

FORAGING BEHAVIOUR OF HONEYBEE ON PARENTAL LINES OF HYBRID CAULIFLOWER PUSA HYBRID- 2

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Abstract

Studies on insect pollination on parental lines of hybrid cauliflower Pusa hybrid 2 revealed that honeybees were predominant pollinators and constituted 85.23%. Pollen gathering honeybees outnumbered nectar collectors. Among honeybees, *Apis dorsata* F., *Apis mellifera* L., *Apis cerana indica* F. and *Apis florea* F. constituted 28.23%, 26.32%, 24.20% and 21.23%, respectively. The number of pollen gatherers reached to its peak at 14.00 hours, while nectar collectors remained constant throughout the day. Foraging behaviour of honeybees on parental lines with regard to their attractiveness showed no significant difference. Frequency of honeybee movement between parental lines viz. male to male, male to female, female to female and female to male also showed no significant difference among them.

Introduction

In cauliflower, F_1 hybrids have been found advantageous for earliness, high yield, bigger curd size, better curd quality, uniform maturity and disease resistance. For large-scale hybrid seed production, self-incompatibility mechanism is being employed. Hybrid seed is obtained by growing together two different inbreds as parental lines and relying mainly upon insect pollinators to cross-pollinate the flowers. Population of natural pollinators differ from location to location depending upon the availability of suitable natural habitat such as forestry and weed flora, which serve as alternate source of nectar and pollen. Investigation on insect pollinators visiting seed production area from natural abode helps to estimate its population. In case of lack of natural pollinators, it is possible to utilise honeybees as they can be reared and their population can be manipulated according to the need of hour. The effectiveness of the honeybees as pollinators for cauliflower seed production has been studied by different workers in open pollinated varieties (RAULA, 1972, SHARMA et al., 1974, ADLAKHA and DHALIWAL, 1979, KAKAR, 1981). Some reports on hybrid seed production in Brussels sprout (FAULKNER, 1974 and 1976) revealed that honeybees were not effective as they were highly selective in their visits to parental lines. Selfed and sibbed seeds in hybrid seed lot were mainly due to selective movement of honeybees. Selfed and sibbed seeds produce plants, which lack vigour and give reduced yields. Hence present study was undertaken to study the foraging behaviour of honeybees on parental lines of hybrid cauliflower Pusa hybrid 2.

Materials and Methods

Seeds were sown on nursery in three different dates viz. 20th July, 5th August and 20th August during 2001 and transplanted exactly after one month. A planting ratio of 4:2 (4 female: 2 male) and a spacing of 60 x 45 cm were maintained. Flowering started in the middle of February and ceased in the middle of March in 2003 in all the three dates of sowing. Observations on insect pollinators were recorded for four days (as four replication) in each date of sowing at 10.00, 12.00, and 14.00 and 16.00 hours on four plants each from both parental lines. Honeybees with pollen in their curbicula were recorded as pollen gatherers and bees without pollen loads were recorded as nectar collectors. From each *Apis* species, 480 bees were observed for their movements between parental lines viz., male to male, male to female, female to female and female to male while foraging on the bloom. Nectar content was measured using graduated thin capillary tube (0.5 μ l size) and nectar sugar content was measured by following phenol-sulphuric acid method (ROBERTS, 1979). Data on bee population was square root transformed and data on percentage proportion of honeybee movement between parental lines were angular transformed before being analysed.

Results

The field was predominantly visited by *Apis* species (85.23%). Other pollinators include dipteran flies; syrphid flies, moths and butterflies contributed 14.77% (Table I). Among *Apis* species, *Apis dorsata*, *Apis mellifera*, *Apis cerana indica* and *Apis florea* constituted 28.23, 26.32, 24.20 and 21.23% respectively. With respect to foraging modes, pollen gatherers (56.06%) found to be more predominant than nectar collectors (43.94%).

