

## Floral Visitors and Foraging Activity of Pollinators on Parental Lines of Sunflower Hybrid (KBSH-44)

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### ABSTRACT

The study was conducted at Main Agricultural Research Station, UAS, Raichur during *rabi* 2020-21 to record the floral visitors and foraging activity of pollinator on parental lines of sunflower hybrid KBSH-44. Totally, thirty species of floral visitors were recorded on parental lines of sunflower hybrid (KBSH-44), among them 15 were hymenopterans, 7 lepidopterans, 5 coleopterans and 3 dipterans. *Apis dorsata* was predominant pollinator (20.08 ±10.45 bees/ 5 capitula/ 5 min.) on CMS parental line (CMS-17A), followed by *A. cerana* and least was *A. florea*. The peak foraging activity of *A. dorsata* was recorded at 1100-1200 hr with 33 bees, *A. cerana* at two peaks at 0900-1100 hr (23 bees) and 1500-1600 hr (19 bees) and *A. florea* at 1000-1200hr (8 bees). The maximum Shannon-Wiener index of diversity (H=1.28) of floral visitors on CMS line was recorded at 0800-0900 hr and 1000-1100 hr of the day and least (H=0.56) was at 1700-1800 hr. In case of fertility restorer line (RHA-95C-1), *Apis dorsata* was recorded peak foraging activity at 1000-1200hr (49 bees/5 capitulum/5 min.), *Apis cerana* at 1100-1200 hr (50 bees/5 capitulum/5 min.) and *Apis florea* recorded at 1100-1300 hr (25 bees/5 capitulum/5 min.). The maximum Shannon-Wiener index of diversity (H=1.32) of floral visitors on R line was recorded at 1700-1800 hr of the day and least (H=1.03) was at 0800-0900 hr. *Apis dorsata* was recorded highest Berger Parker dominance both in CMS line (d=0.471) and in R line (d=0.392).

Keywords : Honey bees, Foraging activity, Nectar secretion

HONEY bees are the most important insect pollinators of cultivated crops worldwide. While many insect pollinators visit the flowers of only a small number of plant species, honey bees visit flowers of diverse plant species for collecting nectar and pollen. Honey bees are one of the few pollinating insects that can be domesticated. They can be delivered to a crop when required and various management options are available to influence the honey bees flower visiting behavior (Anonymous, 2012). The species richness and foraging behavior of honey bees on sunflower is genotype specific and is influenced by morphometric variations of the plant, which includes flower shape, flower structure,

head size, floret length, corolla length, stigma pigmentation and many other factors. Nectar and pollen are the source of food for honey bees, which attract or restrict bee visitation to the host plant (Rinku *et al.*, 2017). Sunflower is an allogamic plant which needs insects during flowering for pollination especially honey bees for seed production. Pollen grains of sunflower are heavy and sticky in nature due to this wind plays a very minor role in transfer of pollen from one flower head to other, which can be done by using honey bees (Furgula, 1954 and Free, 1963). The present study aims to record the floral visitor and pollinator activity on parental lines of sunflower hybrid KBSH-44.

## MATERIAL AND METHODS

The present investigation on 'floral visitors and foraging activity of pollinators on parental lines of sunflower hybrid KBSH-44' was carried out during 2020-21 at Main Agricultural Research Station, UAS, Raichur.

### Pollinator Fauna and their Foraging Activity on Parental Lines (CMS 17A and RHA 95C-1) of Sunflower Hybrid (KBSH-44)

Parental lines of sunflower hybrid were sown in the ratio of 1:3 (male : female) during last of week of November 2020 with a plot size of 40 m x 25 m. In order to record the species abundance, diversity of flower visitor and foraging activity of floral visitors on sunflower capitula was done for 5 minutes duration at hourly intervals, commencing from 06.00 h to 18.00 h.

### Diversity of Flower Visitors on Parental Lines of Sunflower Hybrid

Representative samples of flower visitors were collected by different methods *viz.*, visual scanning, sweep net sampling and bee bowls as per the methodology suggested by Belavadi and Ganeshiah (2013). Collected floral visitors were brought to the laboratory, mounted using insect pins, properly dried and identification was done by the expertise available at the Department of Agricultural Entomology, UAS, Raichur.

