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Foraging behaviour of Major Insect Pollinators of Seed Crop of Broccoli (*Brassica oleracea* L. var. *italica* Plenck) Variety BFT-1

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Abstract—*Broccoli crop was raised under field conditions at the Research Farm of the Department of Soil Science CCS HAU, Hisar. Foraging rate, syrphid fly (14.18) was found the highest foraging rate followed by Apis cerana (10.26), Apis mellifera (9.27), Apis dorsata (7.84) and less flowers was found to visit by Apis florea (1.42). Foraging speed, A. florea (28.29) was found the highest foraging speed followed by A. dorsata (5.19), A. mellifera (4.54), A. cerana (3.56) and least time was spent by syrphid fly (1.90).*

Keywords*: Honey bee, species and foraging behaviour*

1. INTRODUCTION

Broccoli (*Brassica oleracea* L. var. *italica* Plenck) belongs to family Cruciferae and its flower head is used as a vegetable. It is an Italian word from Latin *Brochium* meaning an arm branch. It is known as the "Crown of Jewel Nutrition" because it is rich in vitamins and minerals. The number of flowers visited per minute by any bee species depends upon the number of factors including instinctive foraging behaviour, length of proboscis (Inouye, 1980), floral structure (Free, 1970) particularly the corolla depth (Gilbert, 1980) type and quantity of floral rewards (Rao and Suryanarayana, 1983; Rao, 1991) density of flowers on particular cultivar of the crop concerned and hours of the day. Thakur *et al*. (2004) recorded that *A. mellifera* was the most frequent visitor of broccoli followed by *Helictus sp*. and *A. cerana*. However, *A. cerana* ranked first, *A. mellifera* second and *Helictus sp*. third with regards to their pollination efficiency. Although *Bombus trifasciatus* was the most active while visiting flowers (24.28 flowers per minute) and spent minimum time per flower (1.95 seconds), its population was less compared to honey bees and *Helictus sp*. and hence ranked fourth. The syrphid fly, *Eristalis tenax* ranked last among the top 5 positions.

2. MATERIAL METHODS

Foraging rate of bees was recorded in terms of the number of flowers they visited per minute (Free, 1993). A total of ten bees of each species were observed for recording the number of flowers visited per minute at peak activity time of particular species at peak flowering period of the crop. Ten observations were recorded for each bee species. Foraging speed of bees was recorded in terms of time (seconds) spent by them on each flower. A total of ten bees of each species were observed for recording time spent by them per flower at peak flowering period of the crop. Ten observations were recorded for each bee species.

3. RESULTS AND DISCUSSION

Data on foraging rate of different honey bee species and syrphid fly on broccoli flowers of variety BFT-1 are presented in Table 1. The highest foraging rate (18.61) was of syrphid fly followed by *A. cerana* (12.75), *A. mellifera* (12.12), *A. dorsata* (10.55) and *A. florea* (1.89). Mean maximum foraging rate (no. of flowers visited/minute) of syrphid fly, *A. cerana*, *A. mellifera*, *A. dorsata*, and *A. florea* was observed during 1500-1700, 1100-1300, 1300-1500, 1100-1300 and 0900-1100 h of the day respectively. Mean foraging rate of syrphid fly during peak flowering was observed maximum (14.18) followed by *A. cerana* (10.26), *A. mellifera* (9.72), *A. dorsata* (7.84) and *A. florea* (1.42 no. of flowers visited/minute). Mean foraging rate irrespective of honey bee species during different day hours was maximum between 1100-1300h (10.81) and minimum between 1700-1900h (3.56). Thakur *et al*. (2004) recorded that *A. mellifera* was the most frequent visitor of broccoli followed by *Helictus sp*. and *A. cerana*. However, *A. cerana* ranked first, *A. mellifera* second and *Helictus sp*. third with regards to their pollination efficiency. Although *Bombus trifasciatus* was the most active while visiting flowers (24.28 flowers per minute) and spent minimum time per flower (1.95 seconds), its population was less compared to honey bees and *Helictus sp*. and hence ranked fourth. The syrphid fly, *Eristalis tenax* ranked last among the top 5 positions.