Table I

| Pollinators of cauliflower hybrid | |
|-----------------------------------|----------------|
| Kind | Proportion (%) |
| A. Insects | |
| <i>Apis</i> species | 85.23 |
| Other insects | 14.77 |
| Honeybees | |
| <i>Apis dorsata</i> | 28.23 |
| <i>Apis mellifera</i> | 26.32 |
| <i>Apis cerana</i> | 24.2 |
| <i>Apis florea</i> | 21.23 |
| B. Foraging modes | |
| Pollen gatherers | 56.06 |
| Nectar collectors | 43.94 |

Table II

Effect of different sowing dates and weather factors on abundance of *Apis* during peak flowering period

| Sowing dates | Peak flowering period 2002 | Duration (days) | Number of <i>Apis</i> per 64 plants* | | Weather parameters | | | |
|--------------|----------------------------|-----------------|--------------------------------------|--------------|--------------------|------|---------|------|
| | | | | | Temperature (°C) | | | RH% |
| | | | CC** | 1-3-18-19*** | Max. | Min. | Average | |
| July 20th | 10/02 to 23/02 | 14 | 3306 | 3347 | 22.8 | 8.7 | 15.7 | 94.6 |
| August 5th | 20/02 to 03/03 | 12 | 3196 | 3207 | 23.1 | 10.6 | 16.9 | 91.5 |
| August 20th | 25/02 to 11/03 | 16 | 2817 | 2893 | 24.2 | 10.9 | 17.5 | 89.0 |

* Observed for 2 minutes per plant; ** Female parent; *** Male parent

Table III

Number of gatherers per plant during 2 minutes

| Factors | Pollen gatherers | Nectar collectors |
|-----------------------|------------------|-------------------|
| Sowing Dates | | |
| July 20th | 8.2 (2.91) | 4.8 (2.28) |
| August 5th | 8.11 (2.88) | 4.44 (2.19) |
| August 20th | 6.84 (2.68) | 4.31 (2.17) |
| CD (P=0.05) | 0.07 | 0.02 |
| Hours of Day | | |
| 10.00 | 6.23 (2.55) | 4.39 (2.19) |
| 12.00 | 8.15 (2.90) | 4.49 (2.21) |
| 14.00 | 8.24 (3.01) | 4.50 (2.21) |
| 16.00 | 7.55 (2.82) | 4.61 (2.24) |
| CD (P=0.05) | 0.08 | NS |
| Parental Lines | | |
| CC | 7.6 (2.80) | 4.54 (2.22) |
| 1-3-18-19 | 7.83 (2.84) | 4.47 (2.21) |
| CD (P=0.05) | NS | NS |
| Honeybees | | |
| <i>Apis dorsata</i> | 10.16 (3.24) | 5.56 (2.45) |
| <i>Apis mellifera</i> | 8.68 (3.01) | 4.85 (2.30) |
| <i>Apis cerana</i> | 7.16 (2.74) | 4.12 (2.13) |
| <i>Apis florea</i> | 4.86 (2.30) | 3.5 (1.98) |
| CD (P=0.05) | 0.08 | 0.05 |

The number of pollen gatherers and nectar collecting bees per plant per two minutes are presented in table III. There was significant difference among different dates of sowing with regard to pollen gatherers. July 20th sown crop received more bee visits (8.20) than August 5th sown crop (8.11) and followed by August 20th sown crop (6.84). Pollen gatherers visited more at 14.00 (8.24) followed by 12.00 (8.15), 16.00 (7.55) and 10.00 hour (6.23). Pollen gatherers showed no significant difference between male and female parental lines. Among bees, *Apis dorsata* (10.16) visited more than *Apis mellifera* (8.68), *Apis cerana indica* (7.16) and *Apis florea* (4.86). Nectar collectors showed significant difference among different sowing dates and different bees. July 20th sown crop received more visits (4.80) than August 5th (4.44) and August 20th sown crop (4.31). Among bees, *Apis dorsata* (5.56) visited more than *Apis mellifera* (4.85), *Apis cerana indica* (4.12) and *Apis florea* (3.5). Between parental lines and among different hours of the day there were no significant differences with regard to nectar collectors.

Direction of honeybee movements viz. male to male, male to female, female to female and female to male parent were random as they were not significantly different among them (Table IV).

