

## Effect of Sowing Dates and Day Hours on Nectar Production and Frequency of Honeybee Visits in Parental Lines of Sunflower Hybrid APSH-11<sup>1</sup>

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**ABSTRACT** A study was conducted using parental lines (CMS 7-1A and RHA 271R) of sunflower hybrid APSH 11 to know the effect of sowing dates and day hours on nectar production *vis-a-vis* frequency of honeybee visits on them. At peak of flowering period, volume of nectar, in florets of male and female lines, was measured at 0800, 1000, 1200, 1400 and 1600 h of the day using micropipettes (one lambda size) in the crops sown during mid-December, January and February. Frequency of honeybee visiting a capitulum during two minutes period, was recorded at the aforesaid five specified hours. Nectar production was higher in CMS 7-1A (0.81  $\mu$ l/5 florets) than RHA 271 R line (0.61  $\mu$ l). Irrespective of dates of sowing, there was minimum nectar production at 08 h. Average nectar amount was highest in January sown crop (0.82  $\mu$ l). Nectar production was higher in RHA 271R at 0800 h whereas in CMS 7-1A, nectar production was high during rest of the day. The frequency of honeybee visits was greatly influenced by temperature and relative humidity. The honeybee visits on male or female line were governed by date of sowing and floral rewards. The male line attracted more honeybees (4.71 and 7.46) than the female line (3.48 and 4.33 per 27 capitula during 1999-2000 and 2000-2001 respectively), in the December sowing. However, in the other two sowings, the female parent attracted more honeybees than the male parent. Thus, the study indicated that the female parental line produced more nectar and attracted more honeybees. The sowing dates greatly influenced the foraging preference of honeybees on male and female parental line.

**Key Words** : Sunflower, pollination, nectar, honeybees, sowing date, hybrid seed production

Sunflower hybrid seed is produced by exploiting cytoplasmic genetic male sterility (CGMS) system. In this system, the cytoplasmic male sterile (CMS) line has to be pollinated with maintainer (B) line on one hand to produce seed of A line and on other hand with restorer line to produce hybrid seed. So an efficient mechanism to transfer pollen from B or R line to A line is required. The sunflower pollen is too heavy and sticky to be carried away by wind [1]. The crop is essentially entomophilous and honeybees are the main pollinating agents. The honeybees pollinate the flowers while searching for floral rewards viz pollen and or nectar. Climatic factors influences both volume of floral reward (nectar) and honeybee visits. Therefore, effect of different sowing dates

and day hours on floral rewards and honeybee visits are presented and discussed in the paper.

### MATERIALS AND METHODS

The study was conducted at the Indian Agricultural Research Institute, Regional Station, Karnal (Haryana), during Rabi-spring season of 1999-2000 and 2000-2001. The experimental material for the study comprised of parental lines (CMS 7-1A; female and RHA 271-R; male) of sunflower hybrid, APSH 11.

Sowing was done on three different dates i.e. middle of December, middle of January and middle of February. Seed of the parental lines was dibbled on ridges of five metre row length. Row to row

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and plant to plant spacing of 60 x 30 cm was maintained. Recommended agronomic package of practices were followed for raising the crop. At the peak of flowering (30-65%), five capitula from each of female and male lines were covered with muslin cloth bags in the evening to avoid depletion of nectar by insects. Next day, volume of nectar in one floret from each of the ten covered flower heads was measured using a micropipette (one lambda size) at 0800h. Each floret was marked with correction fluid to avoid repeated observation from the same floret. Similarly, nectar volume was also measured at 1000, 1200, 1400 and 1600 h. Observations on nectar production were made only during 2000-2001. Observations on weather parameters (temperature and relative humidity) were also made at the different day hours.

For recording the frequency of honeybee visits, twenty seven capitula from each of the male and female parental lines were tagged in the three sowing dates in such a way that a pair of male and female flower heads could be observed simultaneously. Each pair of flower head was observed for two minutes period for the number of honeybee visits for four days (replications) at two hourly interval starting from 0800 h. The data was analysed [2] after transformation as square root ( $X + 0.5$ ) because values were small whole numbers including large number of zeros.

## RESULTS AND DISCUSSION

### Nectar production

During the course of evolution, plants developed a system to attract pollinators by offering to them pollen and or nectar as floral reward. The volume of reward (nectar) is related to plant variety, stage of plant growth and immediate weather conditions [3]. In the present study, nectar production was invariably higher in female parent (0.61, 0.97 and 0.86  $\mu\text{l}/5$  florets) than male parent (0.55, 0.67 and 0.58  $\mu\text{l}/5$  florets) in December, January and February sown crops, respectively (Table 1). Comba *et al.* [3] also had similar observations in red campion [*Silene dioica* (L) Clairv]. The more quantity of nectar in female line was due to the absence of pollen reward in that line. So to attract sufficient numbers of pollinators it had to offer more nectar than pollen parent, which had pollen as well.

