Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2021; 9(1): 613-617

Received: 10-11-2020
Accepted: 12-12-2020

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Foraging behavior of various species of Honey bees on Maize among it's correlation with weather parameters

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Abstract
Bees need pollen for their maintenance and development. Maize tassels (*Zea mays* L.) produce large amounts of pollen, which are visited by several bee species. This experiment was conducted in Raj Mohini Devi College of Agriculture and Research station, Ambikapur (Chhattisgarh) in 2020 with the objective to evaluate the factors affecting the foraging behavior of bees in maize. The frequency of visitations of bees to collect pollen was obtained by counting in the first five minutes each time, from 8:00 am to 5:00 pm. We have found the prevalence of Italian honey bees (*Apis mellifera*) visiting the maize tassels preferably between 8:00 am and 5:00 pm exclusively for pollen collection.

Keywords: Correlation, *Apis dorsata*, *Apis cerena indica*, *Apis mellifera*, foraging behavior, weather parameter, *Xylocopa* sp and *Zea mays*

Introduction
The pollination services performed by native and managed bees are indispensable for the maintenance and functioning of ecosystems, reproduction of native plants and agricultural production. The demand for commercial crop pollination services has tripled in the last 50 years and beekeeping is fundamental to guarantee these services and has a great importance in beekeeping production (Goulson *et al.*, 2015) [4]. Despite the importance of bees, there has been intense reduction of these pollinators worldwide. Several factors, alone or combined, have been cited as causes of this phenomenon, especially the reduction of flower abundance and diversity, acute and/or chronic exposure to pesticides, increased incidence of parasites and diseases, introduction of exotic species and climate change (Potts *et al.*, 2016) [19].
Foraging behaviour is one of the distinctive behaviours of honey bees, *Apis mellifera*. This behaviour is the link between the honey bee colony and the ambient environment. It is known that the foraging activity of honey bees is initiated in early morning and finishes in the evening. In some studies, honey bee workers started foraging activity at 6.17 am (Joshi and Joshi 2010) [5] but this commencement time can be greatly impacted by the region. Under desert conditions, Alqarni (2006) [1] found that a higher number of foragers left the colonies at 8 am than at 10 am. In general, the foraging activity fluctuates during the day from the morning until the evening. Reyes-Carrillo *et al.* (2007) [20] found high pollen collection in the early morning while low amounts of pollen were collected in the afternoon. Pernal and Currie (2010) [6] reported a higher foraging rate mean during the afternoon period (36.02 foragers/min) than during the morning period (17.66 foragers/min). Yucel and Duman (2005) [24] found that honey bee workers visited onion flowers from 8.15 to 16.30 h and the peak foraging was between 11.00 to 12.00 h. Foragers have the ability to remember the time of the day at which the higher food resources are available as found with *Sysirinchium palmifolium* plants (Silva *et al.* 2013) [21] and such ability may correlate with foraging activity peaks. In general, the normal foraging interval at the same feeding site is less than 5 min (Yang *et al.* 2008) [23] and bees spend different times per flower depending on the plant species. The time spent per flower was 6.92, 6.50 and 5.54 s for Chinese cabbage, broccoli and kohlrabi, respectively (Sushil *et al.* 2013) [22]. There are numerous factors that may impact foraging activity (e.g. onset and end time, foraging interval and peaks).

Materials and Methods

The study was undertaken at Raj Mohini Devi College of Agriculture and Research station, Ambikapur (Chhattisgarh) substation of Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) India during 2020. This station is situated at an attitude 230 8'33.7596"N and a longitude 830 10'44.0184"E. The foraging behavior of European honey bee, *Apis mellifera Apis dorsata, Apis cerena indica,* and *Xylocopa* sp were observed in maize crops during 4th May to 13 May 2020. The population of above honey bee sp. was recorded at everyday's intervals per 5min/plant. 50 plants were randomly selected and count the number of honey bees visiting by visually observation starting from 8.00AM to 5.00PM with an hours intervals, its total population was recorded and at the end it was averaged and correlated with weather parameters.