Table IV

Movements of honeybees

| Directions | Proportion (%) |
|------------------|----------------|
| Male to male | 25.3 (30.20) |
| Male to female | 24.35 (29.57) |
| Female to female | 21.43 (27.06) |
| Female to male | 28.92 (27.06) |
| CD (P=0.05) | NS |

Figures in parenthesis were angular transformed values

Table V

Nectar content (μl) and nectar sugar content (μg) per flower of parental lines of Pusa hybrid 2 at different hours of day

| Floral rewards | Hours of day | CC | 1-3-18-19 | Mean |
|----------------------|--------------------------|-------|-----------|-------|
| Nectar content | 10.00 | 0.168 | 0.171 | 0.170 |
| " | 12.00 | 0.145 | 0.142 | 0.144 |
| " | 14.00 | 0.133 | 0.128 | 0.131 |
| " | 16.00 | 0.113 | 0.110 | 0.111 |
| | Mean | 0.140 | 0.138 | |
| CD (P=0.05) | Parental lines (P): NS | | | |
| | Hours of day (D): 0.01 | | | |
| | P X D: NS | | | |
| Nectar sugar content | 10.00 | 0.453 | 0.353 | 0.403 |
| " | 12.00 | 0.698 | 0.523 | 0.610 |
| " | 14.00 | 0.835 | 0.682 | 0.758 |
| " | 16.00 | 1.146 | 0.850 | 0.998 |
| | Mean | 0.783 | 0.602 | |
| CD (P=0.05) | Parental lines (P): 0.09 | | | |
| | Hours of day (D): 0.123 | | | |
| | P X D: NS | | | |

Nectar content between parental lines showed no significant difference but nectar sugar content differed significantly (Table V). Nectar sugar content was more in female parent (0.782 μg) than male parent (0.602 μg).

Discussion

Honeybees were found as predominant pollinators (85.23%) in the seed production plot. Earlier, SHARMA et al. (1974) reported that honeybees were the predominant pollinators (42.1%) of cauliflower. SINHA and CHAKRABARTI (1980) reported that honeybees constituted 79, 82.4 and 83.3% respectively in 3 consecutive years. KAKKAR and SHARMA (1991) observed that honeybees constituted 38.7% on cauliflower bloom. These reports supported the present observation. Among honeybees, population of *Apis dorsata* was more than other *Apis* species irrespective of foraging modes. This might be due to presence of more colonies in nature. With respect to foraging modes, pollen gatherers outnumbered nectar collectors. During February and March heavy build up of colony (breeding) after overwintering necessitates more pollen grains to feed the larvae. This resulted in a greater number of pollen gatherers than nectar collectors.

July 20th sown crop received more bee visits than August 5th and August 20th sown crop. Change in major weather factors such as temperature and RH might be responsible for this variation (Table V). Bee foraging activity is highly influenced by prevailing weather factors (SZABO, 1980; SIHAG and ARBOL, 1986; ARBOL, 1987). Pollen gatherers visited more at 12 to 14 hours that coincided with maximum opening of flowers (anthesis). SINHA and CHAKRABARTI (1980) reported maximum honeybee visits at 12 to 14 hours on cauliflower. This supported present result that maximum bee visits recorded at 12 to 14 hours.

There was no significant difference between parental lines with regard to attractiveness of bees. Honeybee movements between parental lines were random and non selective. FAULKNER (1974 and 1976) and FREE and WILLIAMS (1983) reported that bees were able to discriminate between male and female parental lines of Brussels sprouts. A honeybee movement between parental lines was in the ratio of 30:1. The possible reason was differences in height and flower colour variation and also unknown factors. But parental lines of Pusa hybrid 2 were similar in height, flower colour and nectar content except nectar sugar content. High nectar sugar content had no effect on bee preference towards female parent. Correlation and path analysis of bee activity and different environmental factors revealed that nectar sugar concentration had no direct effect on bee activity (SIHAG and ARBOL, 1986; ARBOL, 1987, 1998).

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