



P-ISSN: 2349-8528

E-ISSN: 2321-4902

IJCS 2017; 5(2): 543-547

© 2017 JEZS

Received: 21-01-2017

Accepted: 22-02-2017

Manoj Kumar

Assistant Professor-cum-Junior
Scientist, Department of
Entomology, Dr. Rajendra
Prasad Central Agricultural
University, Pusa, Samastipur,
Bihar, India

Ramashrit Singh

University Professor- cum-Chief
Scientist, Department of
Entomology, Dr. Rajendra
Prasad Central Agricultural
University, Pusa, Samastipur,
Bihar, India

Foraging activity of *Apis* spp. on Coriander (*Coriandrum sativum* L.) flowers

Manoj Kumar and Ramashrit Singh

Abstract

The foraging rate (number of flowers visited/minute) by honeybee species recorded from coriander bloom revealed that the maximum number of flowers (12.87, 9.78) visited per minute by *A. florea* followed by *A. c. indica* (11.03, 8.04) and *A. mellifera* (9.77, 6.99) while the minimum was recorded in *A. dorsata* (8.09, 6.52) for gathering a load of pollen/nectar or both. The maximum mean numbers of flowers were visited at 1200 noon followed by 14.00 PM and minimum at 10.00 AM on almost all dates of observation in both the years. The foraging speed (time spent in second/flower) of honeybee species recorded from coriander bloom revealed that *A. dorsata* spent more time (7.03, 6.41 hrs) for foraging followed by *A. mellifera* (6.30, 5.53) and *A. c. indica* (4.36, 4.00) while the minimum was spent by *A. florea* (3.12, 3.10) for gathering a load of pollen/nectar or both. The maximum foraging speed was recorded at 12.30 PM followed by 14.30 PM while the minimum foraging speed were at 10.30 AM on all dates of observations in both the years.

Keywords: Foraging rate, Foraging speed, *Apis* spp., Coriander

Introduction

Coriander (*Coriandrum sativum* L.) is an important Umbelliferous spice crop grown widely in India. Although seed yield of this crop has been shown to improve considerably by adopting proper cultural practices but insect pollinators have also been reported to play an important role in seed production of Coriander crop. This is because most of the Umbelliferous crops are cross-pollinated mainly by insects. However, little efforts have so far been made in utilizing insect pollinators for seed production in Coriander crop. The humming song of bees and other insects can be heard on entering the field during the blossoming period of the crop. Mishra (1995) ^[1] reported that coriander (*Coriandrum sativum* L.), fennel (*Foeniculum vulgare* L.) and carrot (*Daucus carota* L.) flowers are favourably visited by honeybees more for nectar but also to obtain pollen in the absence of better flora from February to March.

Materials and Methods

The field experiment was conducted at University Apiary, Rajendra Agriculture University (Bihar), Pusa during rabi season of 2006 and 2007. Foraging rate (Number of flowers visited by bees per minute) and foraging speed (time in seconds spent by bees per flower) were recorded on different hours of the day. The foraging rate were recorded from 7th Feb to 19th Feb 2006 and 6th Feb to 18th Feb, 2007 at three days interval at 2 hours interval from 1000 to 1400 hrs on each day, while foraging speed were recorded from 8th Feb to 20th Feb, 2006 and 7th Feb to 19th Feb, 2007 at three days interval at 2hrs interval from 1030 to 1430 hrs on each day.

Results and Discussion

The foraging rate (number of flowers visited/minute time) of honeybee species was recorded from coriander bloom during 2006 have been presented in Table 1. The foraging rate was recorded from 7th February to 19th February, 2006 at 3 days intervals from 10.00 AM to 14.00 PM on each day of observations. The table revealed that different species under study showed differential number of flowers visited per minute time Interestingly all the bees under study invariably, irrespective of species visited more and more number of flowers per minute during day hours i.e. from 1000 to 1400 hrs. It was evident from the table that among the four species of honeybees the maximum number of flower was visited per minute by *A. florea* (12.87) followed by *A. c. indica* (11.03) and *A. mellifera* (9.77) while the minimum was recorded in *A.*

Correspondence**Manoj Kumar**

Assistant Professor-cum-Junior
Scientist, Department of
Entomology, Dr. Rajendra
Prasad Central Agricultural
University, Pusa, Samastipur,
Bihar, India

