEY BEE, *APIS MELLIFERA* (HYMENOPTERA-APIDAE) IN LITCHI FLOWERS IN SURGUJA DISTRICT OF CHHATTISGARH, INDIA

G.P. Painkra* and Sachin Kumar Jaiswal

Indira Gandhi Krishi Vishwavidyalaya, Raipur
All India Coordinated Research Project on Honey Bees and Pollinators,
Department of Entomology, Raj Mohini Devi College of Agriculture and Research Station,
Ambikapur-497001(Chhattisgarh) India.
Email: gppainkrarmd@gmail.com

Received-30.11.2021, Revised-05.01.2022, Accepted-25.01.2022

Abstract: A study was undertaken at Raj Mohini Devi College of Agriculture and Research station, Ambikapur (Chhattisgarh) substation of Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) India. The foraging behavior of European honey bee, *Apis mellifera* was observed in Litchi (orchard) flowers during 27 February 2021- 02April 2021. The maximum foraging activity of honey bee was observed third week of March 2021 (32.76 bees/5min/plant) followed by second week of March 2021 (25.38 bees/5min/plant) and fourth week of March 2021 (122.45 bees/5min/plant) however the lowest population was recorded during first week of April 2021 (6.61 bees/5min/plant). Similarly during the different hours of the day the maximum population of honey bees were recorded at 10.00-11.00 AM (20.63 bees/5min/plant) followed by at 11.00AM-12.00PM (19.72 bees/5min/plant) and at 9.00-10.00AM (19.27 bees/5min/plant). However the lowest population was recorded at 3.00-4.00PM (12.08 bees/5min/plant).

Keywords: European honey bee, Foraging behavior, Litchi flowers, Weather parameters

INTRODUCTION

Honeybee species *Apis dorsata* F; *A. mellifera* L; *A. cerana* F. and *A. florea* F. were the most important and efficient pollinators of litchi flowers (*Litchi chinensis* Sonn.). Pollination is an important step of seeds production in all spermatophytes (seed plants), resulting in the production of genetically diverse offspring (Dafni et al., 2005). The beneficial value of pollination has become a crucial step in agriculture/horticulture production. Among the various pollinating agents insects are the basic one and generally considered best to obtain a good and profitable production (Badiyala and Garg, 1990; Menzel and Waite, 2005). Pollination is a vital step in a litchi production system, as both fruit yield and quality are dependent on the extent of cross pollination. The extent of cross-pollination and enhanced fruit setting in litchi is significantly carried out by honey bees in the region. According to various sources, it is estimated that one third of the total human food supply relies on insect pollination (Said et al., 2015). Litchi (*Litchi chinensis* S.) belongs to family Sapindaceae, is an important subtropical evergreen commercial fruit crop extensively grown in Indian subcontinents. Flowers are usually produced during later winter or early spring in season. Three types of flowers are found in litchi, which open in succession on the same panicle and the flowers vary in sexual development, length and functionality of the stamens and development and functionality of the pistil (Mustard et al., 1953). Type I flowers (Male 1 = M1) are functionally male, lack ovules and having 6-8 stamens which produce much pollen. Type II flowers are hermaphrodite but function as female (F) with well-developed pistil and stigma, having 5-8 stamens which do not dehisce. Type III flowers are male (Male 2 = M2), having 6- 8 stamens which produce plentiful viable pollen. Anthesis of flowers occurs in overlapping cycles, normally of 10 days for Type I, 7-10 days for Type II and 7-10 days for Type III (Mustard et al., 1953; Stern and Gazit, 1996) which also varies with the weather and cultivar. In spite of presence of functional male and female flowers on a single tree, at the same time, self-pollination does not occur in litchi, as the hermaphrodite flowers are generally recognized as self-sterile and therefore, insect-pollination is necessary for the proper fruit set (Pandey and Yadava, 1970; Phadke and Naim, 1974). Presence of plentiful amount of nectar in the self-sterile flowers, attracts insects like honey bees, flies, ants and wasp leading to entomophilic cross pollination. Among several insect visitors honey bees have been reported as the most beneficial insects on litchi (Groff, 1943). Pollination of entomophilous crops by honey bees is regarded as one of the effective and cheapest method for improving the yield and quality of the crops (King et al., 1989)

MATERIALS AND METHODS

Experimental Location The experiment was conducted in litchi orchard of Raj Mohini Devi College of Agriculture and Research station at Ambikapur, Surguja district of Chhattisgarh during 2021. This station is situated at an attitude 230 8’33.7596”N and a longitude 830 10’44.0184”E. The

*Corresponding Author

foraging behavior of European honey bee, *Apis mellifera* was observed in Litchi flowers during 27 February 2021- 02April 2021. The population of above honey bee sp. was recorded at seven days intervals per 5min/plant. 10 plants were randomly selected and count the number of honey bees visiting by visually observation starting from 8.00AM to 4.00PM with one hour intervals, its total population was recorded and at the end it was averaged.

