

FORAGING RATES OF DIFFERENT *APIS* SPECIES VISITING PARENTAL LINES OF *BRASSICA NAPUS* L.

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Most of the insect pollinators of *Brassica* crops belong to *Apis* species. Foraging rate is one of the important factors to compare pollination efficiency of different bee species. In general, more the foraging frequency, more the chances of pollination. 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 & Suryanarayana, 1990; Rao, 1991) density of flowers on particular cultivar of the crop concerned and hours of the day. The present paper reports the comparison of foraging rates of various honeybee species on parental lines of *B. napus* at different hours of the day.

Experimental plots (10.5 x 1.5meter) were raised for hybrid seed production under Punjab conditions by using seeds of cytoplasmically male-sterile (CMS) line (TCMS-PR-05) and restorer (R) line (TFR-91) of *B. napus* hybrid PGSH-51, during year 1998-99, by following recommendations of Punjab Agricultural University, Ludhiana (Punjab). Selected ratio of male to female rows were 2:4. R line plants showed inflorescence about 15 days earlier than those of CMS line. In order to make the flowering synchronous in both the parental lines, early flowering plants were detopped. Foraging activity of *A. dorsata* was enough in the area selected for study because two colonies of this bee species were present in nearby area. Two hives of *A. florea* were procured from other places and transplanted at suitable places (piles of dried sticks arranged just like natural habitat) in the field. In order to compare foraging rates of four honeybee species, two colonies each of *A. mellifera* and *A. cerana* were managed. Number of flowers visited per minute by a particular bee was counted with the help of a stop watch. Four bees of each *Apis* species were observed at each of the four selected hours of day (1000, 1200, 1400 and 1600), on R and CMS lines separately. This experiment was conducted on alternating days during blooming time (40 days) of the crop. Data collected were consolidated, tabulated, transformed ($n+1$ transformation) and subjected to Analysis of Variance (ANOVA). Significance was tested at 5per cent level.

Number of flowers visited per minute by various bee species at different day hours, on R and CMS lines is shown in Table 1. On an average (Table 2), 20.922, 19.572, 15.048 and 7.712 flowers were visited per minute by *A. cerana*, *A. mellifera*, *A. dorsata* and *A. florea* respectively. Foraging rates of *A. cerana* and *A.*

mellifera were not different statistically. Foragers of these two bee species visited significantly more number of flowers per unit time as compared to those of *A. dorsata* and *A. florea*. These findings are in line with the information given by Desh Raj and Rana (1994) about time spent per flower by *A. mellifera* and *A. cerana* on rapeseed (*B. campestris* var. brown sarson) bloom. Jhajj *et al.* (1996) also found the foraging frequency of various bee species as *A. mellifera* > *A. dorsata* > *A. florea* on raya and brown sarson.

On an average (Table 3) *Apis* species visited 15.612, 18.253, 15.326 and 14.062 flowers per minute at 1000hr, 1200hr, 1400hr and 1600hr, respectively. Foraging rate was significantly more at 1200hr. Number of flowers visited/min. by bees at 1000hr, 1400hr and 1600hr did not differ statistically. Maximum foraging rate of bees during 1200-1300hr has also been reported by many workers on *Brassica* crops (Dhaliwal & Bhalla, 1980; Desh Raj & Rana, 1994; Anon, 1999). Maximum foraging rate of *Apis* species at 1200 on parental lines of *B. napus* as observed in present study might be due to the fact that supply of available floral rewards declined by this time due to decreased amount of nectar in flowers as observed by Meyerhoff (1954) in case of Swede rape and increased foraging activity of bees. So, less time was needed to take the forage from a flower and more flowers were visited by a bee to obtain required load of pollen or nectar. Thus hours of day seem to have played an important role in foraging rate of bees because floral rewards of parental lines and foraging activity of insect visitors are directly linked with them.

On an average (Table 4) foraging rate of *Apis* species was significantly more on CMS line (17.607 flowers/min) than that on R line (14.020 flowers/min.). These results are in line with finding of Mohr and Jay (1988), who observed that foraging frequency of honeybees on two different species of Canola (*B. campestris* L. and *B. napus* L.) was different.

