

## Original Research Article

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## Foraging Behavior of Major *Apis* Species on Coriander

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### ABSTRACT

#### Keywords

Foraging rate, *A. mellifera*, *A. dorsata*, *A. florea*

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Investigation was carried out during *Rabi*, 2014-2015 at Research Farm National Research Center on Seed Spices, Tabiji, Ajmer (Rajasthan). Objective of the study is to investigate the foraging behavior of major *Apis* species on coriander. The maximum foraging rate of *A. mellifera* was recorded at 14.00 h (13.6 umbels visited min<sup>-1</sup> and 3.10 plant/five minutes) followed by *Apis dorsata* at 12.00 h (10.66 umbels visited min<sup>-1</sup> and 2.80 plants/five minutes). And *Apis florea* at 14.00 h (9.80 umbels visited min<sup>-1</sup> and 2.55 plants/five minutes).

### Introduction

Coriander (*Coriandrum sativum* Linn.) is an annual herbaceous plant, belongs to the family Apiaceae (Umbelliferae). It is also popularly known as 'Dhania' in north India, 'Dhana' in Bengal, 'Dhaniyalu' in Andhra Pradesh and 'Kathamalli' in Tamil Nadu (Evans *et al.*, 2002). Its origin is considered to be Europe to southwestern Asia. It is cultivated as a winter season annual crop. It can be grown in all types of soil under a wide range of climatic conditions but cool climate and dry weather is required during the maturity of crop. Coriander is mainly grown in various countries like India, Morocco, Romania, France, Spain, Argentina, Italy, Egypt, Russia, Iran, Canada and Australia. Among these

countries, India is the largest producer, consumer as well as exporter country in the world.

Coriander is a highly cross pollinated nature of crop, allowed a large population of insect pollinators during flowering for their pollination. A number of insects are responsible for pollination in various ways. It includes a number honeybee's species i.e. *Apis florea*, *Apis mellifera*, *Apis dorsata* along with many Hymenopteran (Deodikar and Suryanarayana, 1977; Shelar and Suryanarayana, 1981; Baswana, 1984), syrphids (Chaudhary and Singh, 2007) and other dipteran flies, moths and butterflies, many unidentified hymenopteran and natural enemies like Coccinellids and Chrysoperla.

Among the various reasons for low yield, insufficient pollinators during blooming are to be considered as one of the major limiting factor for lowering the production per unit area. Honeybees are to be considered as major pollinators of coriander crops in semi-arid region of Rajasthan play a major role in enhance the quality of coriander.

## Materials and Methods

The present investigation was conducted at the institute's farm, NRC on Seed Spices (ICAR), Tabiji, Ajmer-305206 (Rajasthan) during *Rabi* season of 2014-15. The site is situated in mid part of Rajasthan. The center is located on 74° 35' 39" to 74° 36' 01" East longitude and 26° 22' 12" to 26° 22' 31" North latitude at an altitude of 460.17 m above mean sea level at Ajmer district of Rajasthan. The region falls under agro climatic zone III of Rajasthan.

The climate of this zone is typically semi-arid and sub-tropical characterized by mild winter and moderate summers and associated with relatively high humidity during the months of July-September. The mean annual rainfall is 590 mm, mostly received from south-west monsoon during the last week of June to October.

Weather, the non-monetary input influence the growth, yield and quality of crops as well as biotic phase of soil during the growing season, hence it is important to present climatic variables in this context. The mean weekly meteorological observations were recorded during the crop period from the meteorological observatory of the farm and also depicted in Figure 1. Data revealed that during coriander cropping season, maximum temperature was ranged from 18.3° C to 35.8° C whereas, minimum temperature ranged from 5.1 to 24.6° C during *Rabi* season of year 2014-15, respectively.

The experiment was laid out in factorial

randomized block design with four replications and six treatments. The treatments including: T<sub>1</sub>- without insect pollination (caged), T<sub>2</sub>- open pollination, T<sub>3</sub>- Jaggery solution (10%), Bee pollination with *Apis mellifera* -Caged, T<sub>4</sub>- Sugar solution (10%), T<sub>5</sub>- Jaggery solution (10%) and T<sub>6</sub>- Organic control (Organic salt 5ml/lit.)

