

Abundance and Foraging Behaviour of *Apis mellifera* on Different Cultivars of Cucumber under Polyhouse

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ABSTRACT

Apis mellifera colony was introduced in polyhouse for pollination of cucumber. *A. mellifera* commenced its activity early in the morning at 0700h and attained its peak activity and maximum abundance on cucumber during 0900-1000 h. The cessation of bee activity took place during 1700-1800 h. Maximum activity of bees (7.64 bees/2 plants/5min) on Rani and minimum (4.67bees/2plants/5min) on Pant Sankar Khira was observed during different hours of the day. Significant increase in visiting frequency of honey bees was observed at the time of full bloom of cucumber and again the abundance decreased significantly at the time of cessation of the flowering. *A. mellifera* spent maximum time (20.18seconds/flower) during 0900-1000 h on Pusa Sanyog. On five hybrids (Pant Sankar Khira, Sheetal, Rani, Pusa Sanyog and Mohini) *A. mellifera* spent average time 12.94, 16.23, 18.29, 15.74 and 13.84 seconds/flower, respectively, during peak of flowering period (23-29.04.03). The foraging rate of *A. mellifera* was highest (3.59 flowers/min) prior to cessation of flowering during (30.04-06.05.03) and was significantly higher than all other foraging rates observed in different standard weeks except 3.54 flowers/min during (7-13.05.03), which was statistically at par with each other.

Key words: *Apis mellifera*, abundance, cucumber, foraging speed, pollination, polyhouse

INTRODUCTION

Cucumber being a cross-pollinated and entomophilous crop, the pollen transfer depends upon the foraging behaviour of insect visitors. There are large numbers of insects, which visit the flowers of cucumber for the collection of nectar and/or pollen (Free, 1993; McGregor, 1976; Grewal and Sidhu, 1978) in the field. The honey bees play an important role in pollination of cucumber. At least five honeybee visits per flower is required to pollinate and each honeybee visits about 100 flowers per foraging trip (Rorry, 2000). Poor fruit-set and deformed fruits were the results of inadequate pollination. Therefore, pollination of crops by insects has great influence on the quality and quantity of marketable fruits and seed production (Free, 1993). Importance of honey bee as powerful pollinator in different crops and vegetables was reported by Munawar *et al.* (2009) from Pakistan, Viraktamath (2010), Lal and Singh (2012) from India, Liu *et al.* (2011) and Wang (2011) from China and Munyuli (2011) from Uganda. Honey bees were observed the largest group (77.2%) of pollinating agents in cucurbits (Grewal and Sidhu, 1978). *A. mellifera* constituted 18.47 per cent of visitors to cucumber flowers at Hisar (Gahlawat *et al.*, 2002). In India cucumber is grown in greenhouse/polyhouse during off-season. However, in polyhouses insect pollinators cannot enter and pollinate the crop. Manual or hand pollination is very cumbersome, costly and not as effective as insect/bee pollination. Keeping in the importance of pollinators in polyhouse, an experiment was planned to record the abundance and foraging behavior of Honey bee, *A. mellifera* on the flowers of different hybrids of cucumber

MATERIALS AND METHODS

The present study was carried out on five hybrids of cucumber viz., Pant Sankar Khira, Sheetal, Rani, Pusa Sanyog and Mohini at Greenhouse/polyhouse area of Department of Vegetable Science CCS Haryana Agricultural University, Hisar, Haryana (India). A colony of *A. mellifera* (three frames) was introduced in polyhouse. The humidity, light intensity and temperature under polyhouse were recorded with the help of hygrometer, lux meter and thermometer, respectively. Abundance, number of honey

bees visiting on the flowers of two randomly selected adjoining plants per five minutes of each hybrids, using a hand tally counter and stop watch by visual counting method from flower initiation to the end of flowering at hourly interval from 0600 to 1800 h at weekly interval (13th to 19th standard week) was recorded. Foraging speed, time spent by honey bees was observed on flowers of each hybrid of cucumber and number of flowers visited per minute, including the flying time from one flower to another flower, irrespective of cultivar at hourly interval from 0600 to 1800 h at weekly interval. The time spent to insert the proboscis and suck up the nectar or brushing/collecting pollen was recorded with the help of a chronometer having an accuracy of 0.01 second.

