

## ROLE OF HONEY BEES IN SUNFLOWER HYBRID SEED PRODUCTION

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### Abstract

The foraging behaviour of three species of honey bees *Apis dorsata*, *Apis cerena indica*, *A. florea* (natural population) was investigated on different parental lines of hybrid sunflower viz., KBSH-1, APSH-11 and LSH-3 during January 1993 to May 1993, when the crop was at 50% in bloom. The R lines were more frequently visited by bees than the CMS lines. The bees on CMS lines were observed not carrying fresh pollen. The pollen was robbed by the bees on R lines to an extent of 12.37, 4.18 and 3.19 mg per bee per visit *dorsata*, *A. cerena* and *A. florea* respectively. The capitulum covered with paper bag yielded 10 fold pollen than open ones. Among different methods of pollination tested, natural pollination supplemented with hand pollination yielded 72.31 per cent seed set compared to 15.36 per cent in natural pollination without supplementary pollination.

### Introduction

Sunflower (*Helianthus annuus* L.) was introduced into India during the year 1916 to augment oil seed production. Presently, it is cultivated on 2.4 m.ha with an annual production of 1.8 m. tons. In Karnataka, it is grown on 1.2m.ha with an annual production of 0.6 m. tons (Anonymous, 1993). The first sunflower hybrid BSH-1 was developed in Karnataka State during 1980. The production of hybrid seeds through Cytoplasmic Male Sterile Lines (CMS) and Restorer (R) Lines in different row ratios or blocks is in vogue and the demand for hybrid sunflower seed is growing in leaps and bounds. Sunflower being protandrous and self-incompatible favours cross-pollination through insects. Satyanaryana and Seetharam (1982) have recorded 19 species of insects visiting parental lines of BSH-1 and honey bees formed 87.23 per cent. Many workers have reported the row ratios and the frequency of honey bee visits on different parental lines of sunflower hybrids (Delaude et.al., 1979 ; Satyanarayana and Seetharam, 1982 and Free, 1993). There is no information available on the transfer of pollen by bees in hybrid sunflower seed production. Incomplete seed set and poor seed filling are the major problems in hybrid seed production which may be due to in

complete pollination. The present investigations are aimed to find out the insect fauna affecting pollination in hybrid sunflower parental lines, to understand seasonal fluctuations in the frequency of bee visits on different parental lines, to find out whether the bees visiting CMS-lines could transfer pollen or not, to find out the quantity of pollen carried by individuals of different species of bees and to find out the actual contribution of bees in pollination of sunflower CMS lines, under natural population condition.

### Material and Methods

The study was conducted on different parental lines of sunflower hybrids viz., KBSH-1 (CMS 234A x 6D-1), APSH-11 (CMS7-1A x RHA 271) and LSH-3 (CMS 207 A x MRHA-1) during the summer 1993 at Bangalore. Observations on honey bee visits were made when the crop was at 50% flowering. Twenty flower heads of same age group were selected and tagged in each parental line, a day before the opening of whorls and observations were recorded from 7.00 h to 18.00 h every day for two minutes at hourly interval from second day of flower opening till completion (6th day). The bees visiting CMS lines were collected in specimen tubes, sacrificed and observed for pollen and stereo binocular microscope at 400X. The weight of pollen load was determined after sacrificing 100 bees of each species with full pollen load.

To study the role played by honey bees in transfer of pollen and seed set in hybrid KBSH-1, another experiment was conducted during Monsoon season of 1993 with a row ratio of 3:1. The treatments imposed were T1. nylon mesh bag (to avoid insect pollination and allow wind pollination), T2. cloth bag (to avoid insect and wind pollination), T3 open pollination and T4. hand pollination, in accordance with RCBD. Matured capitula were harvested and the per cent seed set was determined through grading the seed into filled and chaffy.