## Foraging rate of *Apis* species

Foraging rate of the *Apis* foragers under observations was studied by counting the number of umbels visited per minute and in addition, the number of plants visited by the *Apis* species per minute was also recorded. These observations were taken during different times (06.00 to 18.00 h) at full blooming conditions of the crop in open conditions from all four replications.

## Results and Discussion

### Foraging rate of *Apis* species

The foraging rate of different honeybee species in coriander flowers was carried out to know the quantitative pollinator's status, their activities and foraging potential of honeybees on the crop for maximum pollination. The data were recorded at two hourly interval on foraging rate (the number of umbels visited by foragers minute<sup>-1</sup> and the number of plants visited by foragers hr<sup>-1</sup>) of *Apis* pollinators during winter season 2014-15 and have been presented in table 1-3.

*A. florea* started foraging on coriander at 08.00 h (0.10 bees m<sup>-2</sup>), its population increased abundantly and reached to maximum from 10.00 to 14.00 h (19.0-23.1 bee m<sup>-2</sup>) and then declined slowly to cease completely by 18.00 h. The population of *A. mellifera* was not seen till 08.00 h on coriander in winters and then appeared at low level (3.9 bees m<sup>-2</sup>) by 09.00 h, subsequently

increased to peaked from 12.00-14.00 h (14.3 to 17.0 bees m<sup>2</sup>), and then again declined to negligible (0.10 bees m<sup>2</sup>) at 18.00 h. *A. dorsata* was also started foraging at 09.00 h with low level, which gradually increased to its maximum level at 12.00 h (7.19).

The mean foraging rate was higher in *A. mellifera* (5.0) than *A. dorsata* (3.92) and *A. florea*, (2.91). Initially, *A. mellifera* was not observed on coriander flowers till 07.00 h because low temperature and fog water deposited on the floral parts but its population increased latterly. The maximum foraging rate of *A. mellifera* was recorded at 14.00 h (13.6 umbels visited min<sup>-1</sup>). Similarly, the average 1 plant and maximum 3.10 plants were visited by this species in each five minutes (Table 1).

The foraging rate of *A. dorsata* was not recorded up to 07.00 h, on coriander crop, which initiated (0.05) at 08.00 h and become highest at 12.00 h, where 10.66 umbels visited min<sup>-1</sup> by this species. Similarly, the average 1.07 plants and maximum 2.80 plants of coriander were visited in each five minutes by *A. dorsata* during clear and sunny days in winters (Table 2). The average foraging rate of *Apis florea* was recorded lower (2.91) than *A. mellifera* and *A. dorsata*, however, this species was more abundant on coriander. The maximum foraging rate of *A. florea* (9.80 umbels visited min<sup>-1</sup>) was noticed at 14.00 h and then declined at low level at 18.00 h (0.02 umbels visited min<sup>-2</sup>). Similarly, the average 0.93 plants and maximum 2.55 plants of coriander were visited in each five minutes by *A. florea* during 14.00 h (Table 3).

**Table.1** Mean foraging rate of *Apis mellifera* Linn. on coriander under OP conditions

| Time of Visits(hrs) | No. of umbels visited (min <sup>-1</sup> ) | No. of plants visited/five minutes |
|---------------------|--|------------------------------------|
| 6:00                | 0.0*                                       | 0.00                               |
| 8:00                | 0.1  | 0.02                               |
| 10:00               | 6.2  | 1.50                               |
| 12:00               | 10.7                                       | 2.20                               |
| 14:00               | 13.6                                       | 3.10                               |
| 16:00               | 3.9  | 0.20                               |
| 18:00               | 0.5  | 0.00                               |
| Mean                | 5.0  | 1.0                                |