Dorsata (8.09) for gathering a load of pollen/nectar or both. The number of flowers visited by honeybees at different hours of the day also varied widely. The maximum mean number of flower was visited at 1200 noon being 10.83, 11.03, 10.77, 12.01 and 12.32 on 7th, 10th, 13th, 16th and 19th February, 2006, respectively and lowest at 10.00 AM being 9.19, 9.21, 9.42, 9.83 and 10.60 flowers, respectively on different day. The foraging rate on different dates of observations also varied markedly. The maximum foraging rate (11.53) flower per minute was recorded on 19th February, 2006 followed by (10.69) on 16th February, 2006 and lowest (9.80) on 7th February, 2006. The variation in foraging rate on different dates might be influenced either by age of flower or by weather conditions. The temperature and relative humidity prevailing on different dates varied significantly. It was evident from the table 1 that maximum temperature (23.10°C) on 19th February, 2006 resulted in maximum mean foraging rate being 11.53 flower/minute whereas the lowest foraging rate, 9.80 flower/minute was recorded when temperature was 19.05°C on 7th February, 2006. However, the foraging rate was maximum (11.53 flower per minute) when the relative humidity was 77.50% and lowest (9.80 flower per minute) was recorded when the relative humidity was 75.00%.

During 2007, there was a significant difference in the foraging rate on coriander bloom. It was evident from the table 2 that among the four species of honeybees the maximum number of flowers were visited per minute by *A. florea* (9.78) followed by *A. c. indica* (8.04) and *A. mellifera* (6.99) while the minimum was recorded in *A. dorsata* (6.52) for gathering a load of pollen/nectar or both. The number of flowers visited by honeybees at different hours of the day also varied widely. The maximum mean number of flower was visited at 1200 noon being 9.21, 10.09, 8.51, 7.83 and 8.06 on 6th, 9th, 12th, 15th and 18th February, 2007, respectively on different days. The foraging rate on different dates of observations also varied markedly. The maximum foraging rate (9.06 flower per minute) was on 9th February, 2007 followed by (8.37) on 6th February, 2007 and lowest (6.97 flower per minute) on 15th February, 2007. The variation in foraging rate on different dates might be influenced either by age of flower, by weather conditions or quantity of pollen/nectar. The temperature and relative humidity prevailing on different dates varied significantly. It was evident from the table 2 that maximum temperature (18.85°C) on 9th February, 2007 resulted in maximum mean foraging rate, being 9.06 flower per minute, whereas the lowest foraging rate (6.97 flower per minute) was recorded when temperature was 12.65°C on 15th February, 2007. However, the foraging rate was maximum (9.06 flower per minute) when the relative humidity was 77.50% and lowest (6.97 flower per minute) was recorded when the relative humidity was 70.50%. Thus, it may be concluded that *A. florea* being lightest in body weight had highest foraging rate followed by *A. c. indica* and *A. mellifera* while the *A. dorsata* being heaviest had lowest foraging rate on coriander in both the years under study. The maximum foraging rate, recorded at 1200 noon in both the years, revealed that day temperature influenced more foraging during mid-day than forenoon and afternoon. The variation in foraging rate on different dates revealed that age of flower influenced the foraging rate. Full bloom umbel favoured more foraging than the flowers of early age or near maturity. Higher temperature increased the foraging rate. More or less similar observations on foraging rate in different crops had been reported by earlier workers also. Gilbert (1980) [2] reported that foraging rate (number of flowers visited per minute) and foraging speed

(time in second spent per flower) depends upon the foraging behaviour of insects and the floral structure of the crop concerned. Shelar and Suryanarayana (1981) [3] reported that *Apis cerana indica*, *Apis florea* and *Trigona* visited 14.5, 12.6 and 9.7 umbels and 3.5, 2.5 and 1.8 plants per minute during foraging coriander crops. Goyal *et al.* (1989) [4] found that on *Daucus carota*, *A. c. indica* visited fewer umbels in a trip than *A. mellifera*. The average time taken per trip was 19.2/minute and 20.4/minute by *A. c. indica* and *A. mellifera*, respectively. Kumar *et al.* (2003) [5] reported that the foraging rate (number of capitulum visited by bees/minute) revealed more number of capitulum (12.85) were visited by *Apis cerana indica* F. compared to *Apis mellifera* L. (10.98). The foraging rate was maximum at 1.00 PM and minimum at 10.00 A.M for both the species. Kumar (2005) [6] reported that foraging rate (no. of flowers visited/minute) of *Apis florea* on bitter gourd, sponge gourd, bottle gourd and cucumber were 13.1, 8.15, 9.30, 9.55, respectively.