### Results and Discussion

#### Insect pollinators

Three species of honey bees viz., *Apis cerena indica* (Indian bee), *A. dorsata* (Rock bee) and *A. florea* (Bush bee) were observed visiting all the parental lines during the period of investigation. *A. cerena indica* was dominant with 56.6 per cent of total population of bees visited, followed by *A.*

*dorsata* (30.6%) and *A. florea* (12.8%). However, *A. cerena indica* were more prevalent during January, February and April while *A. dorsata* during March and April (Table 1). Similar observations were made by Satyanaryana and Seetharam, 1982, with *A. dorsata* dominating the bee fauna. Though *Xylocopa Sp.* (carpenter bees) and *Scolia Sp.* (scolids) found hovering in the field did not forage on sunflower. However, the present study revealed that honey bees are the true pollinators in sunflower.

### Seasonal fluctuation and daily rhythms

All the three species of honey bees visited sunflower parental lines tested. The bees visited Restorer Lines more frequently than the CMS lines, may be due to the availability of pollent and nectar (more rewarding) in them. Maximum bee visits were observed during January to March with a steep decline in April/May (Table 3). This may be due to more absconding nature of natural populations of bees during hot summer months due to insufficient bee flora in bloom. The bees were active all through the day from 07.00 to 18.00 h on all sunflower parental lines, with a peak at 09.00 h, which may be due to the dehiscence of anthers and availability of pollen in large quantity. The visits declined as the day progressed (Fig.1)

### Behaviour of honey bees on CMS lines

The bees were less active on CMS lines compared to R lines. The presentation of nectar in deep corolla tube makes the bee to work for more time ranging from two to six minutes on each capitulum (Table 4). The investigations carried out on the bees visiting CMS lines revealed that one to 5.2 per cent of them carried dry pollen and 94.8 to 99 % were devoid of pollen on their body parts (Figure 2). Therefore it could be inferred that the bees collecting nectar from R lines have not visited the CMS Lines simultaneously, which suggests a special foraging behaviour common among the species of bees studied.

### Behaviour of honey bees on restorer lines

The bees were more brisk and active on R lines compared to CMS lines, may be due to the availability of pollen and nectar. The number of capitula visited by *A. cerena*, *A. dorsata* and *A. florea* in two minutes were 5,3.33 and 2.33, respectively (Table 4). The pollen gatherers were relatively abund

nant than nectar gatherers. The maximum weight of pollen carried away by individual bee per trip was 12.37 (11.8-13.0), 4.18. (3.82-4.50) and 3.19 (2.51-3.92) mg. for *A. dorsata*, *A. cerena* and *A. florea*, respectively (Table 2).

### **Pollen robbing**

The experiment conducted to investigate the quantity of pollen carried away from the main capitula of 6D-1 by the bees indicated that the capitulum uncovered yielded less pollen (3.340 and 3.647 mg.) compared to capitula covered with paper bags (39.473 and 43.596 mg.) during May 93 and January 94, respectively (Table 6). It is evident from the above that most of the pollen produced by R line was carried away by bees resulting in dirth of pollen for supplementary hand pollination.

### **Pollination methods and seed set**

Among different methods of pollination tested hand pollination with natural pollination proved to be far more superior with 72.31 per cent seed set followed by natural pollination (15.36). The treatment in which the capitula covered with nylon mesh bags (wind polliantion) yielded 0.28 % seed set and there was no seed set in the capitulum covered with cloth bag (Table 5). This indicates that bees and wind together affecting 15 to 30 per cent pollination in hybrid seed production of KBSH-1 under natural conditions.

### **Conclusion**

All the sunflower parental lines were visited by three species of bees viz., *A. cerena indica*, *A. dorsata* and *A. florea*. There was considerable seasonal fluctuation among the species. The peak activity of bees was observed at 09.00 h. The R lines were more attractive than CMS lines. A very small per cent (1 to 5) of bees on CMS lines contained dry pollen. The contribution of bees in KBSH-1 hybrid seed production was very less (15 - 30%) compared to supplementary hand pollination (65-85%). The bees were carrying away most of the pollen from R lines creating pollent dirth for supplementary hand pollination.

Efficient media for pollen transfer in sunflower hybrid seed production is the need of the hour. There is a scope to increase hybrid seed yield through increased bee population and enhanced visits of pollen/nectar gatherers from R line to CMS line. Till then supplementary hand pollination is the only way out.