RESULTS AND DISCUSSION

Abundance of *Apis mellifera*. In polyhouse *A. mellifera* commenced its activity early in the morning at 0700h. It attained its peak activity during 0900-1000 h and cessation of activity took place during 1700-1800 h. The mean abundance of honey bees was observed maximum during 0900-1000 h and minimum during 1700-1800 h. Among the different hybrids, maximum activity was observed 7.64 bees/2 plants/ 5 min on Rani and it was minimum (4.67bees/2plants/5min) on Pant Sankar Khira during different hours of the day. The maximum activity (8.25, 9.50 and 11.28 bees/2plant/5min) of honey bees was observed during 0900-1000 h on Pant Sankar Khira, Sheetal and Pusa Sanyog, respectively, while it was maximum 13.35 and 8.32 bees/2 plant/5 min on Rani and Mohini, respectively during 1000-1100 h, which was significantly higher than all other observations of the day (Table 1).

The data in table 2 revealed that on Pant Sankar Khira maximum abundance (6.36bees/2plants/5min) was observed during peak of flowering period (16-22.04.03) and minimum (2.31bees/2plants/5min) at the time of flower initiation (26.03-1.04.03). Likewise maximum abundance of honey bees on Rani and Mohini was during middle of flowering period (16-22.04.03) with the mean of 9.54 and 7.31bees/2plants/5min, respectively. The maximum value for Sheetal and Pusa Sanyog was observed 6.59 and 9.09

bees/2 plants/5 min, respectively, at the peak of flowering period (23-29.04.03). The lowest mean abundance on Pant Sankar Khira and Sheetal was observed during initiation of flowering period (26.03-1.04.03) with the values of 2.31 and 3.15 bees/2 plants/5 min, respectively. Whereas lowest mean abundance on Rani, Pusa Sanyog and Mohini were observed during cessation of flowering period (07-13.05.03) with the mean values of 4.06, 4.15 and 2.38 bees/2 plants/5 min, respectively. Average number of bees throughout the day irrespective of hybrids was low in the beginning of flowering and cessation of flowering. Significant increase in visiting frequency of honey bees was observed at the time of full bloom and again the abundance decreased significantly at the time of cessation of the flowering.

Finding of Gahlawat *et al.*, (2002) who reported that *Apis mellifera* started visits on cucumber flowers early in the morning 0600 h and the peak was observed at 0800 h, which was significantly higher than those of any other time of the day, support the present investigation. They further reported that *A. mellifera* constituted 18.47 per cent of visitors to cucumber flowers at Hisar with 0.08, 2.58, 1.75 and 0.83 bees/m²/5min at 0600, 0800, 1000 and 1200 h, respectively. Grewal and Sidhu (1978) from Punjab stated that 16 species of bees visited flowers of *Cucurbita pepo* L., *Cucumis melo* L., *M. charantia* L. They further reported that *Apis* spp. constituted 70 and 77 per cent of the total number of visiting bees during 1974 and 1975, respectively.

Foraging speed/time spent per flower. *A. mellifera* spent maximum time (20.18seconds/flower) during 0900-1000 h on Pusa Sanyog and was significantly higher than time spent/flower on all other hybrids. The foraging speed of honey bees was observed maximum (15.37, 19.27, 20.03, 20.18 and 14.63 seconds/flower) during 0900-1000 h on Pant Sankar Khira, Sheetal, Rani, Pusa Sanyog and Mohini, respectively and significantly higher than foraging speed of all other hours of the day, it was observed minimum (7.70, 7.65 and 4.33 seconds/flower) on Sheetal, Rani and Mohini, respectively and 6.53 and 8.40 seconds/flower on Pant Sankar Khira and Pusa Sanyog, respectively. Irrespective of hours of the day honeybee spent maximum time (14.95seconds/flower) on Rani, which was significantly more than the time spent on other hybrids, while minimum (10.45seconds/flower) on Mohini. (Table 1). On five hybrids (Pant Sankar Khira, Sheetal, Rani, Pusa Sanyog and Mohini) honey bees spent average maximum time 12.94, 16.23, 18.29, 15.74 and 13.84 seconds/flower, respectively, during peak of flowering period (23-29.04.03), which were significantly higher than all other time spent/flower observed during different standard weeks. Honey bees spent average minimum time 7.33, 9.15, 9.64, 8.88 and 7.25 seconds/flower on Pant Sankar Khira, Sheetal, Rani, Pusa Sanyog and Mohini, respectively, at the time of cessation of flowering during 19th standard week (07-13.05.03) (Table 2). The time spent per flower by *A. mellifera* was observed maximum (15.41seconds) during peak of flowering period (23-29.04.03) and was significantly higher than time spent/flower during all other standard weeks. Whereas honey bees spent minimum time (8.45 seconds/flower) at the time of cessation of flowering during (07-13.05.03) and was significantly lower than all other foraging speed observed during different standard weeks (Table 3). Irrespective of hybrids honey bees spent maximum time/flower during peak of flowering period (16-29.04.03), which were significantly higher than all other observations of foraging speed during different standard weeks (Table 6). The minimum foraging speed 9.64, 10.71, 12.12, 11.26, 10.40, 8.74, 4.56, 3.84, 6.53, 8.69 and 6.45 seconds/flower of honey bees was observed at 0700-0800, 0800-0900, 0900-1000, 1000-1100, 1100-1200, 1200-1300, 1300-1400, 1400-1500, 1500-1600, 1600-1700 and 1700-1800 h at the time of cessation of

flowers during (7-13.05.03) and significantly lower than all other observations.