\*Mean of four replication; OP- Open pollination

**Table.2** Mean foraging rate of *Apis dorsata* Fab. on coriander under OP conditions

| Time of Visits(hrs) | No. of umbels visited (min <sup>-1</sup> ) | No. of plants visited/five minutes |
|---------------------|--|------------------------------------|
| 6:00                | 0.0*                                       | 0.00                               |
| 8:00                | 0.05                                       | 0.01                               |
| 10:00               | 6.10                                       | 2.00                               |
| 12:00               | 10.66                                      | 2.80                               |
| 14:00               | 7.13                                       | 1.60                               |
| 16:00               | 2.50                                       | 1.00                               |
| 18:00               | 1.0  | 0.10                               |
| Mean                | 3.92                                       | 1.07                               |

\*Mean of four replication; OP- Open pollination

**Table.3** Mean foraging rate of *Apis florea* Fab. on coriander under OP conditions

| Time of Visits(hrs) | No. of umbels visited (min <sup>-1</sup> ) | No. of plants visited/five minutes |
|---------------------|--|------------------------------------|
| 6:00                | 0.00*                                      | 0.00                               |
| 8:00                | 0.10                                       | 0.10                               |
| 10:00               | 2.18                                       | 1.05                               |
| 12:00               | 5.63                                       | 1.20                               |
| 14:00               | 9.80                                       | 2.55                               |
| 16:00               | 2.56                                       | 1.60                               |
| 18:00               | 0.12                                       | 0.02                               |
| Mean                | 2.91                                       | 0.93                               |

\*Mean of four replication; OP- Open pollination

The foraging rate of different honeybee species in coriander flowers was carried out to know the quantitative pollinator's status, their activities and foraging potential of honeybees on the crop for maximum pollination.

The mean foraging rate was higher in *A. mellifera* (5.0) than *A. dorsata* (3.92) and *A. florea*, (2.91). Initially, *A. mellifera* was not observed on coriander flowers till 07.00 h because of low temperature and fog water deposited on the floral parts but its population increased latterly. The maximum foraging rate of *A. mellifera* was recorded at 14.00 h (13.6 umbels visited min<sup>-1</sup>). Similarly, the average 1 plant and maximum 3.10 plants were visited by this species in each five minutes. The similar results obtained in the study carried out by Choudhary and Singh (2007) and Kant *et al.*, (2013) who reported the foraging rate of *Apis cerana* (15.2), *A. mellifera* (13.1) and *Episyrphus balteatus* (7.8) and other hymenopterans on coriander crop. Sushil *et al.*, (2013) also reported that the more honeybee foragers visited broccoli followed by kohlrabi and finally Chinese cabbage with 6.05, 5.35 and 5.05 bees/plant, respectively are partially agreement with present results.

The maximum foraging rate of *A. mellifera* was recorded at 14.00 h (13.6 umbels visited

min<sup>-1</sup>). Similarly, the average 1 plant and maximum 3.10 plants were visited by this species in each five minutes. The foraging rate of *A. dorsata* was not recorded up to 07.00 h, on coriander crop, which initiated (0.05) at 08.00 h and become highest at 12.00 h, where 10.66 umbels visited min<sup>-2</sup> by this species.

Similarly, the average 1.07 plants and maximum 2.80 plants of coriander were visited in each five minutes by *A. dorsata* during clear and sunny days in winters. Synage (1947) reported the maximum foraging frequency of *A. mellifera* from 11.00 to 15.00 h whereas, for *A. cerana*, was shorter by 2 hours from 11.00 to 13.00 h and *A. dorsata* peaked from 10.00 to 12.00 h are accordance with the present findings.

Waheb and Ebadah (2011) was also reported the major bee pollinator and maximum activities of *A. mellifera* between 12.00 to 14.00 h.

The maximum foraging rate of *A. florea* (9.80 umbels visited min<sup>-1</sup>) was noticed at 14.00 h and then declined at low level at 18.00 h (0.02 umbels visited min<sup>-2</sup>). Similarly, the average 0.93 plants and maximum 2.55 plants of coriander were visited in each five minutes by *A. florea* during 14.00 h.

The average foraging rate of *Apis florea* was recorded lower (2.91) than *A. mellifera* and *A. dorsata*, however, this species was more abundant on coriander.

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