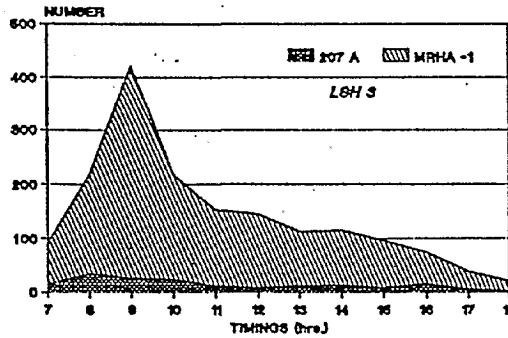
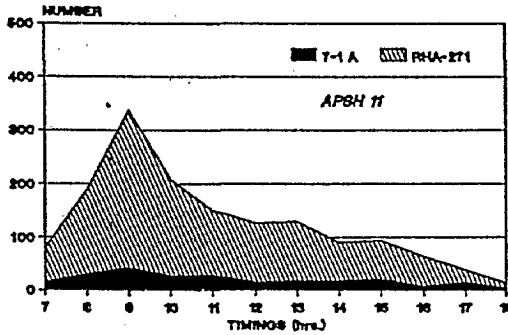
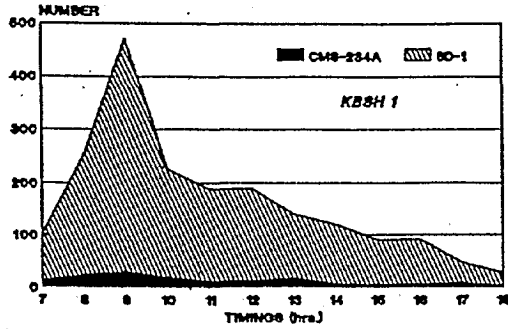


Fig.1 HONEY BEES ACTIVITY ON PARENTAL LINES OF HYBRID SUNFLOWER

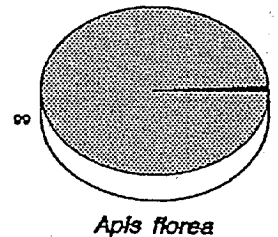
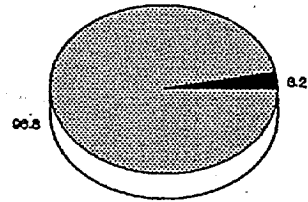
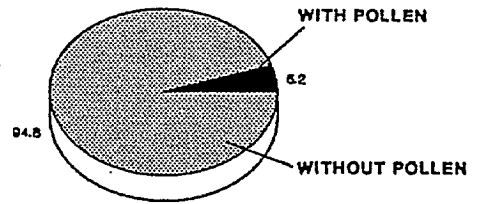


Fig.2 HONEY BEES WITH AND WITH OUT POLLEN ON MALE STERILE LINES

Table 1: Seasonal fluctuation in bee fauna during hybrid seed production at Bangalore

Flowering period	Per cent honey bees		
	A.cerena	A.dorsata	A.florea
January 1993	85	03	12
February	81	06	13
March	18	66	16
April	26	58	16
May	73	20	07
Total	283	153	64
Mean	56.6	30.6	12.8

Table 2: Quantity of pollen (mg./bee/trip) carried away by different honey bee species

Species	Quantity of pollen	
	Mean	Range
A.dorsata	12.37	11.80 - 13.00
A.cerena	4.18	3.82 - 4.50
A.florea	3.19	2.51 - 3.92
	S.E.m	0.36
	C.D (5%)	1.43
	C.V (%)	3.54

Table 4: Number of capitula visited by foraging bees per two minutes on the parental lines of KSSH-1 during February 1993

Hour of observation	A.dorsata		A.cerena		A.florea	
	6D-1	CMS 234A	6D-1	CMS 234A	6D-1	CMS 234A
9.00 h	4	1 *	6	1	3	1
12.00 h	3	1	5	1	2	1
15.00 h	3	1	4	1	2	1
Total	10	3	15	3	7	3
Mean	3.33	1.00	5.00	1.00	2.33	1.00