Results and Discussion

The result depicted in Table 1 and Figure 1 that the population of various numbers of pollinators *i.e. Apis dorsata, Apis cerena indica, Apis mellifera* and *Xylocopa* sp. were recorded on Maize during 4th May to 13 May 2020. Among these pollinators of maize crops the European honey bee (*Apis mellifera*) was recorded maximum foraging activity during the study period and followed by *Apis cerena indica, Apis dorsata* and *Xylocopa* species. During this period the population of *Apis mellifera* was recorded lowest at 5.00 PM (8.43 bees/5min/plant) and maximum foraging activity at 1.00 PM (23.86 bees /5min/plant). However maximum foraging activity of Indian bee (*Apis cerena indica*) were recorded at 9.00 AM (14.71 bees/5min/plant) and lowest at 5.00 PM (7.14 bees/5min/plant) while maximum foraging activity of Rock bee (*Apis dorsata*) were recorded at 8.00 AM (13.29 bees/5min/plant) and lowest at 5.00 PM (3.29 bees/5min/plant). The activity of *Xylocopa* sp. were recorded at 8.00AM to 5.00 PM where maximum foraging activity of *Xylocopa* were recorded at 9.00 AM (1.57 bees/5min/plant).

These findings are in agreement with the earlier workers Dalio (2013 and 2015) [2, 3] recorded the foraging behaviour of honey bee, *Apis mellifera* on *Parthenium* and *Trianthema*, Painkra *et al* (2014) noticed the comparative foraging activity of honey bees on buckwheat crop. Fazal Said *et al* (2015) who recorded the foraging activity of Himalayan bee, *Apis ceana* on sunflower, Painkra (2016) [8] who observed the foraging activity of rock bee, *Apis dorsata* on lajwanti grass, Painkra and Shaw (2016) [9] recorded the foraging activity of honey bees on niger flowers. Kumar and Singh (2016) noticed the foraging activity of bees on coriander flowers and Manhare *et al* (2017) [10] observed the foraging activity of Indian honeybee on buckwheat. Painkra *et al.,* (2014 & 2014) recorded the foraging behavior of honey bees on niger flowers. Painkra (2018, 2019) [11] observed the foraging activity of giant bee, *Apis dorsata* on *Ageratum conyzoides* and coriander flowers. Painkra and Kumaranag (2019) [14] who were recorded the foraging activity of stingless bee in sunflower and in broccoli flowers.

Correlation coefficients (r) studies of the population of various numbers of pollinators recorded on maize with meteorological parameters at Ambikapur (Chhattisgarh) during 4th May to 13 May 2020.

The result depicted in Table 2-5 that the population of various numbers of pollinators *i.e. Apis dorsata, Apis cerena indica, Apis mellifera* and *Xylocopa* sp. were recorded on Maize and correlated with meteorological parameters.

a. The activity of the population of *Apis mellifera* showed positive non-significant correlation with maximum temperature (r = 0.215) and evening relative humidity (r = 0.186) whereas, non-significant but negatively correlated with minimum temperature, rainfall and morning relative humidity (r = -0.143, -0.426, -0.292, respectively).
b. The activity of the population of *Apis cerana indica* showed positive non-significant correlation with maximum temperature (r = 0.557) and evening relative humidity (r = 0.224) whereas, non-significant but negatively correlated with minimum temperature, rainfall and morning relative humidity (r = -0.207, -0.413, -0.037, respectively).
c. The activity of the population of *Apis dorsata* showed positive non-significant correlation with rainfall (r = 0.353) and morning relative humidity (r = 0.326) whereas, non-significant but negatively correlated with minimum temperature, maximum temperature and evening relative humidity (r = -0.269, -0.191, -0.253, respectively).
d. The activity of the population of *Xylocopa sp* showed positive non-significant correlation with minimum temperature(r = 0.389) and maximum temperature(r = 0.106) whereas, non-significant but negatively correlated with rainfall, morning relative humidity and evening relative humidity (r = -0.059, -0.477, -0.490, respectively).

Table 1: Population of various numbers of pollinators recorded on Maize during 4th May to 13 May 2020

Time interval	*Apis dorsata*	*Apis cerana indica*	*Apis mellifera*	*Xylocopa*	Mean
8:00 AM	13.29	9.00	10.57	0.86	8.43
9:00 AM	11.43	14.71	18.14	1.57	11.46
10:00 AM	11.57	10.43	12.57	0.00	8.64
11:00 AM	4.86	11.29	15.29	0.00	7.86
12:00 PM	7.00	10.00	17.29	0.14	8.61
1:00 PM	11.29	10.57	23.86	0.71	11.61
2:00 PM	6.86	11.14	11.86	0.00	7.47
3:00 PM	6.29	10.43	14.00	0.29	7.75
4:00 PM	4.71	8.14	15.71	0.00	7.14
5:00 PM	3.29	7.14	8.43	1.00	4.97
Overall mean	8.057	10.286	14.771	0.457	

