

Effect of Date of Sowing on Foraging Behaviour of Honeybees in Seed Crop of Sunflower Hybrid APSH-11

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ABSTRACT Maximum honeybee activity was recorded in February sown crop followed by January and December. Its activity was highly influenced by air temperature and humidity. Among honeybees, *Apis mellifera* was the most abundant species. Its frequency was lower in December (11.15) sown crop, followed by January (19.32) and February (21.25) sowings. In the early morning (08:00 hr) its proportion is lower (13.12) than rest of the day (18.09 to 18.53). The highest mean (7.31) honeybee activity was recorded at 10:00 hr. Proportion of pollen gathering bees was more in December (3.32) sown crop than those sown in January (1.59) and February (1.94), whereas the nectar collecting bees were maximum in February (14.45) sown crop, followed by January (13.23) and December (6.68), indicating a shift in the behaviour of honeybees from pollen gathering in December to nectar collection in February.

Key word: Honeybee behaviour, sunflower, hybrid seed production

Hybrid seed production in sunflower (*Helianthus annuus*) is done using three line (A, B and R) system. Breeder and Foundation seeds of female parental line (A) are produced by pollination of the line with maintainer line (B). On the other hand, hybrid seed production involves pollination of A line with restorer line (R). In both cases, pollen has to be transferred to A line from male fertile plants. There is no wind pollination as the sunflower pollen is heavy and sticky. However, honeybees play an important role in this process. Many species of honeybees, namely *Apis mellifera*, *A. dorsata*, *A. cerana indica* and *A. florea* were found to pollinate sunflower crop and the honeybee activities are governed by weather conditions [1, 2] and their specific needs. In the present study, efforts were made to identify suitable conditions for presence of abundance of different honeybee species and their choice of floral reward in the form of pollen or nectar.

MATERIALS AND METHODS

The experiment was conducted using parental lines (CMS 7-1A and RHA 271) of sunflower hybrid APSH 11, during *rabi*-spring for two consecutive years at experimental farm of Indian Agricultural Research Institute Regional Station, Karnal (Haryana). The seed crop was sown on three dates, *i.e.* middle of December, middle of January and middle of February in rows of 5 m each on ridges, with a spacing of 60 cm x 30 cm, between rows and plants, respectively. Recommended agronomic package of practices were followed. Twenty-seven plants each from female and male lines, were tagged for observation on frequency of bee visits, in each sowing date. One pair of male and female plants was observed simultaneously for two minutes. Number of visits of different species of honeybees, namely *Apis mellifera*, *A. dorsata* and *A. cerana indica*, foraging for either nectar or pollen on the tagged plants per two minutes was

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recorded. The observations were taken at peak flowering period (30-60%) of the crop, at two hourly interval starting from 8:00 hr to 16:00 hr, in all the three sowing dates. A honeybee with pollen in its corbicula (pollen basket) was taken as pollen gatherer and the rest were considered as nectar collector.

RESULTS AND DISCUSSION

Effects of sowing dates

The mean number of honeybees visiting 27 flower heads was significantly higher (10.26) in February sown crop than January (6.29) and December (4.10) sown crops during first year (Table 1). The differences in number of bees in all the three sowing dates in both years were significant.

Different dates of sowing provide different environment with large variation in climate during flowering period. In general, honeybee visit was greatly influenced by different sowing dates in both years, as both the environmental factors, *i.e.* temperature and RH were different during flowering period. Maximum bee visit was recorded in February sown crop because of the moderate air temperature and RH. Sinha *et al.* [3] reported maximum bee activity at an average temperature of 21°-23°C and 70 per cent RH. In

fact, the bee activity is related to environmental conditions (temperature and RH). Temperature (23.4°C) and humidity (62%) were congenial, during second year, for bee activities in January sown crop, whereas similar suitable environmental conditions were recorded during February sown crop than January sown crop during first year.

Frequency of visit of different honeybee species visit was depended upon the presence of the bee hives of the species in the locality, climatic conditions and flowering crop. The *Apis mellifera* had maximum frequency, whereas *A. dorsata* had minimum frequency of visits. The low frequency of *Apis dorsata* was attributed to the presence of only a few beehives on nearby trees. The high frequency of *A. mellifera* was due to the presence of nearly 40 bee boxes in the apiary of Regional Station, Karnal. Calmasur and Ozbek [4] in a survey in Turkey had reported similar observations. The *A. mellifera* was more active on sunflower crop than *A. dorsata* and *A. florea* foraging for nectar [5]. Sinha and Atwal [1] also reported maximum visit of *A. mellifera* on sunflower hybrid seed plots.