Table 1. Effect of sowing dates and hours of the day on nectar production ( $\mu\text{l}/5$  florets) in parental lines of sunflower hybrid APSH 11

Hour of the day	Nectar production ( $\mu\text{l}/5$ florets) in			Temp. ( $^{\circ}\text{C}$ )	RH (%)
	CMS 7-1A	RHA 271-R	Average		
Mid December, 2000					
0800h	0.03	0.20	0.12	22.5	62.1
1000h	0.40	0.37	0.39	25.4	51.1
1200h	0.90	0.73	0.82	28.0	46.1
1400h	0.87	0.97	0.92	30.5	37.6
1600h	0.87	0.50	0.69	30.3	35.4
Mean	0.61	0.55	0.58	27.3	46.5
Mid January 2001					
0800h	0.20	0.50	0.35	23.8	63.9
1000h	0.90	0.73	0.82	28.3	47.5
1200h	1.20	0.57	0.89	29.5	41.3
1400 h	1.27	0.87	1.07	31.9	35.2
1600 h	1.27	0.70	0.99	30.8	33.8
Mean	0.97	0.67	0.82	28.9	44.3
Mid February, 2001					
0800h	0.43	0.10	0.27	32.8	36.7
1000h	0.53	0.23	0.38	37.0	27.8
1200h	0.97	0.73	0.85	38.3	27.1
1400h	1.20	1.03	1.12	38.8	29.3
1600h	1.17	0.83	1.00	38.6	22.0
Mean	0.86	0.58	0.72	37.1	28.6
Average over sowing dates					
0800h	0.22	0.27	0.25		
1000h	0.61	0.44	0.53		
1200h	1.02	0.67	0.85		
1400h	1.11	0.96	1.04		
1600h	1.10	0.68	0.89		
Mean	0.81	0.61	0.71		

Among the three sowing dates, the January sown crop produced maximum nectar. The nectar production was low in morning (0.03 to 0.43  $\mu$ l at 0800 h) but it increased as day progressed (0.87 to 1.27 ml at 1400 h). Comba *et al.* [3] also observed differences in temporal distribution of nectar reward in many plant species. The nectar production was positively associated with the air temperature ( $r = 0.93, 0.99$  and  $0.85$ ) but negatively with the relative humidity ( $r = -0.87, -0.98$  and  $-0.64$  in Dec., Jan. and Feb. sowings, respectively (Table 2).

**Table 2.** Correlation coefficients of nectar production and honeybee visits on hybrid seed crop of sunflower with prevailing temperature and RH, and the bee visits with nectar production in three dates of sowing.

Correlation coefficient of	December	January	February
Temp. with nectar	0.93*	0.99*	0.85
Temp. with bees	0.61	0.73	-0.58
RH with nectar	-0.87	-0.98*	-0.64
RH with bees	-0.58	-0.63	0.17
Nectar with bees	0.65	0.77	-0.86

\*Significant at  $P = 0.05$

Critical examination of data for sowing dates, parental lines and hour of day revealed that nectar production was more in male line (0.2 and 0.5  $\mu$ l) at 0800 h than female (0.03 and 0.2  $\mu$ l in December and January sown crops, respectively). But during rest of the day, nectar production was higher in female line florets. Similar observations were made by Comba *et al.* [3] in white campion (*Silene latifolia* Poiret). Higher nectar secretion in male line in the morning was to attract pollinators when pollen is available (at the time of anther dehiscence). In sunflower, nectar is the main floral reward. In situations where nectar is the chief attractant, pollen presentation must synchronise with the nectar availability. Anthesis in sunflower takes place between 0500 to 0800 h [4]. The nectar collecting honeybees visit male line in morning (to collect nectar) and get dusted with fresh pollen. In the later hours (1000-1200 h) of the day, the bees visit female line because of availability of more nectar and perform the job of pollination.

In the February sown crop (flowering in beginning of May), no such trend was observed because in the month of May the sun rises much earlier than 0800 h, the earliest time of observation in the study. Such pattern might have occurred at still earlier hour of the day.

From the above observations (Table 1), it can be inferred that (1) female line produced more nectar than male line; (2) there was maximum amount of nectar production in January sown crop flowering in mid April; (3) nectar production was positively associated with prevailing air temperature while negatively with relative humidity; (4) amount of nectar production in both parental lines was maximum at 1400 h and (5) male line produced comparatively more nectar than the female line in the early hours coinciding with the anther dehiscence.

#### Frequency of bee visits

Different dates of sowing provided different environment with large variation in climate during flowering period. In general, honeybee visits were greatly influenced by different sowing-dates in both the years as the environmental factors (temp., RH etc.) during flowering period were different. The frequency of bee visits was the highest (10.26) in February sown crop (flowering in mid April) in 1999-2000 (Table 3), because the average air temperature was moderate and RH was also not too high. In the first year, temp ( $28.7^{\circ}$  C) and humidity (64%) was congenial to bee activities in the February sown crop while in the second year, the same suitable environmental conditions (temp. =  $23.4^{\circ}$  C and RH = 62%) were found in January sown crop. Sinha *et al.* [5] reported maximum bee activity at an average temperature of  $21-23^{\circ}$ C and 70% RH. The honeybee activity in December sown crop (4.10 & 5.9 in first and second year, respectively) was restricted due to low minimum air temperature during flowering time (March end). Similarly, the frequency of bee visits during January sowing in 1999-2000 and February sowing in 2000-2001 was adversely affected due to high maximum temperature. The bee frequency was, therefore, positively correlated with the average air temperature up to a certain limit. Abrol [6], and Dimitrov [7, 8] also found similar correlation.