Pollinator population count was used to compute Shannon-Weiner index of diversity (H) by using the following formula:

$$H = -\sum p_i \times \ln p_i$$

Where,  $p_i$  is the proportion of the  $i^{\text{th}}$  species

The dominant species on any given sampling day was determined by the Berger-Parker dominance index 'd' which gives the proportion of the total numbers of individuals in a sample that is due to the dominant species and was calculated by:

$$d = n_i/NT$$

Where,

$n_i$  is the number of individuals of the  $i^{\text{th}}$  species on sampling date and NT is the total number of individuals in the sample (Southwood, 1988).

### Nectar Yield and Total Soluble Solids (TSS)

Quantity of nectar and TSS in the nectar produced by the disc florets ( $n=25$ ) of CMS and R line were estimated. The randomly selected capitula were enclosed with butter paper cover to avoid the visit of pollinators. Next day the covers were removed from the capitula and the quantity of nectar produced per floret was measured from 06.00 to 18.00 h at two hourly intervals by using calibrated capillaries/micro syringe. The quantity of nectar collected was expressed in micro litre ( $\mu\text{l}$ )/floret (Belavadi and Ganeshiah, 2013). The quality of nectar in terms of sugar (TSS) content was assessed by using hand refractometer in field itself and expressed in percentage.

## RESULTS AND DISCUSSION

### Floral Visitors of Parental Lines (CMS-17A and RHA 95C-1) of Sunflower Hybrid (KBSH-44)

Observations on foraging activity in the parental lines of sunflower hybrid KBSH-44 showed that the flowers were visited by 15 species of floral visitors from five families of Hymenoptera, seven species from four families of Lepidoptera, five species from three families of Coleoptera and one each species from three families of Diptera (Table 1). Among the fifteen hymenopteran species recorded, ten species belonged to the family Apidae, three species belonged to the family Vespidae, two species each from family Halictidae and Megachilidae and one species of the family Sphecidae. The lepidopteran floral visitor were represented by three species under family Nymphalidae, two species from Erebididae and one species each represented by Pieridae and Sphingidae. Order Coleoptera was represented by two species each under the family Chrysomelidae and Coccinellidae, one species under the family Scarabaeidae. Order Diptera was represented by one species each under the families Syrphidae, Sacrophagidae and Muscidae.

TABLE 1  
List of floral visitors of parental lines of sunflower hybrid KBSH-44

Scientific name	Family	Order	
<i>Apis dorsata</i> Fabricius	Apidae	Hymenoptera	
<i>Apis cerana indica</i> Fabricius			
<i>Apis florea</i> Fabricius			
<i>Xylocopa aestuans</i> (Linnaeus)			
<i>Xylocopa fenestrata</i> (Fabricius)			
<i>Amegilla</i> sp.			
Unidentified	Halictidae		
<i>Lassooglossum</i> sp.			
Unidentified sp.	Vespidae		
<i>Vespa tropica</i> (Linnaeus)			
<i>Ropalidia marginata</i> (Lepeletier)	Sphecidae		
<i>Poslistos</i> sp.			
Unidentified sp.	Megachilidae		
<i>Megachile disjuncta</i> (Fabricius)			
<i>Megachile lanata</i> (Fabricius)	Sphingidae		
Unidentified sp.			
<i>Danaus chrysippus</i> Linnaeus	Nymphalidae		Lepidoptera
<i>Junonia lemonias</i> (Linnaeus)			
<i>Tirumala limniace</i> (Cramer)	Pieridae		
<i>Catopsilia</i> sp.			
<i>Amata passalis</i> (Fabricius)	Erebidae		
<i>Amata cyssea</i> (Stoll)			
<i>Gametis versicolor</i> (Fabricius)	Scarabaeidae	Coleoptera	
<i>Coccinella transversalis</i> Fabricius	Coccinellidae		
<i>Chilomenes sexmaculata</i> Fabricius			
<i>Monolepta</i> sp.	Chrysomelidae		
<i>Leptisma</i> sp.			
<i>Eristalinus</i> sp.	Syrphidae	Diptera	
Unidentified sp.	Sarcophagidae		
Unidentified sp.	Muscidae		