The foraging speed (time spent in second/flower) of honeybee species was recorded from coriander blooms during 2006 and data so obtained have been presented in Table 3. The foraging speed was recorded from 8th February to 20th February, 2006 at 3 days intervals from 10.30 AM to 14.30 PM on each day of observation. The data revealed that *A. dorsata* spent more time (7.03 second/umbel) for foraging followed by *A. mellifera* (6.30 second/umbel) and *A. c. indica* (4.36 second/umbel) while minimum time was spent by *A. florea* (3.12 second/umbel). The observations recorded on various dates during flowering time, exhibited that the foraging speed of honeybees, *A. mellifera*, *A.c. indica*, *A. dorsata* and *A. florea* were more in the later stage of flowering than the early stage, as evidenced from time spent (second/umbel) 6.03, 4.26, 6.60 and 2.96 on 8th February, 2006, 6.30, 4.33, 7.23 and 3.06 on 11th February, 2006, 6.63, 4.36, 7.40 and 3.23 on 14th February, 2006, 5.90, 4.20, 6.40 and 2.93 on 17th February, 2006 and 6.66, 4.66, 7.53 and 3.40 on 20th February, 2006, respectively. The foraging speed of *Apis* spp. also varied with hour of the day. The maximum speed of foraging was recorded at 12.30 PM on all the dates of observations *viz.*, 5.45, 5.75, 5.98, 5.10 and 6.03 second/umbel on 8th, 11th, 14th, 17th and 20th February, 2006, respectively and lowest foraging speed were at 10.30 AM being 4.60, 4.60, 5.08, 4.83 and 5.05 on above dates of observation, respectively. The foraging speed on different dates of observations also varied markedly. The maximum foraging speed (5.57 second/umbel) was on 20th February, 2006 followed by (5.41 second/umbel) on 14th February, 2006 and lowest (4.86 second/umbel) on 17th February, 2006.

The temperature and relative humidity prevailing on different dates varied significantly. The foraging speed in relation to day temperature and relative humidity revealed that maximum time (5.57 second/umbel) was spent when the temperature was 23.60°C and relative humidity was 79.00% on 20th February, 2006 and lowest time spent (4.86 second/umbel) was when the temperature was minimum (17.70°C) and relative humidity was (68.50%) on 17th February, 2006. During 2007, there was a significant difference in the foraging speed on coriander bloom. It was evident from the table 4 that among the four species of honeybees the maximum time spent in second per flower by *A. dorsata* was 6.41 followed by *A. mellifera* (5.53) and *A.c. indica* (4.00) while the minimum time spent by *A. florea* (3.10) for gathering a load pollen/nectar or both. The foraging speed on different dates of observations also varied markedly. The maximum foraging speed (5.33 second/umbel) was on 10th February, 2007

followed (4.98 second/umbel) on 13th February, 2007 and lowest (4.24 second/umbel) on 16th February, 2007. The foraging speed of *Apis* spp. also varied on different hours of the day. The maximum speed of foraging was recorded at 12.30 PM on all the dates of observations viz., 5.33, 5.95, 5.60, 4.78 and 5.05 second/umbel on 7th, 10th, 13th, 16th and 19th February, 2007, respectively and lowest foraging speed were at 10.30 AM being 4.35, 4.83, 4.53, 4.00 and 4.23 on above dates of observation, respectively. It was also evident from the table 4 that maximum temperature (19.70 °C) on 10th February, 2007 resulted in maximum foraging speed being 5.33 second/umbel whereas lowest foraging speed (4.24 second/umbel) was recorded when temperature was minimum (15.95 °C) on 16th February, 2007. However, the foraging speed was maximum (5.33 second/umbel) when relative humidity was 80.00% and lowest (4.24 second/umbel) when the relative humidity was (63.50%).