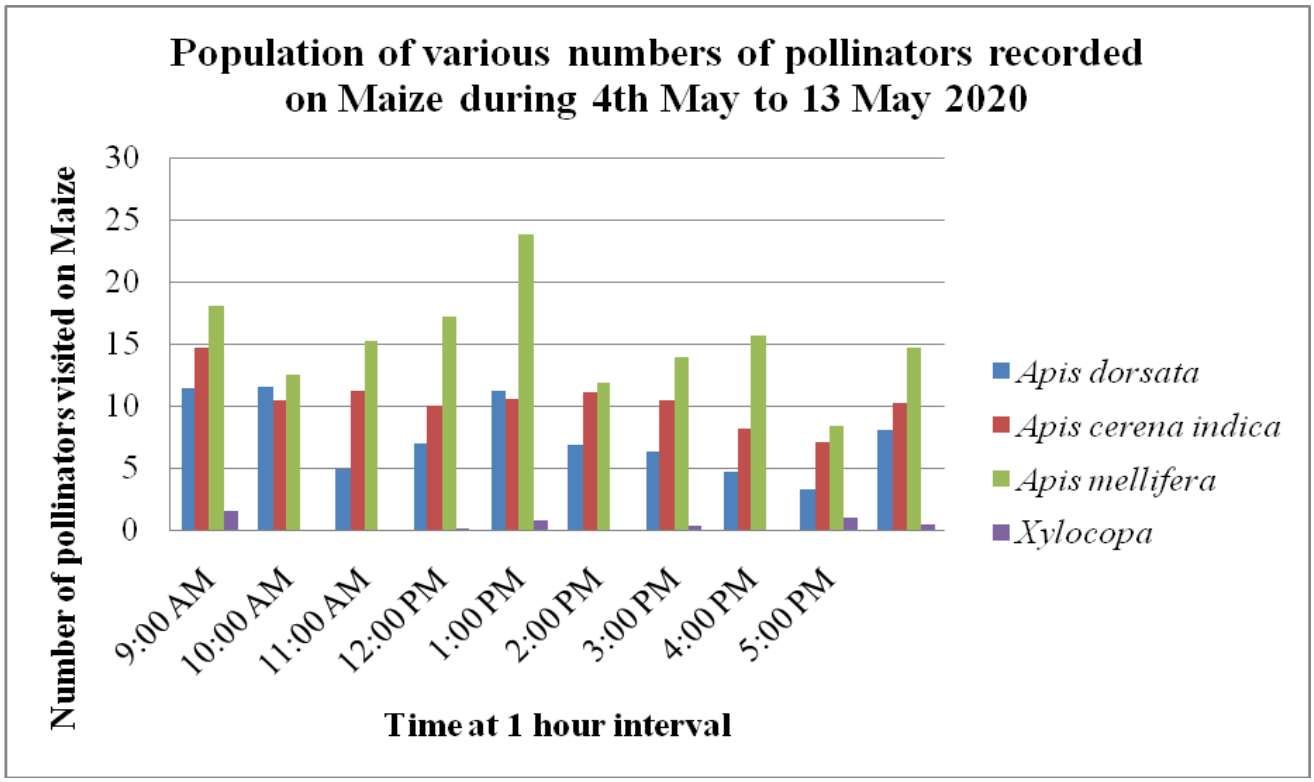

Fig 1: Population of various numbers of pollinators recorded on Maize during 4th May to 13 May 2020

Table 2: Correlation of *Apis mellifera* recorded on maize with meteorological parameters at Ambikapur, during 2020

Observation Date	*Apis mellifera*	Temperature (^{0}C)		Rainfall (mm)	Relative Humidity (%)	
		Max.	Min.		Mor.	Eve.
4-May-2020	12.9	36.3	18.5	6.3	90	69
5-May-2020	23.8	31.6	19.3	3	89	57
6-May-2020	23.1	32	18	0	82	69
8-May-2020	20.7	33.5	19.6	0	68	38
11-May-2020	9.9	37	17	5.3	91	35
12-May-2020	4.9	34	20	0	77	38
13-May-2020	8.1	28.0	17.0	9.4	98	74
Correlation value = r		-0.143	0.215	-0.426	-0.292	0.186