These findings are in close proximity with Collison and Martin (1979), who reported that except in early morning and late afternoon, the average time a bee spent on a flower of cucumber decreased throughout the day. The average, 11.4 seconds per flower visit, corresponds to a foraging rate of 5.3 flowers per minute. While Foster and Levin (1967) observed that bees spent about 6.6 and 3.15 seconds per flower on two strains of muskmelon.

Foraging rate/flowers visited per minute. The perusal of the data presented in Table 3 revealed that irrespective of hybrids and hours of the day, the foraging rate of *A. mellifera* was highest (3.59 flowers/min) prior to cessation of flowering during (30.04-06.05.03) and was significantly higher than all other foraging rates observed in different standard weeks except 3.54 flowers/min during (7-13.05.03), which was statistically at par with each other. The foraging rate of honey bees at the time of initiation of flowering during 14th standard week (2-8.04.03) 3.22, 15th standard week (9-15.04.03) 3.09, 13th standard week (26.03-1.04.03) and 16th standard week (16-22.04.03) 2.95 did not show any significant difference among themselves but was significantly higher than 2.79 flowers/minute at peak period of flowering during (23-29.04.03), which was statistically lower than all other foraging rates observed during study. The number of flower visited per minute by honey bees was highest (3.57) during 1600-1700 h, which was at par with 3.39, 3.39, 3.35, 3.28 and 3.28 flowers per minute during 1200-1300, 1700-1800, 0700-0800, 1400-1500 and 1500-1600 h, respectively and was statistically higher than 3.10, 3.07, 3.00, 2.82 and 2.67 flowers per minute during 1100-1200, 0800-0900, 1300-1400, 1000-1100 and 0900-1000 h, respectively, which were at par with each other, irrespective of flowering period.

These results are in the same lines as reported by (Kropakova *et al.*, 1974). They observed that *A. mellifera* visited 4 to 5 blooms per minute of cucumber. But Gahlawat *et al.* (2002) reported that the foraging rate of *A. mellifera* on cucumber was 17.90, 22.00, 20.43 and 15.85 flowers per minute during 0600, 0800, 1000 and 1200 h, respectively with a mean 19.05 flowers per minute. While Gupta *et al.* (1984) observed that *A. mellifera* visited 25.8 and 33.6 flowers per minute in the morning and afternoon, respectively.

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Table: 1 Abundance and foraging speed of *Apis mellifera* on the flowers of different hybrids of cucumber during different hours of the day under polyhouse

Hours of the day	Abundance (Number of bees/2 plants/5 min.)					Foraging speed{Time spent (seconds/flower)}				
	Pant Sankar Khira	Sheetal	Rani	Pusa Sanyog	Mohini	Pant Sankar Khira	Sheetal	Rani	Pusa Sanyog	Mohini
0700-0800	2.46	3.03	4.85	5.07	2.28	8.27	15.23	15.61	13.34	13.81
0800-0900	4.25	6.17	8.53	8.42	4.75	12.76	16.53	19.34	15.58	14.11
0900-1000	8.25	9.50	12.71	11.28	7.67	15.37	19.27	20.03	20.18	14.63
1000-1100	7.53	7.96	13.35	9.78	8.32	14.10	18.10	19.16	16.85	13.04
1100-1200	5.92	5.42	9.50	8.28	6.75	12.95	15.60	17.45	15.80	11.92
1200-1300	3.78	4.07	6.00	6.21	5.03	10.89	14.56	14.88	13.40	11.06
1300-1400	2.25	2.78	4.71	3.78	3.32	7.28	7.70	7.65	8.40	4.33
1400-1500	4.53	3.07	6.17	5.78	5.89	6.53	8.04	10.09	9.47	6.20
1500-1600	6.21	5.07	8.71	7.25	7.07	9.45	11.80	12.41	10.46	8.88
C.D. 1600-1700	4.00	4.57	6.07	4.89	4.57	11.31	12.80	16.48	12.17	9.29
1700-1800	2.25	2.64	3.42	3.14	1.92	10.74	10.43	11.32	10.59	7.70
Mean	4.67	4.93	7.64	6.72	5.23	10.88	13.64	14.95	13.29	10.45