Thus, it may be concluded that among the *Apis* spp., *A. dorsata* being heaviest in body weight had highest foraging speed followed by *A. mellifera* and *A. C. indica* while the *A. florea* being lightest had lowest foraging speed on coriander in both the years which is rich in pollen and nectar. The foraging speed of *Apis* spp. in relation to day hour revealed that highest speed was recorded at 12.30 PM and lowest at 10.30 AM in both the years. This clearly shows that day temperature influenced the foraging speed of *Apis* spp. The variation in foraging speed on different dates might be influenced either by age of flower or by weather conditions. The temperature and relative humidity prevailing on different

dates varied significantly in both the years. More or less similar observations on foraging speed in different crops had been reported by earlier workers also. Gilbert (1980) [2] reported that foraging speed (time in second spent per flower) and foraging rate (number of flowers visited per minute) depends upon the foraging behaviour of insects and the floral structure of the crop concerned. Kumar *et al.* (1989)[7] reported that on a plot caged with 4-frame nucleus hive of *Apis cerana* onion umbels received an average time spent by a bee on a flower were 3.5 and 3.3 second in an open plots, respectively. Sharma and Singh (1999) [8] reported that foraging behaviour of *Apis* species on carrot umbels indicated that *A. florea* spent more time (27.09 sec/umbel) than *A. dorsata* (9.20 sec/umbel) and visited 2.20 and 4.40 umbels/min, respectively. Chaudhary and Kumar (2002) [9] reported that *A. mellifera* spent least time (5.2 sec./flower) to collect pollen whereas, *A. c. indica* spent maximum time (5.5 sec./flower). *A. florea* spent maximum time to collect pollen (7.2 sec./flower). Kumar *et al.* (2003) [5] reported that the foraging speed (time in seconds spent by a bee per capitulum) revealed that *A. mellifera* spent more time (6.69 seconds/capitulum) compared to *Apis cerana indica* (5.37 seconds/capitulum). The foraging speed of both the species was recorded highest at 2.00 PM and lowest at 10.00 AM. Kumar (2005) [6] reported that the maximum mean time (sec) spent/flower by *Apis mellifera* on bitter gourd, sponge gourd and cucumber was recorded to be 7.43, 6.69, 7.66, respectively and on bottle gourd *Apis cerana indica* (7.15).

Table 1: Foraging rate (number of flowers visited/minute) of *Apis* spp. on Coriander bloom during 2006

Date of Observation	Time of Observation (hrs.)	<i>Apis</i> spp.				Mean no. of flowers visited /minute at different hrs. of the day	Mean Temp. (°C)	Mean R.H. (%)
		Mean number of flowers visited/minute by <i>Apis</i> spp.*						
		<i>A. mellifera</i>	<i>A. dorsata</i>	<i>A. C. indica</i>	<i>A. florea</i>			
	1000	8.50	8.00	10.04	10.20	9.19		
07.02.2006	1200	10.00	8.20	11.68	13.42	10.83	19.05	75.00
	1400	9.70	7.30	9.10	11.43	9.38		
	Mean	9.40	7.83	10.27	11.68	9.80		
	1000	8.70	7.90	9.90	10.32	9.21		
10.02.2006	1200	10.80	8.40	11.44	13.47	11.03	19.85	72.00
	1400	9.90	7.90	10.13	11.92	9.96		
	Mean	9.80	8.06	10.49	11.90	10.07		
	1000	9.70	7.50	9.87	10.60	9.42		
13.02.2006	1200	10.60	8.20	10.80	13.49	10.77	20.25	72.50
	1400	9.40	8.00	11.50	12.31	10.30		
	Mean	9.90	7.90	10.72	12.13	10.16		
	1000	9.20	8.80	10.10	11.20	9.83		
16.02.2006	1200	9.70	9.20	13.33	15.80	12.01	22.90	74.50
	1400	9.80	7.00	11.64	12.46	10.23		
	Mean	9.56	8.33	11.69	13.15	10.69		
	1000	9.40	8.40	10.70	13.90	10.60		
19.02.2006	1200	10.20	8.10	13.65	17.32	12.32	23.10	77.50
	1400	11.10	8.60	11.72	15.25	11.67		
	Mean	10.23	8.36	12.02	15.49	11.53		
Grand Mean		9.77	8.09	11.03	12.87	10.45		
		CD(P=0.05)	S.Em (+)					
Hours		0.180	0.064					
Insect Visitors		0.208	0.074					
Hour x Insect visitors		0.360	0.129					

* Mean of 5 observations during peak blooming period.

