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Foraging behaviour of honey bees on coriander (*Coriandrum sativum* L.) flowers in Ambikapur of Chhattisgarh

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Abstract
A field observation was undertaken at Rajmohini Devi College of Agriculture and Research Station, Ambikapur of Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) during 2017-18 to study the foraging activity of various honey bee species on different time hours on coriander bloom. Various honey bee species *i.e. Apis cerana, Apis mellifera,* and *Apis dorsata* were observed and the *Apis dorsata* was found dominant bee species. *Apis indica* was noticed maximum population at 1200hrs (6.77 bees/5min/m^2) followed by at 1000hrs (5.16 bees/5min/m^2) however the lowest population was recorded at 0800hrs (1.77 bees/5min/m^2). *Apis mellifera* population was recorded highest at 1200hrs (6.57 bees/5min/m^2) followed by at 1000hrs (4.97 bees/5min/m^2) however, lowest population was found at 0800hrs (1.85 bees/5min/m^2). *Apis dorsata* population was found foraging maximum at 1200hrs (7.47 bees/5min/m^2) followed by at 1000hrs (6.5 bees/5min/m^2) and the lowest was recorded at 1600hrs (2.2 bees/5min/m^2).

Keywords: *Apis cerana, Apis mellifera, Apis dorsata,* coriander bloom, foraging activity

Introduction
Coriander, *Coriandrum sativum* Linn. is an important annual herbaceous crop, belongs to the family Apiaceae (Umbelliferae). It is called the '*dhanayaka*' or '*kusthumbari*' in the Sanskrit literature and in Hindi it is also called Dhaniya. The genus *Coriandrum* includes the cultivated plant *C. sativum* and the wild species *C.tordylium* Coriander is an annual herb and, according to the climatic conditions, it is cultivated in summer or winter annual crop. At the flowering period the plant can reach heights between 0.20 and 1.40 m. Coriander is an important spice crop which is grown for leaves as well as seed. In leaves it is found the starch, protein, vitamin A. It is also used as medicine. Its good fragrance is used in oil, wine, chocolate and in sweets.
In India, the area of coriander cultivation has been reported to be 4.7 lakh hectare with a production of 37 lakh tonnes and an average productivity of 789 kg/ha. Coriander powder export from India was 2246 metric tons and as curry powder including coriander in the mixture was 8318 metric tons (Anonymous 2006).
India has been recognized as the home of spices in the world. India is the world largest producer, consumer and exporter of seed spice. Seed spices constitute an important group of agricultural commodity and play a very significant role in our national economy. Seed spices are important export oriented commodity and about 10 per cent of our production is exported as raw and also as value added products, realizing foreign exchange worth of rupees 206.25 crores per year. It is the only seed spice included in national crops forecasting system (Sivaraman *et al*., 2001) [10].
The flower's fragrance of coriander is attractive due to nectar which attract the necter feeding insect it is a good source of nectar which attract the honey bees and other insects for foraging to sustain their life. In this article is being explained about the foraging activity of honey bees.

Materials and Methods
The experiment was undertaken at Rajmohini Devi College of Agriculture and Research Station, Ambikapur (Chhattisgarh) during 2017-18 to study the foraging activity of honey bees during the blooming period on coriander. The foraging activity of different honey bee species i.e. *Apis cerana indica, Apis mellifera* and *Apis dorsata* were recorded during the day hours at 0800, 1000, 1200,1400 and 1600hrs two hours intervals and counted the numbers and

averaged the population of honey bees and the dominant bee species were worked out. The observation were taken weekly intervals at five minutes from one square meter area at five spots from 1st January to 18th February 2018.

Results and Discussion

The result depicted in Table 1. It is revealed that the three species of honey bees i.e. *Apis cerana, Apis mellifera,* and *Apis dorsata* were recorded foraging on coriander bloom.The population of *Apis indica* was recorded higher at 1200hrs noon (6.77 bees/5min/m2) followed by at 1000hrs (5.16 bees/5min/m2) at the 1400hra and 1600hrs were also recorded lower population (4.85 bees/5min/m2) and (3.77 bees/5min/m2) respectively. However the lowest population was recorded at 0800hrs (1.77 bees/5min/m2).