RESULTS AND DISCUSSION

The result depicted in Table 1. and Figure 1. that the population of European honey bee was recorded maximum foraging activity during third week of March 2021 (32.76 bees/5min/plant) during this period the population was recorded highest at 10.00-11.00 AM (39.00 bees/5min/plant) and started declined at 11.00-12.00PM (38.10 bees/5min/plant) and the lowest was recorded at 3.00- 4.00 PM (21.40 bees/5min/plant). followed by second week of March 2021 (25.38 bees/5min/plant) during this period the population was recorded highest at 10.00- 11.00 AM (28.80 bees/5min/plant) and started declined at 11.00-12.00PM (26.90 bees/5min/plant) and the lowest was recorded at 3.00- 4.00 PM (17.20 bees/5min/plant) and fourth week of March 2021 (22.45 bees/5min/plant) during this period the population was recorded highest at 10.00- 11.00 AM (25.40 bees/5min/plant) and started declined at 11.00-12.00PM (23.00 bees/5min/plant) and the lowest was recorded at 3.00- 4.00 PM (16.30 bees/5min/plant). however the lowest population was recorded during first week of April 2021 (6.61 bees/5min/plant) during this period the population was recorded highest at 10.00- 11.00 AM (08.10 bees/5min/plant) and started declined at 11.00-12.00PM (07.90 bees/5min/plant) and the lowest was recorded at 3.00- 4.00 PM (03.20 bees/5min/plant). Similarly during the different hours of the day the maximum population of honey bees were recorded at 10.00-11.00 AM (20.63 bees/5min/plant) followed by at 11.00AM-12.00PM (19.72 bees/5min/plant) and at 9.00-10.00AM (19.27 bees/5min/plant). However the lowest population was recorded at 3.00-4.00PM (12.08 bees/5min/plant). These findings are in agreement with the earlier workers, Singh et al., (2006) recorded the maximum number of bee foragers/minute/panicle at 10.30-11.30 hr., followed by 11.30- 12.30 hr., while the least number was recorded at 15.30-16.30 hr. in litchi and the peak foraging activity was recorded between 09.00-10.00 hr. The study supports the present findings. Similarly, Bhatnagar and Karnatak (2010) revealed that in litchi total time spent per bee per flower was highest (5.83 sec.) in the morning at 09.00-11.00 hr. Khan (1929), Das and Chaudhury (1958) and Shukla (1968), while working on the floral biology of litchi, demonstrated that dehiscence in a maximum number of flowers occurred between 07.00 and 12.00 hr. Litchi flowers occurred both during day and night, with peak opening in the early morning (6.00 hr.) and dehiscence began about one day after floral anthesis and continued upto three days, with not all the anthers in a flower dehiscing simultaneously. This took place continuously, occurring more frequently between 08.00 and 10.00 hr., with no apparent environmental, cultural or genetic effect. Further, nectar secreted only in the morning and the pollinators forage primarily between 06.00 and 12.00 hr. although foraging continues later in the day at much lower levels. This indicates synchronisation with foraging rate and time of honey bees.

Correlation coefficients (r) studies of mean population of *Apis mellifera* with weather parameters during 27 February 2021- 02April 2021:

Correlation of the data on the weekly mean population of *Apis mellifera* with meteorological parameters on Litchi flowers during 2021, revealed that population of *Apis mellifera* showed positive and highly significant correlation with evening relative humidity (r = 0.723) whereas, significant but negatively correlated with and sun shine hours (r = -0.864. However, non-significant but positive correlation with minimum temperature, rainfall and morning relative humidity (r = 0.203, 0.353 and 0.521) while, non-significant but negative correlation with maximum temperature and wind velocity (r = -0.334, -0.052) was observed.