C.D. (p=0.05) for foraging speed

For hours of the day = 0.17

For hours of the day = 0.05

For hybrid = 0.12

For hybrid = 0.03

Table: 2 Abundance and foraging speed of *Apis mellifera* on the flowers of different hybrids of cucumber under polyhouse

Standard Weeks	Abundance (Number of bees/2 plants/5 min.)					Foraging speed(Time spent (seconds/flower))				
	Pant Sankar Khira	Sheetal	Rani	Pusa Sanyog	Mohini	Pant Sankar Khira	Sheetal	Rani	Pusa Sanyog	Mohini
13 th (26.03-1.04.03)	2.31	3.15	6.31	5.02	4.20	10.07	12.36	13.76	13.15	7.41
14 th (2-8.04.03)	3.54	3.72	7.34	5.75	5.15	10.65	13.79	15.31	14.00	8.43
15 th (9-15.04.03)	5.25	5.72	9.13	6.77	5.43	11.73	15.20	16.74	14.22	12.36
16 th (16-22.04.03)	6.36	6.22	9.54	8.72	7.31	12.65	15.92	17.02	14.88	13.25
17 th (23-29.04.03)	6.22	6.59	9.34	9.09	6.79	12.94	16.23	18.29	15.74	13.84
18 th (30.04-6.05.03)	5.52	5.38	7.75	7.52	5.36	10.76	12.85	13.87	12.20	10.63
19 th (7-13.05.03)	3.52	3.75	4.06	4.15	2.38	7.33	9.15	9.64	8.88	7.25
Mean	4.67	4.93	7.64	6.72	5.23	10.88	13.64	14.95	13.29	10.45
C.D. (p=0.05) for abundance					C.D. (p=0.05) for foraging speed					
For week = 0.14					For week = 0.04					
For hybrid = 0.11					For hybrid=0.03					

Table: 3 Foraging speed and foraging rate of *Apis mellifera* on cucumber during different hours of the day under polyhouse

Standard Weeks	Foraging speed (Time spent (seconds/flower))											Foraging rate (No of flowers visited /min)											
	0700-0800	0800-0900	0900-1000	1000-1100	1100-1200	1200-1300	1300-1400	1400-1500	1500-1600	1600-1700	1700-1800	0700-0800	0800-0900	0900-1000	1000-1100	1100-1200	1200-1300	1300-1400	1400-1500	1500-1600	1600-1700	1700-1800	
13 th																							
(26.03-1.04.03)	12.07	12.41	15.10	14.69	12.71	11.02	7.70	8.69	10.21	10.53	9.69	3.25	3.00	2.75	3.00	3.50	2.75	2.50	2.75	3.50	3.25	3.25	
14 th																							
(2-8.04.03)	12.18	15.31	16.86	16.76	15.13	12.62	7.24	8.62	10.19	12.25	9.63	3.75	3.25	3.00	3.00	3.25	3.50	2.50	3.00	3.75	3.25	3.25	
15 th																							
(9-15.04.03)	15.10	18.43	19.86	17.81	16.21	14.72	8.08	8.98	11.40	13.54	10.42	3.50	3.25	2.50	3.00	3.25	3.50	2.75	3.00	2.75	3.50	3.00	
16 th																							
(16-22.04.03)	15.51	18.56	21.52	18.53	16.89	15.01	8.40	9.19	12.11	14.41	12.04	3.00	2.75	2.50	3.00	3.00	3.00	2.75	3.00	2.75	3.50	3.25	
17 th																							
(23-29.04.03)	16.24	19.30	21.64	19.06	17.88	16.10	8.01	10.91	12.65	14.89	12.82	3.00	2.75	2.25	2.25	2.50	3.00	2.75	3.25	2.75	3.25	3.00	
18 th																							
(30.04-6.05.03)	12.02	14.92	18.17	15.65	13.98	12.50	5.52	6.22	11.10	12.56	10.04	3.25	3.00	2.75	2.75	3.00	4.00	4.00	4.25	4.00	4.25	4.25	
19 th																							
(7-13.05.03)	9.64	10.71	12.12	11.26	10.40	8.74	4.56	3.84	6.53	8.69	6.45	3.75	3.50	3.00	2.75	3.25	4.00	3.75	3.75	3.50	4.00	3.75	
Mean	13.25	15.66	17.90	16.25	14.74	12.96	7.07	8.06	10.60	12.41	10.16	3.35	3.07	2.67	2.82	3.10	3.39	3.00	3.28	3.28	3.57	3.39	

C.D. (p=0.05) for foraging speed

C.D. (p=0.05) for foraging rate

For week = 0.04

For week = 0.35

For hours of the day= 0.05

For hours of the day = 0.44