Apis mellifera population was recorded maximum at 1200hrs noon (6.57 bees/5min/m2) followed by (4.97 bees/5min/m2) and lower population was noticed at 1400hrs and 1600hrs (3.05 bees/5min/m2) and (1.87 bees/5min/m2) respectively however the lowest was recorded at 0800hrs (1.85 bees/5min/m2).

Apis dorsata population was recorded foraging on coriander flowers. It was started foraging at 0800hrs (2.57 bees/5min/m2), 1000hrs (6.5 bees/5min/m2), 1200hrs (7.47 bees/5min/m2), 1400hrs (4.87 bees/5min/m2) and 1600hrs (2.2 bees/5min/m2) respectively. The highest population was recorded at 1200hrs noon followed by at 100hrs and the lowest was recorded at 1600hrs.

The present findings are close agreement with the earlier workers, Painkra *et al.* (2014) [4, 5, 8] who recorded the activity of three bees species i.e. *Apis dorsata, Apis indica and Apis florea* on niger flowers. Among the three species Apis indica was main forager followed by *Apis dorsata* and *Apis florea*. The maximum foraging activity of *Apis indica* was found in between 0900hrs to 1100hrs (65.00 bees/5min/m^2) and similar trends were found between *Apis dorsata* and *Apis florea* (16.62 bees/5min/m^2). Painkra *et al.* (2014) [4, 5, 8] recorded the maximum foraging activity of bees of Apis indica was found at 1100hrs (115.00 bees/ 5min/m^2) while the maximum activity of *Apis dorsata* was found at 11oohrs (30.00 bees/5min/m^2). Whereas the lowest was recorded at 1700hrs (5.00 bees/5min/m^2). Kumar and singh (2016) [1] recorded the Initiation- Cessation and period of foraging activity of honeybees on coriander flowers. *Apis mellifera* started foraging earlier (8.48 AM, 8.52 AM) followed by *Apis florea* (9.18 AM, 9.26 AM), *Apis dorsata* (9.21 AM, 9.24 AM) and *Apis cerana indica* (9.25 AM, 9.18 AM) started later. Similarly, *Apis cerana indica,* ceased her activity earlier (4.02 PM, 4.10 PM) followed by *Apis florae* (4.01 PM, 4.05 PM), *Apis dorsata* (4.46 PM, 4.05 PM) while *Apis mellifera* remained active till (4.53 PM, 4.24 PM) late hours. Painkra and Shaw (2016) [3, 7] who recorded the activity of honey bees in niger flowers, The foraging activity of *Apis cerana indica* was found higher in first week of November 2011 and 2nd week of December 2012 (33.83 bees/5min/m2). Its maximum visitation was found at 1100hrs (66.06 bees/5min/m2). The maximum foraging activity of *Apis dorsata* was observed at 1100hrs (11.75 bees/5min/m2) whereas, the lowest was observed at 1700hrs (0.50 bee/5min/m2).The higher foraging activity of *Apis florea* was noticed at 1300hrs (4.00 bees/5min/m2) and was found least at 0900hrs (0.56 bee/5min/m2). Painkra (2016) [3, 7] recorded the foraging behaviour of rock bees, *Apis dorsata* on lajwanti grass that the bee was found maximum visitation at 1000-1100hrs and the lowest was at 1600-1700hrs and followed by at 0800-0900hrs. In different hours of the day low average population was recorded at 0800-0900hrs (52.44 bees/5min/m^2) and reached its peak population at 1000-1100hrs (140.33 bees/5min/m^2) and found decreased lowest at 1600-1700hrs (16.22 bees/5min/m^2). Painkra *et al.* (2014) [4, 5, 8] recorded the foraging activity of *Apis cerana indica* highest at 1100hrs (51.10 bees/5min/m^2) and lowest at 1700hrs (3.5 bees/5min/m^2) and *Apis dorsata* was found maximum at 1100hrs (8.20 bees/5min/m^2) and lowest at 1500hrs (2.10 bees/5min/m^2). *Apis florea* was found maximum at 1100hrs (3.56 bees/5min/m^2) however the lowest at 1300hrs (1.15 bees/5min/m^2) on buckwheat crop. Manhare *et al.* (2017) [2] who recorded the Indian bee, *Apis cerana indica* Fabr. and other honey bee spp. on buckwheat flowers. The maximum visitation of *Apis cerana indica* was found at 1200hrs (98.62 bees/5min/m2) similar population was recorded of *Apis dorsata* at 1200hrs (61.12 bees/5min/m2) and lowest was recorded at 1700hrs (1.25 bees/5min/m2) and *Apis florea* was recorded maximum at 1400hrs (3.25 bees/5min/m2) and lowest at 0800hrs (0.57 bees/5min/m2) and Painkra (2018) [6] who also noticed the activity of *Apis dorsata* on *Ageratum conyzoides* weed. Its maximum activity was noticed at 1100hrs (2.77 bees/5min/m2) and the lowest was recorded (0.72 bees/5min/m2) at 1700hrs.