Table 2: Foraging rate (number of flowers visited/minute) of *Apis* spp. on Coriander bloom during 2007

Date of Observation	Time of Observation (hrs.)	<i>Apis</i> spp.						
		Mean number of flower visited/minute by <i>Apis</i> spp.*				Mean no. of flowers visited /minute at different hrs. of the day	Mean Temp. (°C)	Mean R.H. (%)
<i>A. mellifera</i>	<i>A. dorsata</i>	<i>A. c. indica</i>	<i>A. florea</i>					
	1000	6.40	6.10	7.43	9.70	7.41		
06.02.2007	1200	8.51	7.33	9.56	11.43	9.21	18.55	92.50
	1400	8.40	7.01	8.42	10.08	8.48		
	Mean	7.77	6.81	8.47	10.40	8.37		
	1000	7.42	6.87	7.49	9.98	7.94		
09.02.2007	1200	9.53	8.49	10.23	12.09	10.09	18.85	77.50
	1400	9.03	7.26	9.07	11.23	9.15		
	Mean	8.66	7.54	8.93	11.10	9.06		
	1000	5.90	5.74	7.23	9.07	6.99		
12.02.2007	1200	7.26	7.09	8.49	11.20	8.51	17.30	86.00
	1400	6.40	6.21	7.32	9.47	7.35		
	Mean	6.52	6.35	7.68	9.91	7.62		
	1000	5.23	5.07	7.10	8.00	6.35		
15.02.2007	1200	7.10	6.43	8.27	9.53	7.83	12.65	70.50
	1400	6.22	5.93	7.11	7.61	6.72		
	Mean	6.18	5.81	7.49	8.38	6.97		
	1000	6.27	5.19	7.20	8.30	6.74		
18.02.2007	1200	6.39	7.00	8.42	10.42	8.06	16.70	69.00
	1400	4.93	6.02	7.26	8.54	6.69		
	Mean	5.86	6.07	7.63	9.09	7.16		
Grand Mean		6.99	6.52	8.04	9.78	7.84		
		CD(P=0.0)	S.Em (±)					
Hours		0.075	0.027					
Insect Visitors		0.087	0.031					
Hour x Insect visitors		0.150	0.054					

* Mean of 5 observations during peak blooming period.

Table 3: Foraging speed (time spent in second/flower) of *Apis* spp. on Coriander during 2006

Date of observation	Time of observation (hrs.)	<i>Apis</i> spp.						
		Mean time (second) spent/flower by <i>Apis</i> spp.*				Mean time (second) spent/flower	Mean Temp. (°C)	Mean R.H. (%)
<i>A. mellifera</i>	<i>A. c. indica</i>	<i>A. dorsata</i>	<i>A. florea</i>					
	1030	5.8	3.5	6.1	3.0	4.60		
08.02.2006	1230	6.0	4.9	7.7	3.2	5.45	19.60	72.50
	1430	6.3	4.7	6.0	2.7	4.93		
	Mean	6.03	4.26	6.60	2.96	4.99		
	1030	5.7	4.0	5.8	2.9	4.60		
11.02.2006	1230	7.0	4.6	8.0	3.4	5.75	20.35	67.00
	1430	6.2	4.4	7.9	2.9	5.35		
	Mean	6.30	4.33	7.23	3.06	5.23		
	1030	6.4	4.3	6.2	3.4	5.08		
14.02.2006	1230	7.2	4.9	8.4	3.4	5.98	20.35	69.50
	1430	6.3	3.9	7.6	2.9	5.18		
	Mean	6.63	4.36	7.40	3.23	5.41		
	1030	5.5	4.7	6.2	2.9	4.83		
17.02.2006	1230	6.2	3.9	7.1	3.2	5.10	17.70	68.50
	1430	6.0	4.0	5.9	2.7	4.65		
	Mean	5.90	4.20	6.40	2.93	4.86		
	1030	6.0	3.8	6.9	3.5	5.05		
20.02.2006	1230	7.2	5.3	8.0	3.6	6.03	23.60	79.00
	1430	6.8	4.9	7.7	3.1	5.63		
	Mean	6.66	4.66	7.53	3.40	5.57		
Grand Mean		6.30	4.36	7.03	3.12	5.21		
		CD(P=0.05)	S.Em (±)					
Hours		0.097	0.035					
Insect Visitors		0.112	0.040					
Hour x Insect visitors		0.195	0.070					

* Mean of 5 observations during peak blooming period.