Similar findings with Abou-Shaara et al., (2013) noted that all the bees spent more time in flowers during the early time of day period, while less in later period. This is due to the flower biology, as the anthesis and dehiscence of litchi flowers mostly occur in early period of the day, facilitate the availability of pollens to the foragers. As well as nectar secretion starts in early period and on the succeeding period of day it declines due to increase in day temperature. Apart from this, foraging activity of bees is also greatly affected by the atmospheric condition. In many studies, it has been revealed that with increase in day temperature, the activities of bees greatly reduce and vice versa. A significant negative correlation (r = −0.09) was found by Abou-Shaara et al., (2013) between foraging activity and temperature.

Table 1. Mean population of *Apis mellifera* visit/5 min/m^2 in Litchi flowers during 27 February 2021- 02April 2021

Date of observations	*Apis mellifera* visit/5 min/m^2 at different hours of the day									
	8:00-9:00 AM	9:00-10:00 AM	10:00-11:00 AM	11:00-12:00 AM	12:00-1:00 PM	1:00-2:00 PM	2:00-3:00 PM	3:00-4:00 PM	Total	Mean
27/02/2021	7.10	8.90	10.40	10.10	8.60	7.20	6.10	5.30	**63.70**	**7.96**
05/03/2021	10.40	10.90	12.10	12.30	9.70	10.80	11.90	9.10	**87.20**	**10.90**
12/03/2021	26.70	27.30	28.80	26.90	25.60	24.80	25.70	17.20	**203.00**	**25.38**
19/03/2021	35.30	36.20	39.00	38.10	34.80	28.10	29.20	21.40	**262.10**	**32.76**
26/03/2021	23.80	25.10	25.40	23.00	21.80	22.70	21.50	16.30	**179.60**	**22.45**
02/04/2021	6.80	7.20	8.10	7.90	6.40	6.80	6.50	3.20	**52.90**	**6.61**
Total	**110.10**	**115.60**	**123.80**	**118.30**	**106.90**	**100.40**	**100.90**	**72.50**	**848.50**	**106.06**
Mean	**18.35**	**19.27**	**20.63**	**19.72**	**17.82**	**16.73**	**16.82**	**12.08**	**141.42**	**17.68**

Table 2. Correlation between *Apis mellifera* with meteorological parameters during 27 February 2021- 02April 2021

Month	SMW	*Apis mellifera*	Max. Temp. (°C)	Min. Temp. (°C)	Rain Fall (mm)	RH I (%)	RH II (%)	Wind Velocity (Kmph)	Sun Shine (hours)
February	**09**	7.96	30.94	14.26	0.00	72.00	21.86	2.60	10.06
March	**10**	10.90	33.51	15.51	0.00	63.29	18.71	2.44	9.80
	11	25.38	31.00	16.27	5.00	79.71	27.57	2.46	8.70
	12	32.76	32.26	17.63	0.00	74.14	29.57	2.11	6.04
	13	22.45	35.13	16.49	0.00	56.00	16.29	3.11	9.31
April	**14**	6.61	36.81	18.87	0.00	49.71	14.71	2.24	9.73
Correlation coefficient (r value)		**1**	**-0.334**	**0.203**	**0.353**	**0.521**	**0.723***	**-0.052**	**-0.864***