Number of different honeybee species in all the three sowing dates were significantly different in both the years. The *A. mellifera* had the highest

Table 1. Effect of sowing dates on mean number of honeybees visiting flower heads during peak flowering in seed plot of sunflower hybrid APSH 11; and prevailing weather conditions

Date of sowing	No. of honeybee visits/27 flower heads	Observation period (peak flowering)	Prevailing weather (peak flowering)			RH (%)
			Minimum	Maximum	Average	
Year 1						
December	4.10	28 March-1 April	15.0	33.6	24.3	60
January	6.29	14-19 April	19.4	37.9	28.6	42
February	10.26	8-14 May	23.6	33.8	28.7	64
Year 2						
December	5.90	27 March-1 April	13.7	27.5	20.6	59
January	8.53	17-21 April	16.3	30.5	23.4	62
February	6.12	29 April-2 May	21.5	40.6	31.0	36

Table 2. Effects of date of sowing on honeybee visit and pollen/nectar collecting behaviour in seed crop of sunflower hybrid APSH 11

Treatment	Number of honeybees per 27 flower heads								
	Year 1			Year 2			Average over years		
	E ₁	E ₂	E ₃	E ₁	E ₂	E ₃	E ₁	E ₂	E ₃
<i>Apis mellifera</i>	10.55 (3.09)	16.90 (3.42)	27.36 (4.46)	11.76 (3.13)	21.75 (3.91)	15.14 (3.20)	11.15	19.32	21.25
<i>Apis dorsata</i>	0.24 (0.82)	0.30 (0.84)	0.98 (1.11)	0.78 (0.99)	0.77 (1.00)	1.35 (1.16)	0.51	0.53	1.16
Others	1.50 (1.22)	1.68 (1.32)	2.45 (1.50)	5.15 (2.09)	3.07 (1.72)	1.89 (1.39)	3.32	2.37	2.17
Mean	4.10	6.29	10.26	5.90	8.53	6.12			
CD at P=0.05		0.15			0.14				
Pollen (P ₁)	2.97 (1.57)	0.94 (1.05)	2.50 (1.45)	3.67 (1.68)	2.24 (1.42)	1.37 (1.16)	3.32	1.59	1.94
Nectar (F ₂)	5.23 (1.85)	11.64 (2.67)	18.03 (3.25)	8.12 (2.46)	14.82 (3.00)	10.87 (2.68)	6.68	13.23	14.45
CD at P=0.05		0.12			0.12				

Figures in parentheses are transformed $\{\text{square root}(x+0.5)\}$ values; E₁= December sowing, E₂= January sowing, and E₃= February sowing

frequency (Table 2), whereas *A. dorsata* had the least frequency in all dates of sowings for both the years. The mean number of *A. mellifera* (visiting 27 flower heads) was maximum in February sowing (21.25), followed by January (19.32) and December (11.15) sowings. Similarly, frequency of *A. dorsata* was more in February (1.16) sowing, followed by January (0.53) and December (0.51) sowings. The later two sowings were at par during second year. Other honeybee species in contrast showed higher frequency of visits in December (3.32), followed by January (2.37) and February (2.17) sowings.

Effects of time

Frequency of honeybee visit was higher between 10:00 hr and 16:00 hr and it ranged from 18.09 to 18.53 per 27 flower heads (Table 3).

Frequency of visits by *A. mellifera* was significantly higher than *A. dorsata* and other

honeybees. On the other hand, visits by *A. dorsata* were significantly fewer than the other two groups at all the time of anthesis during observation in both the years (Table 3). The frequency of *A. mellifera* was less at 8:00 hr (13.12) than at other times of day. The maximum frequency was at 16:00 hr (20.08). During second year also, the species had the least frequency of visits (11.15) at 8:00 hr, though the highest frequency (18.21) was recorded at 14:00 hr. The frequencies of visits at 10:00, 12:00 and 14:00 hr were at par statistically. The frequency of bee visits at 16:00 hr (16.10) was significantly more than that at 8:00 hr.

The visit of *Apis dorsata* was maximum at 8:00 hr (1.95), but at other hours of the day. It was at par with each other. The other honeybees also had higher frequency of visits at 8:00 hr (3.66).