Conclusion

It is concluded that the various species of honey bees i.e. *Apis indica, Apis mellifera, Apis dorsata and Apis florea* species were recorded to visiting the coriander flower. Among them Apis dorsata was found dominant sp and good forager. Overall the maximum foraging activity was recorded at 1200noon so it is suggested not to apply the insecticides during the visitation of honey bees.

Table 1: Foraging activity of honey bees on coriander flowers during 2017-18.

	Bee visit/ 5min/m^2 (Hours of the day)															**Total**	**Mean**
	Apis indica					***Apis mellifera***					***Apis dorsata***						
Date of observation	**0800**	**1000**	**1200**	**1400**	**1600**	**0800**	**1000**	**1200**	**1400**	**1600**	**0800**	**1000**	**1200**	**1400**	**1600**		
01/01/2018	1.0	1.2	3.0	2.8	2.6	1.4	3.0	5.0	2.4	1.8	2.2	7.0	8.0	6.2	2.4	50	3.33
07/01/2018	2.0	3.0	6.0	5.0	3.0	1.6	2.8	4.2	3.8	1.6	1.8	3.6	5.0	4.2	2.2	49.8	3.32
14/01/2018	3.60	7.0	6.2	5.8	4.2	1.4	2.4	6.2	4.2	2.6	2.4	4.2	6.6	4.4	2.4	63.6	4.24
21/01/2018	1.8	5.0	7.8	4.0	3.8	2.2	5.2	8.2	3.8	2.2	3.0	7.0	10.4	5.0	4.4	73.8	4.92
28/01/2018	2.2	7.0	9.0	5.8	4.2	2.4	7.2	10.2	3.6	2.6	3.2	7.6	10.6	5.8	2.4	83.8	5.58
04/02/2018	1.4	5.6	7.0	6.2	5.8	2.0	5.0	5.8	2.4	1.4	2.6	6.2	5.6	7.2	0.4	64.6	4.30
11/02/2018	1.0	8.3	10.2	5.0	4.2	1.6	9.2	6.6	2.2	1.0	2.4	9.4	7.0	3.0	1.2	72.3	4.82
18/02/2018	1.2	4.2	5.0	4.2	2.4	2.2	5.0	6.4	2.0	1.8	3.0	7.0	6.6	3.2	2.2	56.4	3.76
Total	14.2	41.3	54.2	38.8	30.2	14.8	39.8	52.6	24.4	15	20.6	52	59.8	39	17.6		
Mean	1.77	5.16	6.77	4.85	3.77	1.85	4.97	6.57	3.05	1.87	2.57	6.5	7.47	4.87	2.2		

Fig 1: A view of coriander flowers

Fig 2: A view of *Apis mellifera* foraging on coriander flowers

Fig 3: A view of *Apis indica* foraging on coriander flowers

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