Sanganna *et al.* (2022) recorded 30 species of floral visitor on parental lines of Sunflower hybrid (RSFH-130) at Raichur. The similar findings were reported by Ali *et al.* (2015) from Pakistan, a total of 15 insect species belonging to three main orders *i.e.*, Hymenoptera (three families, nine species), Lepidoptera (three families, four species) and Diptera (two families, two species). Among the three orders, hymenopterans represent 91 per cent of all the recorded species followed by lepidopterans (6%) and dipterans (3%). Devaramane *et al.* (2018) reported that, 22 species of pollinators recorded in sunflower comprising of Hymenoptera (72.73%), Diptera (9.09%) and Lepidoptera (18.18%). Jadhav *et al.* (2011) from Thirupathi, who recorded five families of Hymenoptera, four families of Lepidoptera and three families of Coleoptera and one family of Diptera visiting sunflower capitulum.

#### Cytoplasmic Male Sterile Parental Line (CMS-17A)

*Abundance of floral visitors on CMS parental line (CMS-17A) of Sunflower hybrid (KBSH-44)* : The relative abundance of *Apis* and Non-*Apis* floral visitors (no./5 capitulum/5min.) on CMS line was recorded. Totally 511 floral visitors were recorded on CMS line. Among *Apis* species of floral visitors *A. dorsata* was predominant ( $20.08 \pm 10.45$  bees), followed by the *A. cerana* ( $14.75 \pm 6.35$  bees) and the least abundant was *A. florea* ( $3.08 \pm 2.84$  bees). The foraging activity of *A. cerana* recorded two peaks one at 09.00-11.00 h (23 bees) another at 15.00-16.00 h (19 bees), while, *A. dorsata* peaked at 11.00-12.00 h (33 bees) and *A. florea* at 10.00-12.00 h (8 bees) (Table 2). Among non-*Apis* species, hymenopterans were predominant ( $3.91 \pm 2.77$  bees) and recorded peak foraging activity at 10.00-11.00 h (8 bees), followed by lepidopterans ( $0.33 \pm 0.49$ ), coleopterans ( $0.25 \pm 0.45$ ) with foraging activity at 06.00-09.00 h and least foraging activity was recorded by dipterans ( $0.16 \pm 0.38$ ). Similar trend was recorded on Sesame at Siruguppa (Sanganna and Eswarappa, 2015).

*Diversity and dominance of floral visitors on CMS parental line (CMS-17A) of Sunflower hybrid (KBSH-44)* : The maximum Shannon-Wiener index of

diversity (H) of floral visitors (H=1.28) on CMS parental line was recorded at 09.00-10.00 h and 10.00-11.00 h of the day and lowest (H=0.56) was recorded at 17.00-18.00 h of the day. The highest (d=0.471) Berger Parker dominance was recorded with *A. dorsata* and lowest with dipterans (d=0.003). Highest dominance with respect to the hours of the day was recorded at 17.00-18.00 h (0.75) and lowest at 08.00-09.00 h and 10.00-11.00 h (0.43) (Table 2).

### Fertility Restorer Parental Line (RHA 95C-1)

*Abundance of floral visitors on fertility restorer parental line (RHA 95C-1) of Sunflower hybrid (KBSH-44)* : The relative abundance of *Apis* and Non-*Apis* floral visitors (no./5 capitulum/5 min.) on fertility restorer parental line (RHA 95C-1) was recorded. Totally 954 floral visitors were recorded on fertility restorer line. Among *Apis* species, *A. dorsata* was predominant (31.16 ± 15.98 bees), followed by the *A. cerana* (30.83 ± 12.48 bees) and least was *A. florea* (15.25 ± 7.66 bees). The peak foraging activity of *A. dorsata* was recorded at 10.00-12.00 h of the day with 49 bees, *A. cerana* at 11.00-12.00 h (50 bees) and *A. florea* at 11.00-13.00 h (25 bees) (Table 3). Among the non-*Apis* species, hymenoptera were the predominant (1.33 ± 0.98 bees) and their peak foraging activity was at 17.00-18.00 h (3 bees), followed by lepidopterans and coleopterans (0.33 ± 0.49) and the least abundance was recorded with dipterans (0.33 ± 0.49 beetles).