The environmental parameters change as the day progresses. The bee frequency at different hours of day, in the three dates of sowings was statistically at par in 1999-2000 because of low variation in temperature (range 15.0-37.9°C). However, in the year 2000-2001, significantly varying number of bees visited the crop at different hours of the day due to larger variation in temperature (range 13.7-40.7°C). Maximum honeybee activity was observed at 1000 and 14 h. Sinha and Atwal [9] at Karnal found no effect on time of observation (1000 & 1400 h), however, they did not study bee visits at 0800, 1200 and 1600 h. Singh *et al.* [10] and Satyanarayana and Seetharam [11] reported peak activity at 1000 h as well as in the evening hours.

The difference in nectar production by the parental lines affected the frequency of honeybees visiting them. The female line (7.34) attracted significantly more honeybees than the male (6.43) in 1999-2000 (Table 4). Frequency of the honeybees

in 2000-2001 was statistically at par in both the parental lines. The preference of honeybees for male or female line was greatly influenced by the sowing dates of the crop. In the December sown crop, the male line (4.71 and 7.46) had more honeybee visits than the female (3.46 & 4.33 in 1999-2000 and 2000-2001, respectively). In the other two sowing dates, female line attracted more pollinators. The higher frequency of bee visits on male line in December sown crop was because of crop flowering coinciding with that of brood development of honeybees. The honeybees require protein rich diet in the form of pollen for their broods. Perusal of the data across sowing dates indicated that male line (6.88 and 7.61) attracted more honeybees at 0800 h than the female (5.90 and 4.57) in both years. In the morning hours, nectar production was also more in the male line than the female. Moreover, pollen is also available on the male line in the morning hours. During rest of the day the female line had more bee visits than the male, corresponding to the pattern of nectar production.

**Table 3.** Frequency of honeybee visits on parental lines and weather parameters during flowering in sunflower hybrid APSH 11

Sowing dates	Number of honeybees visiting 27 capitula			Air Temperature (°C)			Average RH (%)
	RHA 271-R	CMS 7-1 A	Average	Max.	Min.	Average	
1999-2000							
December	4.71(1.95)	3.48(1.47)	4.10(1.71)	33.6	15.0	24.3	60
January	5.53(1.90)	7.06(1.82)	6.29(1.86)	37.9	19.4	28.6	40
February	9.04(2.50)	11.48(2.20)	10.26(2.35)	33.8	23.7	28.7	64
Average	6.43	7.34					
2000-2001							
December	7.46(2.53)	4.33(1.61)	5.90(2.07)	27.6	13.7	20.7	60
January	8.07(2.44)	9.00(1.98)	8.53(2.21)	31.3	16.2	23.4	62
February	5.11(2.01)	7.14(1.83)	6.12(1.92)	40.7	21.5	31.1	36
Average	6.88	6.82					
Average over years							
December	6.09	3.90	5.00				
January	6.80	8.03	7.41				
February	7.07	9.31	8.19				

Parenthesis are transformed {square root (x + 0.5)} values; CD = P = 0.5 - parental lines (both years) = 0.07; sowing dates 1999-2000 = 0.09; sowing dates 2000-2001 = 0.08; parental lines x sowing dates = 0.12.

Table 4. Frequency of honeybee visits at different hours of the day on parental lines of sunflower hybrid APSH-11

Day hours	No. of honeybees visiting 27 capitula								
	1999-2000			2000-2001			Average over years		
	RHA 271-R	CMS 7-1A	Average	RHA 271-R	CMS 7-1A	Average	RHA 271-R	CMS 7-1A	Average
0800	6.88(2.36)	5.90(1.72)	6.39(2.04)	7.61(2.63)	4.57(1.60)	6.09(2.12)	7.25	5.23	6.24
1000	6.81(2.17)	7.38(1.84)	7.09(2.00)	7.44(2.44)	7.60(1.90)	7.52(2.17)	6.86	7.49	7.31
1200	6.11(2.06)	7.22(1.77)	6.67(1.91)	6.44(2.15)	7.43(1.86)	6.94(2.01)	6.28	7.33	6.81
1400	5.89(1.95)	7.82(1.88)	6.85(1.91)	6.72(2.20)	7.68(1.89)	7.20(2.04)	6.31	7.75	7.03
1600	6.44(2.05)	8.39(1.95)	7.42(2.00)	6.17(2.20)	6.85(1.79)	6.51(2.00)	6.31	7.62	6.97
Mean	6.43	7.34		6.88	6.82		6.66	7.08	

Parenthesis are transformed {square root (x + 0.5)} values

CD for day hours = NS in 1999-2000 and 0.11 at 5% for 2000-2001

CD for parental lines X day hours = 0.16 at 5% (both years).

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