\* Max. time spent on a capitulum 6 minutes

Table 5: Seed set in CMS 234A as influenced by different types of pollination during Monsoon season 1993

Treatment	Per cent seed set
T1 : Nylon mesh bag	0.28 (0.1 - 0.3)
T2 : Cloth bag	0.00 --
T3 : Natural pollination	15.36 ( 15 - 36 )
T4 : Hand pollination	72.31 ( 65 - 85 )
	C.D (5%) 0.15
	C.V (%) 0.59

Table 3: Seasonal fluctuation of bee visits on different parental lines of Sunflower hybrids at Bangalore during 1993

Day of flowering in capitulum	Flowering Period					Mean	Day of Flowering in capitulum	Flowering Period					Mean
	Jan. 1993	Feb. 1993	March 1993	April 1993	May 1993			Jan. 1993	Feb. 1993	March 1993	April 1993	May 1993	
	1993	1993	1993	1993	1993			1993	1993	1993	1993	1993	
CMS-234A													
2nd	8*	16	13	4	3	8.8	2nd	83	50	63	40	28	66.4
3rd	13	8	8	3	3	7.0	3rd	180	129	124	38	32	100.6
4th	6	10	6	5	3	6.0	4th	154	86	110	37	27	82.8
5th	9	6	3	3	1	4.4	5th	131	103	87	34	30	77.0
6th	12	4	3	2	2	4.6	6th	135	96	100	29	28	77.6
Total	48	44	33	17	12	Total	683	644	484	178	145	Total	
Mean	(9.6)	(8.8)	(6.6)	(3.4)	(2.4)	Mean	(136.6)	(128.8)	(96.8)	(35.6)	(29.0)	Mean	
7-1A													
2nd	12	21	13	6	4	11.2	2nd	68	47	73	32	32	50.4
3rd	21	21	9	8	4	12.6	3rd	138	89	81	35	35	75.6
4th	16	16	11	3	5	10.2	4th	126	98	57	27	27	67.0
5th	15	7	4	5	3	6.8	5th	112	72	56	30	30	60.0
6th	19	4	5	3	4	7.4	6th	111	54	59	19	29	54.4
Total	83	69	42	25	20	Total	555	460	326	143	153	Total	
Mean	(16.6)	(13.8)	(8.4)	(5)	(4)	Mean	(111)	(92)	(65.2)	(28.6)	(30.6)	Mean	
207-A													
2nd	9	18	4	3	2	7.2	2nd	69	48	91	31	32	54.2
3rd	22	7	5	3	3	8.0	3rd	168	109	92	31	36	87.2
4th	16	8	5	2	2	6.6	4th	157	68	71	35	23	70.8
5th	9	6	5	2	2	4.6	5th	136	119	31	30	30	69.2
6th	9	4	2	1	4	4.0	6th	133	70	51	51	17	59.8
Total	89	43	21	11	30	Total	663	414	336	144	149	Total	
Mean	(17.8)	(8.6)	(4.2)	(2.2)	(2.6)	Mean	(132.6)	(82.8)	(67.2)	(28.8)	(29.8)	Mean	

\* Mean total bee visits / 2 minutes / 5 flowers

Table 6: Quantity of pollen (mg./ capitulum) available under open and protected condition in R line 6D-1

Day of flowering	Pollen weight (mg.)			
	May 1993		January 1994	
	open	protected	open	protected
First	2.060	23.220	2.916	23.210
Second	4.773	48.570	5.230	45.650
Third	6.183	59.310	6.290	60.400
Fourth	4.623	51.150	4.200	57.490
Fifth	2.973	39.140	3.146	50.150
Sixth	1.760	36.560	2.560	46.980
Seventh	0.976	18.360	1.186	21.290
Total	23.348	276.31	25.528	305.170
Mean	3.34	39.473	3.647	43.596
C.D (5%)	0.62	6.17	1.73	6.55
C.V	6.06	5.07	15.35	4.87

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