* Correlation significant at 5% level of significance

Table 3: Correlation of *Apis cerena indica* recorded on maize with meteorological parameters at Ambikapur, during 2020

Observation Date	*Apis cerena indica*	Temperature (^{0}C)		Rainfall (mm)	Relative Humidity (%)	
		Max.	Min.		Mor.	Eve.
4-May-2020	11.1	36.3	18.5	6.3	90	69
5-May-2020	15.5	31.6	19.3	3	89	57
6-May-2020	11.9	32	18	0	82	69
8-May-2020	13.6	33.5	19.6	0	68	38
11-May-2020	4.9	37	17	5.3	91	35
12-May-2020	7.6	34	20	0	77	38
13-May-2020	7.4	28.0	17.0	9.4	98	74
Correlation value = r		-0.207	0.557	-0.413	-0.370	0.224

* Correlation significant at 5% level of significance

Table 4: Correlation of *Apis dorsata* recorded on maize with meteorological parameters at Ambikapur, during 2020

Observation Date	*Apis dorsata*	Temperature (^{0}C)		Rainfall (mm)	Relative Humidity (%)	
		Max.	Min.		Mor.	Eve.
4-May-2020	3.6	36.3	18.5	6.3	90	69
5-May-2020	7.1	31.6	19.3	3	89	57
6-May-2020	3.2	32	18	0	82	69
8-May-2020	4.9	33.5	19.6	0	68	38
11-May-2020	10.7	37	17	5.3	91	35
12-May-2020	13.3	34	20	0	77	38
13-May-2020	13.6	28.0	17.0	9.4	98	74
Correlation value = r		-0.269	-0.191	0.353	0.326	-0.253

* Correlation significant at 5% level of significance

Table 5: Correlation of *Xylocopa* sp. recorded on maize with meteorological parameters at Ambikapur, during 2020

Observation Date	*Xylocopa* sp.	Temperature (^{0}C)		Rainfall (mm)	Relative Humidity (%)	
		Max.	Min.		Mor.	Eve.
4-May-2020	0.6	36.3	18.5	6.3	90	69
5-May-2020	0	31.6	19.3	3	89	57
6-May-2020	0	32	18	0	82	69
8-May-2020	1.4	33.5	19.6	0	68	38
11-May-2020	0.7	37	17	5.3	91	35
12-May-2020	0.2	34	20	0	77	38
13-May-2020	0.3	28.0	17.0	9.4	98	74
Correlation value = r		0.389	0.106	-0.059	-0.477	-0.490

* Correlation significant at 5% level of significance

Conclusion

It is concluded that the various species of honey bees *i.e. Apis dorsata, Apis cerena indica, Apis mellifera and Xylocopa* species were recorded to visiting the Maize flower. Among them *Apis cerena indica* was found dominant sp. and good forager. Overall the maximum foraging activity was recorded at 9:00 AM –1:00 PM so it is suggested not to apply the insecticides during the visitation of honey bees.