Table1: Foraging rate of different honey bee species on broccoli flowers of variety BFT-1 at different hours of the day during February, 2014

Species	Number of flower visited per minute					Mean
	0900-1100	1100-1300	1300-1500	1500-1700	1700-1900	
Apis mellifera	10.40 (3.37)	11.52 (3.53)	12.12 (3.62)	9.40 (3.22)	5.14 (2.46)	**9.72 (3.24)**
Apis dorsata	9.37 (3.20)	10.55 (3.38)	7.57 (2.91)	6.44 (2.71)	5.27 (2.50)	**7.84 (2.94)**
Apis cerana	10.29 (3.43)	12.75 (3.70)	10.20 (3.34)	10.12 (3.33)	7.41 (2.88)	**10.26 (3.34)**
Apis florae	1.89 (1.69)	1.75 (1.63)	1.78 (1.66)	1.70 (1.61)	0.00 (1.00)	**1.42 (1.52)**
Syrphid fly	17.98 (4.34)	17.48 (4.29)	16.82 (4.22)	18.61 (4.42)	0.00 (1.00)	**14.18 (3.65)**
Mean	**10.09 (3.21)**	**10.81 (3.31)**	**9.70 (3.15)**	**9.25 (3.06)**	**3.56 (1.97)**	

- Each value represents mean of 10 observations at each sampling time
- Figures in parentheses are √(x+1) transformed values

Factors	SE(m)	SE(d)	C.D. (p=0.05)
Species	0.037	0.052	0.104
Day hours	0.037	0.052	0.104
Species x Day hours	0.083	0.117	0.232

Data on foraging speed (time spent per flower) of different honey bee species during different day hours on flowers of broccol seed variety BFT-1 crop are presented in table 2. The highest foraging speed was of *A. florea* (42.51) followed by *A. dorsata* (6.04), *A. mellifera* (5.52), *A. cerana* (4.61) and syrphid fly (2.61). Mean maximum foraging speed of *A. florea*, *A. dorsata*, *A. mellifera*, *A. cerana* and syrphid fly was observed during 1500-1700, 1500-1700, 1500-1700, 1500-1700 and 1300-1500 h of the day respectively. Foraging speed of *A. florea* during peak flowering irrespective of day hours was observed maximum (28.29) followed by *A. dorsata* (5.19), *A. mellifera* (4.54), and *A. cerana* (3.56) and syrphid fly (1.90).

Table 2: Foraging speed of different honey bee species on broccoli flowers of variety BFT-1 at different hours of the day during February, 2014

Species	Time spent per flower (sec)					Mean
	0900-1100	1100-1300	1300-1500	1500-1700	1700-1900	
Apis mellifera	4.01 (2.23)	3.81 (2.18)	4.07 (2.24)	5.52 (2.54)	5.30 (2.48)	**4.54 (2.34)**
Apis dorsata	5.24 (2.49)	4.74 (2.39)	4.44 (2.32)	6.04 (2.65)	5.48 (2.53)	**5.19 (2.48)**
Apis cerana	3.77 (2.18)	2.60 (1.89)	2.52 (1.87)	4.61 (2.35)	4.31 (2.29)	**3.56 (2.12)**
Apis florae	29.24 (5.38)	35.77 (6.00)	33.95 (5.79)	42.51 (6.49)	0.00 (1.00)	**28.29 (4.93)**
Syrphid fly	2.18 (1.78)	2.40 (1.83)	2.61 (1.89)	2.32 (1.82)	0.00 (1.00)	**1.90 (1.66)**
Mean	**8.89 (2.81)**	**9.86 (2.86)**	**9.52 (2.82)**	**12.20 (3.17)**	**3.02 (1.86)**	

- Each value represents mean of 10 observations at each sampling time
- Figures in parentheses are √(x+1) transformed values

Factors	SE(m)	SE(d)	C.D. (p=0.05)
Species	0.084	0.119	0.235
Day hours	0.084	0.119	0.235
Species x Day hours	0.188	0.265	0.525

Foraging speed of honey bee species during different day hours was observed maximum between 1700-1900h (12.20) and minimum between 0900-1100h (8.89). Devkota and Thapa (2005) studied that two bee species (*A. cerana* and *A. mellifera*) differed significantaly ($P<0.05$) on the number of flower visits per minute on broccoli. *A. cerana* showed higher flower visiting efficiency as compared to *A. mellifera*. The average number of flower visited by *A. cerana* bee was 11.387 and 12.107 per minute as compared to 9.033 and 10.889 flower per minute by *A. mellifera* under caged and open conditions respectively.

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