Table 4: Foraging speed (time spent in second/flower) of *Apis* spp. on Coriander bloom during 2007

Date of Observation	Time of Observation (hrs.)	<i>Apis</i> spp.						
		Mean time (second) spent/flower by <i>Apis</i> spp.*				Mean time (second) spent/flower	Mean temp. (°C)	Mean R.H. (%)
		<i>A. mellifera</i>	<i>A. c. indica</i>	<i>A. dorsata</i>	<i>A. florea</i>			
07.02.2007	1030	5.0	4.0	5.0	3.4	4.35	16.95	86.50
	1230	6.2	4.2	7.6	3.3	5.33		
	1430	5.4	3.8	6.2	3.0	4.60		
	Mean	5.53	4.00	6.27	3.23	4.76		
10.02.2007	1030	5.8	4.3	5.9	3.3	4.83	19.70	80.00
	1230	6.7	4.9	8.1	4.1	5.95		
	1430	6.1	4.5	7.3	2.9	5.20		
	Mean	6.20	4.57	7.10	3.43	5.33		
13.02.2007	1030	5.2	4.0	5.6	3.3	4.53	18.35	90.50
	1230	6.4	4.4	8.0	3.6	5.60		
	1430	5.8	4.2	6.4	2.8	4.80		
	Mean	5.80	4.20	6.67	3.23	4.98		
16.02.2007	1030	4.4	3.9	4.7	3.0	4.00	15.95	63.50
	1230	5.3	3.3	7.2	3.3	4.78		
	1430	5.0	3.0	5.7	2.0	3.93		
	Mean	4.90	3.40	5.87	2.77	4.24		
19.02.2007	1030	4.7	4.2	5.0	3.0	4.23	16.50	63.50
	1230	5.7	3.9	7.4	3.2	5.05		
	1430	5.2	3.4	6.0	2.4	4.25		
	Mean	5.20	3.83	6.13	2.86	4.51		
Grand Mean		5.53	4.00	6.41	3.10	4.76		
		CD(P=0.05)		S.Em (+)				
Hours		0.085	0.030					
Insect Visitors		0.098	0.035					
Hour x Insect visitors		0.170	0.061					

* Mean of 5 observations during peak blooming period

References

- Mishra RC. Honeybees and their management in India. ICAR Publ. New Delhi, 1995, 146/168.
- Gilbert FS. Flowers visiting by hover flies (Syrphidae). Ann. Rev. Ecol. and Syst. 1980; 6:139-170.
- Shelar DG, Suryanarayana MC. Preliminary studies on pollination of coriander (*Coriandrum sativum* L.). Indian Bee J. 1981; 43(4):110-111.
- Goyal NP, Singh Manjit, Kandoria JL. Role of insect pollination in seed production of carrot, *Daucus carota* L. Indian Bee J. 1989; 51(3):89-93.
- Kumar M, Singh R, Chand H. Foraging rate and foraging speed of *Apis cerana indica* Fab. And *Apis mellifera* L. in sunflower (*Helianthus annuus* L.) Shashpa. 2003; 10(1):27-32.
- Kumar R. Foraging activity of honeybees on summer cucurbits. Published M.Sc.(Ag) Thesis, R.A.U., Pusa, Bihar, 2005.
- Kumar J, Mishra RC, Gupta JK. Effect of honeybee pollination on onion (*Allium cepa* L.) seed production. Indian Bee J. 1989; 51(1):3-5.
- Sharma SK, Singh JR. Pollinating efficiency of *Apis dorsata* and *A. florea* on carrot (*Daucus carota*). Indian Bee J. 1999; 61(1-4):75-78.
- Chaudhary OP, Kumar R. Honeybee foraging behaviour and pollination studies on Niger (*Guizotia abyssinica* Cass.) J oilseeds Res. 2002; 19(2):257-258.