The environmental parameters change as the

Table 3. Effects of day-hour on honeybee's visit and their pollen/ nectar collecting behaviour in seed crop of sunflower hybrid APSH 11

Treatment	Number of honeybees per 27 flower heads																	
	Year 1						Year 2						Average over years					
	8:00	10:00	12:00	14:00	16:00		8:00	10:00	12:00	14:00	16:00		8:00	10:00	12:00	14:00	16:00	
<i>Apis mellifera</i>	15.08 (3.40)	18.87 (3.71)	18.46 (3.71)	18.85 (3.67)	20.08 (3.79)		11.15 (2.91)	17.81 (3.61)	17.81 (3.56)	18.21 (3.60)	16.10 (3.39)		13.12	18.34	18.14	18.53	18.09	
<i>Apis dorsata</i>	1.08 (1.12)	0.48 (0.93)	0.35 (0.87)	0.27 (0.83)	0.33 (0.86)		2.81 (1.53)	0.83 (1.05)	0.35 (0.87)	0.42 (0.9)	0.42 (0.91)		1.95	0.66	0.35	0.35	0.38	
Others	3.00 (1.60)	1.92 (1.37)	1.19 (1.16)	1.44 (1.24)	1.83 (1.35)		4.31 (1.90)	3.92 (1.86)	2.65 (1.58)	2.98 (1.63)	3.00 (1.69)		3.66	2.92	2.55	2.21	2.42	
Mean	6.39	7.09	6.67	6.85	7.42		6.09	7.52	6.94	7.20	6.51		6.24	7.31	6.81	7.03	6.97	
CD at P=0.05	0.19																	
Pollen (P ₁)	3.68 (1.72)	1.89 (1.35)	1.78 (1.28)	1.57 (1.19)	1.76 (1.24)		4.46 (1.86)	2.67 (1.52)	1.49 (1.19)	1.89 (1.27)	1.64 (1.26)		4.07	2.28	1.64	1.73	1.70	
Nectar (F ₂)	9.10 (2.35)	12.29 (2.66)	11.56 (2.55)	12.14 (2.63)	13.07 (2.76)		7.72 (2.37)	12.37 (2.82)	12.39 (2.82)	12.51 (2.82)	11.37 (2.74)		8.41	12.33	11.98	12.33	12.22	
CD at P=0.05	0.16																	

Figures in parentheses are transformed (square root of (X+0.5)) values

day progresses. Air temperature and RH directly affect the honeybee activity. The bee visit frequency at different hours of day, in the three dates of sowing was statistically at par during first year because of low variation in temperature (range 28.3°-39.2°C) (Table 1). However, during second year, significantly different number of bees visiting the crop at different hours of the day was due to large variation in temperature (22.5°-38.8°C). Sinha and Atwal [1] reported no effect of time on frequency of bee visits between 10:00 and 14:00 hr at Karnal. However, they did not record bee visits at 8:00, 12:00 and 16:00 hr. Singh *et al.* [6] and Satyanarayana and Seetharam [7] reported peak frequency of honeybee visits at 10:00 hr.

Pollen/nectar collecting behaviour

In general, pollen gatherers were significantly more (Table 2) in December (3.32) and February (1.94) sown crops than January (1.59). The nectar collectors on the other hand were manifold higher than pollen gatherers. The highest number was recorded in February (14.45) sown crop, followed by January (13.23) and December (6.68) sowings.

Number of pollen gathering bees was significantly higher at 8:00 hr (3.68) than those during rest of the day during first year (Table 3). The frequency of such bees during rest of the day remained at par with each other. Similarly, during second

year, frequency of pollen gatherers was significantly more at 8:00 hr (4.46) than those at other periods. The frequency at 10:00 hr (2.67) was also significantly more than those at 12:00 (1.49), 14:00 (1.89) and 16:00 hr (1.64).

Contrary to pollen gatherers, nectar collectors were by and large low at 8:00 hr (8.41). The nectar foragers were maximum at 10:00 and 14:00 hr (12.33), followed by 16:00 hr (12.22) and at 12:00 hr (11.98) (Table 3). Frequency of nectar collecting bees was more than pollen gatherers. The difference was lesser in December sown crop as compared to other two sowings. The nectar/pollen gathering behaviour depends upon its availability and need of honeybees. Pollen is rich in protein, whereas nectar is rich in energy (sugar). Honeybees need pollen during breeding/multiplication period, but nectar is required for maintenance of colony and storage (in the form of honey) for dry periods. Breeding takes place in spring (February-March) so more pollen is required in that period. In summer and rainy season, nectar is required for maintenance. Hence, in December sown crop which flowers during March-end, proportion of pollen gatherers was more as compared to January and February sown crops (flowers in middle of April and starting of May, respectively).

The number of pollen gathering bees was more at 8:00 hr than rest of the day. It may be due to the fact that anthers dehisce in the morning [8]. So pollen-gathering honeybees forage mainly in morning, when R-line is in male-stage. During rest of the day, honeybees forage mainly for nectar in both parental lines due to non-availability of pollen grains. Thus, the overall frequency (over hours of day) of nectar foragers is more than that of pollen foragers. Fell [9] had reported similar observations.

Maximum honeybee activity was recorded in February sown seed crop of sunflower hybrid when most of the bees were nectar gatherers,

whereas pollen collecting bees were more in December sown crop at Karnal.

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