References

1. Alqarni AS. Tolerance of summer temperature in imported and indigenous honeybee *Apis mellifera* L. Races in central Saudi Arabia. Saudi Journal of Biological Sciences 2006;13:123-127.
2. Dalio JS. Foraging activity of *Apis mellifera* on *Parthenium hystophorus*. Journal of Pharmacy and Biological Sciences 2013;7(5):01-04.
3. Dalio JS. Foraging behaviour of *Apis mellifera* on *Trianthema portulacastrum*. Journal of Entomology and Zoology Studies 2015;3(2):105-108.
4. Goulson D, Nicholls E, Botías C, Rotheray EL. Bee declines driven by combined stress from parasites, pesticides, and lack of flowers. Science 2015;347(6229):1255957.
5. Joshi NC, Joshi PC. Foraging behaviour of *Apis Spp*. on Apple Flowers in a subtropical environment. New York Science Journal, 2010;3:71-76.
6. Pernal SF, Currie RW. The influence of pollen quality on foraging behavior in honeybees (*Apis mellifera* L.). Behavioral Ecology and Sociobiology 2010;51:53-68.
7. Painkra GP, Shivastava Shiv K, Shaw SS, Gupta Rajeev. Effect of weather parameters on the activity of various insect pollinators/visitors visiting on niger flowers, *Guizotia abyssinica* Cass. Progressive Research-An International Journal 2015;10(1):544-547.
8. Painkra GP. Foraging behaviour of rock bee, *Apis dorsata* on lajwanti grass (M*imosa pudica)* in surguja of chhattisgarh . Journal of Plant Development Sciences 2016;8(11):543-545.
9. Painkra GP, Shaw SS. Foraging behaviour of honey bees in niger flowers, *Guizotia abyssinica* Cass.in North zone of Chhattisgarh. International Journal of Plant Protection 2016;9(1):100-106.
10. Manhare JS, Painkra GP, Bhagat PK, Painkra KL. Studies on the foraging activity of Indian honeybee, *Apis cerana indica* Fabr and other honeybee spp. on buckwheat flowers, Journal of Plant Development Sciences 2017;9(8):823-828.
11. Painkra GP. Foraging behaviour of giant bee, *Apis dorsata* (Hymenoptera- Apidae) on *Ageratum conyzoides* in northern hill zone of Chhattisgarh. Journal of Plant development Sciences 2018;9(10):517-520.
12. Painkra GP. Foraging behaviour of honey bees on coriander (*Coriandrum sativum* L.) flowers in Ambikapur of Chhattisgarh**.** Journal of Entomology and Zoology Studies. 2019;7(1):548-550.
13. Painkra GP. Foraging behaviour of stingless bee, *Tetragonula iridipennis* (Hymenoptera - Apidae) in broccoli flowers in Ambikapur of Chhattisgarh**.** Journal of Plant Development Sciences, 2019;11(7):431-433.
14. Painkra GP, Kumaranag KM. Foraging activity of stingless bee, *Tetragonula iridipennis* Smith (Hymenoptera-Apidae-Meliponinae) in sunflower. Journal of Plant Development Sciences 2019;11(8):463-466.
15. Painkra GP. Foraging behavior of Italian honey bee, *Apis mellifera* (Hymenoptera-Apidae) in broccoli flowers. Journal of Plant Development Sciences 2019;11(11):681-683.
16. Painkra GP. Foraging behavior of European honey bee, *Apis mellifera* (Hymenoptera-Apidae) in marigold flowers in Chhattisgarh, India. Journal of Plant Development Sciences 2020;12(3):177-180.
17. Paikara SP, Painkra GP, Painkra KL, Bhagat PK. Foraging behavior of different bee species on coriander flowers. Journal of Plant Development Sciences 2020;12(9):517-528.
18. Paikara SP, Painkra GP. Effects of independent variables on various dependent factors on coriander flowers. Journal of Plant Development Sciences 2020;12(11):657-664.
19. Potts SG, Imperatriz-Fonseca V, Ngo HT, Aizen MA, Biesmeijer JC, Breeze TD *et al*. Safeguarding pollinators and their values to human well-being. Nature 2016;540(7632):220-229.
20. Reyes-Carrillo JL, Eischen FA, Cano-Rios P, Rodriguez Martinez R, Camberos UN. Pollen collection and honey bee forage distribution in Cantaloupe. Acta Zoologica Mexicana 2007;23:29-36.
21. Silva DP, Moisan-De-Serres J, Souza DC, Hilgert-Moreira SB, Fernandes MZ, Kevan PG *et al*. Efficiency in pollen foraging by honey bees: time, motion, and pollen depletion on flowers of *Sysirinchium palmifolium* (Asparagales: Iridaceae). Journal of Pollination Ecology, 2013;11:27-32.
22. Sushil SN, Stanley J, Hedau NK, Bhatt JC. Enhancing seed production of three Brassica vegetables by honey bee pollination in north-western Himalayas of India. Universal Journal of Agricultural Research, 2013;1:49-53.
23. Yang EC, Chuang YC, Chen YL, Chang LH. Abnormal foraging behavior induced by sublethal dosage of imidacloprid in the honey bee (Hymenoptera: Apidae). Journal of Economic Entomology 2008;101:1743-1748.

24. Yucel B, Duman I. Effects of foraging activity of honeybees (*Apis mellifera* L.) on onion (*Allium cepa*) seed production and quality. Pakistan Journal of Biological Sciences 2005;8:123-126.
25. Yadav S, Painkra GP. Foraging behavior of rock bee (*Apis dorsata*) on mustard ecosystem in Ambikapur, Chhattisgarh. Journal of Plant Development Sciences 2020;12(10):635-639.