***SMW – Standard Meteorological Week,** *Correlation significant at 5 % level

Fig 1.:- Experimental field of Litchi

A. mellifera

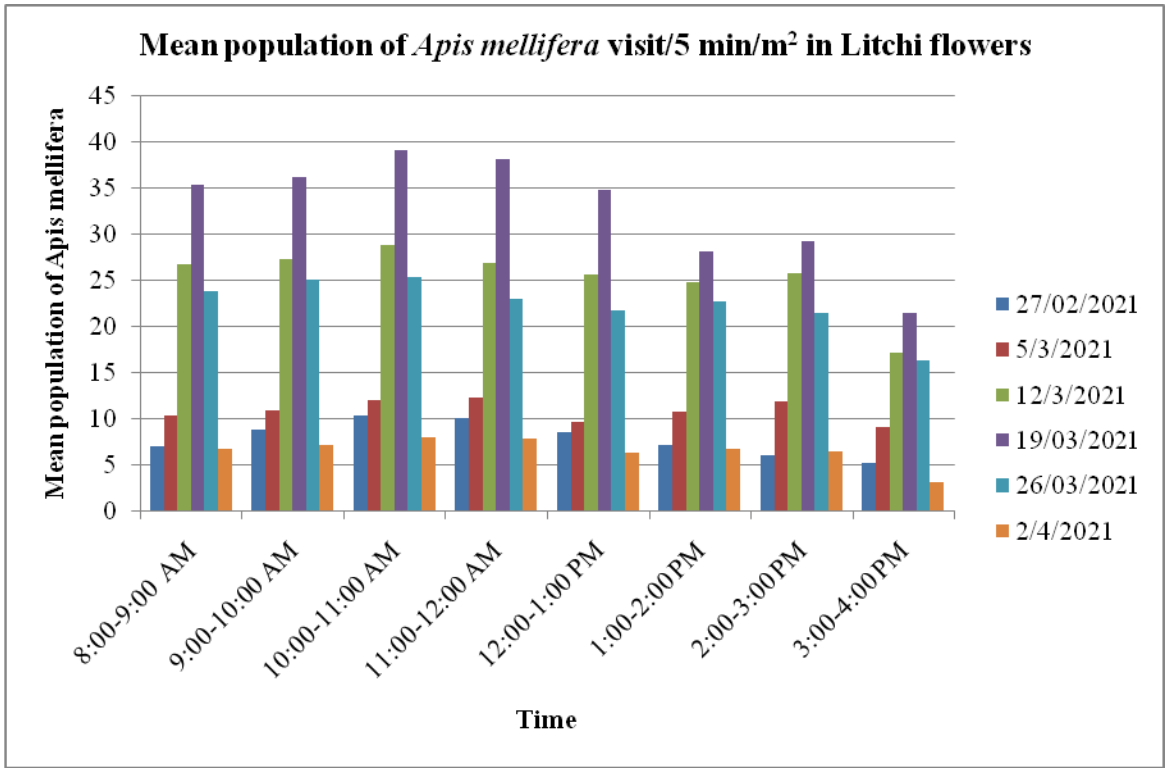

Fig. 1: Mean population of *Apis mellifera* visit/5 min/m² in Litchi flowers during 27 February 2021- 02April 2021

CONCLUSION

In conclusion, the present study revealed that the maximum foraging activity of honey bee was observed third week of March 2021 (32.76 bees/5min/plant) followed by second week of March 2021 (25.38 bees/5min/plant) and fourth week of March 2021 (122.45 bees/5min/plant) however the lowest population was recorded during first week of April 2021 (6.61 bees/5min/plant). Similarly during the different hours of the day the maximum population of honey bees were recorded at 10.00-11.00 AM (20.63 bees/5min/plant) followed by at 11.00AM-12.00PM (19.72 bees/5min/plant) and at 9.00-10.00AM (19.27 bees/5min/plant). However the lowest population was recorded at 3.00-4.00PM (12.08 bees/5min/plant).Maximum foraging speed was recorded during early period, while maximum foraging rate observed during later period of the day. Further, maximum pollinators were found to forage early in the day and very few in the later period. Hence, being an entomophilous plant, litchi requires adequate visit of insect pollinators which will help in better pollination resulted into better fruit set. Thus to allow the frequent visit of different pollinators decision should be taken regarding any chemical measure during the flowering period.

ACKNOWLEDGEMENT

The author is highly thankful to Project Coordinating Unit, All India Coordinated Research Project on Honey Bees and Pollinators, Division of Entomology, ICAR-IARI, New Delhi-110012 for providing the financial support and technical guidance during the whole research work.

REFERENCES

Abou-Shaara, H.F., Al-Ghamdi, A.A. and Mohamed, A.A. (2013). Honey bee colonies performance enhance by newly modified beehives. Journal of Apicultural Science.; 57:45-57.
Google Scholar

Badiyala, S.D. and Garg, R. (1990). Studies on pollination and fruit production by Apis mellifera L. in seven cultivars of litchi (Litchi chinensis Sonn.). Indian Bee Journal.; 52(1):28-30.
Google Scholar

Bhatnagar, S. and Karnatak, A.K. (2010). Impact of day hours and distance of bee hives on the foraging behaviour of Apis mellifera L. visiting litchi (Litchi chinensis Sonn.). Pantnagar Journal of Research. 8:166-169.
Google Scholar