*Diversity and dominance of floral visitors on fertility restorer parental line (RHA 95C-1) of Sunflower hybrid (KBSH-44)* : The maximum Shannon-Wiener index of diversity (H) of floral visitors (H=1.32) on restorer line was recorded at 17.00-18.00 h of the day and least (H=1.03) was recorded at 08.00-09.00 h. The highest (d=0.392) Berger Parker dominance index among the floral visitors of the line was recorded for *A. dorsata* and lowest with coleopterans (d=0.003), whereas, with respect to the hours of the day, highest dominance was recorded at 08.00-09.00 h (d=0.49) (Table 3).

*Nectar yield and total soluble solids (TSS) content in the nectar of parental lines of Sunflower hybrid*

*KBSH-44* : Nectar production in both the parental lines of sunflower hybrid was recorded separately. CMS parental line (CMS 17A) produced 1.30 µl/floret and fertility restorer parental line (RHA 95C-1) produced 1.08 µl/floret (Table 4). Cytoplasmic male sterile parental line produced more quantity of nectar as compared with fertility restorer line. Because of production of more quantity of nectar by CMS parental line which attract more number of nectar foragers compared with fertility restorer parental line. CMS 17A line recorded 5.76 per cent TSS while RHA 95C-1 recorded 5.74 per cent TSS content in nectar.

The study found that the peak nectar production by the disc florets of both parental lines (CMS and R lines) of sunflower hybrid (KBSH-44) was between 14.00-16.00 h of the day and highest total soluble solids of the nectar produced by the parental lines was between 14.00 to 16.00 h of the day (Table 4). Gowda *et al.* (2003) reported that the mean nectar yield per floret of various sunflower genotypes showed a significant difference. The mean nectar yield per floret ranged from 0.21 mg (265R) to 0.59 mg (586R). CMS lines were found to have more mean nectar content as compared with R lines of sunflower (0.4 and 0.37 mg/floret, respectively). Bees have differential preference for one of the two parental lines. This difference could be due to the differences between lines for nectar production and for concentration and quality of sugars (Basualdo *et al.*, 1999).

The fertility restorer line attracts more number of pollen foragers and cytoplasmic male sterile lines are attracting more number of nectar foragers. CMS lines produce more quantity of nectar compared to the restorer lines. Sinha and Vaishampayan (1995) reported the female lines (CMS lines) sunflower hybrids were visited by nectar foragers, these lines produce only nectar. Whereas, both nectar and pollen foragers visited the male (restorer) lines and these lines produce both nectar and pollen. Satyanarayana and Seetharam (1982) reported that, higher frequency of visitation was observed in pollen parent as compared to that in seed parent due to pollen and nectar was present in pollen parent. The pollen forager honey

TABLE 2  
Abundance, diversity and dominance of floral visitors on CMS parental line (CMS 17A) of sunflower hybrid (KBSH-44) under open condition

Time (hrs)	Number of floral visitors/5 capitula/5 min.								Total	“H” value	“d” value
	Apis species			Non-Apis species			Coleo ptera				
	<i>Apis cerana</i>	<i>Apis dorsata</i>	<i>Apis florea</i>	Hymeno ptera	Diptera	Lepido ptera					
0600 - 0700	10	7	1	0	0	0	1	19	1.02	0.52	
0700 - 0800	20	18	2	2	0	0	1	43	1.09	0.46	
0800 - 0900	22	25	3	4	1	1	1	57	1.28	0.43	
0900 - 1000	23	27	6	5	0	0	0	61	1.16	0.44	
1000 - 1100	23	31	8	8	0	1	0	71	1.28	0.43	
1100 - 1200	15	33	8	7	0	0	0	63	1.19	0.52	
1200 - 1300	11	30	4	7	0	0	0	52	1.11	0.57	
1300 - 1400	7	26	2	6	0	0	0	41	1.02	0.63	
1400 - 1500	10	21	2	4	0	1	0	38	1.17	0.55	
1500 - 1600	19	14	1	3	1	0	0	38	1.11	0.50	
1600 - 1700	11	7	0	1	0	1	0	20	0.99	0.55	
1700 - 1800	6	2	0	0	0	0	0	8	0.56	0.75	
Total	177	241	37	47	2	4	3	511			
Mean ± SD	14.75 ± 6.35	20.08 ± 10.45	3.08 ± 2.84	3.91 ± 2.77	0.16 ± 0.38	0.33 ± 0.49	0.25 ± 0.45				
“d” value	0.346	0.471	0.072	0.091	0.003	0.007	0.005				