R line flowers offer both nectar and pollen, hence bees visiting them were pollen and/or nectar gatherers, while the flowers of CMS line provided only nectar as they do not produce pollen, so foraging bees were only nectar gatherers. Therefore, honey bees spent more time on R line flowers for collection of nectar and pollen than that on CMS line for collection of nectar only. Similar type of conclusion was drawn by Adegas and Nogueira Couto (1992) that nectar collecting bees spent less time per flower as compared to pollen gatherers on *B. napus* L. var *oleifera* (Cultivar CTC-4).

Foraging rate is one of the important factors to determine pollination efficiency of any bee species. So, from this study it may be concluded that *A. cerana* and *A. mellifera* have statistically same foraging rate. Both of these bee species showed significantly higher foraging rate as compared to *A. dorsata* and *A. florea*. Significantly, lesser foraging frequency was recorded in case of *A. florea*. Foraging rate varied according to hours of the day and it was observed to be maximum at 1200hr. Number of flowers visited per minute on CMS line was significantly higher in comparison to that on R line.

Table 1. Number of flowers visited per minute by different *Apis* species on parental lines of *B. napus* at selected hours of day.

Days Hours	<i>Apis</i> species	Number of flowers visited/min.	
		R line	CMS line
10 am	<i>Apis mellifera</i>	17.666 (4.299)	20.666 (4.652)
	<i>Apis cerana</i>	19.625 (4.528)	22.5 (4.846)
	<i>Apis dorsata</i>	12.5 (3.674)	15.5 (4.062)
	<i>Apis florea</i>	7 (2.826)	9.440 (3.224)
12 pm	<i>Apis mellifera</i>	20.904 (4.672)	25.833 (5.172)
	<i>Apis cerana</i>	20.167 (4.595)	28.583 (5.438)
	<i>Apis dorsata</i>	15.8 (4.098)	16.834 (4.174)
	<i>Apis florea</i>	7.4 (2.892)	10.5 (3.381)
14 pm	<i>Apis mellifera</i>	16 (4.108)	20 (4.522)
	<i>Apis cerana</i>	17 (4.242)	24.5 (4.999)
	<i>Apis dorsata</i>	14.75 (3.964)	15.5 (4.062)
	<i>Apis florea</i>	5 (2.445)	9.857 (3.282)
16 pm	<i>Apis mellifera</i>	15.5 (4.062)	20 (4.582)
	<i>Apis cerana</i>	15.5 (4.061)	19.5 (4.488)
	<i>Apis dorsata</i>	15 (3.999)	14.5 (3.936)
	<i>Apis florea</i>	4.5 (2.344)	8 (2.998)

Table 2. Foraging rates of different bee species irrespective of day hours and parental lines.

Day hours	<i>A. mellifera</i>	<i>A. cerana</i>	<i>A. dorsata</i>	<i>A. florea</i>
Number of flowers	19.572	20.922	15.048	7.712
Visited/min. by bees	(4.508)	(4.650)	(3.996)	(2.924)

Table 3. Foraging rates of *Apis* species irrespective of bee species and parental lines.

Day hour	10 am	12 pm	2 pm	4 pm
Number of flowers	15.612	18.253	15.326	14.062
Visited/min. by bees	(4.014)	(4.302)	(3.953)	(3.809)

Table 4. Number of flowers visited per minute by *Apis* species on R and CMS lines irrespective of bee species and day hours.

Parental line	R line	CMS line
Number of flower	14.020	17.607
visited/min. by bees	(3.800)	(4.238)

CD _{0.05}		
For day hours		= 0.167
For <i>Apis</i> spp.		= 0.167
For Parental lines		= 0.118
For interaction day hours x <i>Apis</i> spp.		= Non significant
For interaction day hours x Parental lines		= Non significant
For interaction <i>Apis</i> spp. x Parental lines		= 0.236
For interaction day hours x <i>Apis</i> spp. x Parental lines		= Non significant
F value		
For day hours		= 11.8209
For <i>Apis</i> spp.		= 168.2535
For Parental lines		= 52.7422

Figures in parenthesis are $\sqrt{n+1}$ transformations.

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