Dafni, A. and Kevan, P.G. (2005). Practical pollination biology. Enviroquest. 20:114-128.
Google Scholar

Das, C.B., Chaudhury, K.R. (1958). Blossom biology of litchi (Litchi chinensis Sonn.). Indian Horticulture. 6(1):17-22.
Google Scholar

Groff, G.W..(1943). Some ecological factors involved in successful lychee culture. Proceedings of Florida State Horticultural Society. 56:134-55.
Google Scholar

King, J., Exley, E.M. and Vithanage, V. (1989). Insect pollination for yield increases in lychee. Proceedings of the Fourth Australian Conference on Trees and Nut Crops, Exotic Fruit Growers Association, Lismore, Australia, 142-5.
Google Scholar

Menzel, C. and Waite, G.K. (2005). Litchi and Longan: Botany, Production and Uses. CABI Publishing, UK, , 336.
Google Scholar

Mishra, M. and Kumar, N. (2018). Foraging Behaviour of Honey Bees on Litchi Bloom. Environment & Ecology. 36(1):120-126.
Google Scholar

Mustard, M.J., Liu, S. and Nelson, R.Q. (1953). Observation of floral biology and fruit setting in lychee varieties. Proceedings of the Florida State Horticultural Society. 66:212- 220.
Google Scholar

Painkra, G.P. (2016). Foraging behaviour of rock bees, *Apis dorsata* on lajwanti grass (Mimosa pudica) in Surguja of Chhattisgarh. Journal of Plant Development Sciences.; 8(11):543-545.
Google Scholar

Painkra, G.P. (2018). Foraging behaviour of giant bees, *Apis dorsata* (Hymenoptera – Apidae) on *Ageratum conyzoides* in Northern hill Zone of Chhattisgarh. Journal of Plant Development Sciences. 10(9):517-520.
Google Scholar

Painkra, G.P. (2019). Foraging behaviour of honey bees on coriander (*Coriandrum sativum* L.) flowers in Ambikapur of Chhattisgarh, Journal of Entomology and Zoology Studies , 7(1): 548-550.
Google Scholar

Painkra, G.P. (2019). Foraging behaviour of stingless bee, *Tetragonula iridipennis* (Hymenoptera –Apidae) in broccoli flowers in Ambikapur of Chhattisgarh. Journal of Plant Development Sciences, 11(7) : 431-433.
Google Scholar

Painkra, G.P. and Kumaranag, K.M. (2019). Foraging activity of stingless bee, *Tetragonula iridipennis* smith (Hymenoptera-Apidae Meliponinae) in sunflower. Journal of Plant Development Sciences, 11(8) : 463-466.
Google Scholar

Painkra, G.P. and Shaw, S.S. (2016). Foraging behaviour of honey bees in niger flowers, *Guizotia abyssinica* Cass. in North Zone of Chhattisgarh. International Journal of Plant Protection. 9(1):100-106.
Google Scholar

Painkra, G.P. (2019). Foraging behavior of Italian honey bee, *Apis mellifera* (Hymenoptera-Apidae) in broccoli flowers. Journal of Plant Development Sciences, *11*(11), pp.681-683.
Google Scholar

Pandey, R.S. and Yadava, R.P.S. (1970). Pollination of litchi (Litchi chinensis) by insects with special reference to honey bees. Journal of Apiculture Research. 9(2):100- 105.
Google Scholar

Phadke, K.G. and Naim, M. (1974). Observations on the honeybee visitation to the litchi blossoms at Pusa, Bihar, India. Indian Bee Journal. 36:9-12.
Google Scholar

Said, F., Inayatullah, M., Ahmad, S., Iqbal, T. and Shah, R.A. (2015). Foraging behaviour of the Himalayan Honeybee, Apis cerana (Hymenoptera: Apidae) associated with sunflower (Helianthus annuus L.) at Peshawar District of Khyber Pakhtunkhwa (KP). Journal of Entomology and Zoology Studies.; 3(3):203-207.
Google Scholar

Singh, B., Kumar, M., Sharma, A.K. and Yadav, L.P. (2006). Relative abundance of insect visitors on litchi (Litchi chinensis Sonn.) bloom. Environment and Ecology. 24:275- 277.
Google Scholar

Stern, R.A. and Gazit, S. (1996). Litchi pollination by the honey bee. Journal of the American Society for Horticultural Science. 121:152-157.
Google Scholar