TABLE 3  
Abundance, diversity and dominance of floral visitors on fertility restorer parental line (RHA 95 C-1) of sunflower hybrid (KBSH-44) under open condition

Time (hrs)	Apis species				Non-Apis species			Total	“H” value	“d” value
	<i>Apis cerana</i>	<i>Apis dorsata</i>	<i>Apis florea</i>	Hymenoptera	Diptera	Lepidoptera	Coleoptera			
0600-0700	14	16	3	1	0	1	1	36	1.23	0.44
0700-0800	26	26	6	1	1	1	1	62	1.22	0.41
0800-0900	30	40	10	1	0	0	0	81	1.03	0.49
0900-1000	40	44	18	2	0	0	0	104	1.11	0.42
1000-1100	40	49	21	1	1	0	0	112	1.13	0.43
1100-1200	50	49	25	3	0	1	1	129	1.22	0.38
1200-1300	44	46	25	0	0	0	0	115	1.07	0.40
1300-1400	38	38	22	1	1	0	0	100	1.16	0.38
1400-1500	32	34	18	2	0	0	0	86	1.15	0.39
1500-1600	28	20	17	0	0	1	0	66	1.14	0.42
1600-1700	20	8	12	1	0	0	1	42	1.21	0.47
1700-1800	8	4	6	3	0	0	0	21	1.32	0.38
Total	370	374	183	16	3	4	4	954		
Mean ± SD	30.83 ± 12.48	31.16 ± 15.98	15.25 ± 7.66	1.33 ± 0.98	0.25 ± 0.45	0.33 ± 0.49	0.33 ± 0.49			
“d” value	0.387	0.392	0.191	0.016	0.003	0.004	0.004			

TABLE 4  
Nectar secretion and its total soluble solids (TSS) content in the flowers of parental lines of sunflower hybrid (n=25 florets)

Time (hrs)	Sunflower hybrid (KBSH-44)			
	Cytoplasmic male sterile line (CMS 17A)		Restorer line (RHA 95 C-1)	
	Nectar ( $\mu$ l/floret)	TSS (%)	Nectar ( $\mu$ l/floret)	TSS (%)
0600	1.00 <sup>f</sup> (0.00)	1.00 <sup>f</sup> (0.00)	1.00 <sup>g</sup> (0.00)	1.00 <sup>g</sup> (0.00)
0800	1.08 <sup>e</sup> (0.17)	5.51 <sup>e</sup> (29.37)	1.01 <sup>f</sup> (0.01)	5.31 <sup>f</sup> (27.22)
1000	1.26 <sup>d</sup> (0.59)	5.87 <sup>d</sup> (33.46)	1.06 <sup>e</sup> (0.13)	6.12 <sup>e</sup> (36.48)
1200	1.36 <sup>c</sup> (0.86)	6.41 <sup>c</sup> (40.21)	1.08 <sup>d</sup> (0.17)	6.50 <sup>d</sup> (41.32)
1400	1.52 <sup>a</sup> (1.32)	7.11 <sup>b</sup> (49.58)	1.16 <sup>a</sup> (0.34)	6.92 <sup>c</sup> (47.00)
1600	1.52 <sup>a</sup> (1.31)	7.27 <sup>a</sup> (51.93)	1.10 <sup>c</sup> (0.21)	7.27 <sup>a</sup> (51.98)
1800	1.41 <sup>b</sup> (1.01)	7.15 <sup>b</sup> (50.11)	1.15 <sup>b</sup> (0.33)	7.04 <sup>b</sup> (48.68)
Sem $\pm$	0.003	0.027	0.001	0.028
Mean	1.30	5.76	1.08	5.74
Sem $\pm$	0.003	0.027	0.001	0.028
CD @ 5%	0.008	0.085	0.003	0.088
CV (%)	0.333	0.824	0.154	0.853

The values with same superscript in a column do not differ significantly by DMRT  
Values outside the parenthesis are square root transformed values

bee visit the CMS line for nectar collection for immediate energy requirement of the body. During this process the pollen foragers transfer the pollen from restorer line to CMS line. This will help in effective pollination and production of good quality hybrid seeds.

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