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Diversity and abundance of pollinator fauna in Sunflower

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Abstract
Sunflower was visited by a wide range of insects during the flowering season, including bees, moths, ants, butterflies, thrips, beetles, bugs, and other insect species. A study on insect pollinators of sunflower was carried out at Hirehalli village of Tumkur district in Karnataka during 2019-20. Hymenopterans and Dipterans were the major pollinators recorded in the flowering season. The predominant pollinators observed during the study period were four honey bees species, such as *Trigona* sp, *A. cerana*, *A. florae* and *Apis dorsata*. and two species of bumble bees viz., *Xylocopa aestuans* and *X. latipus*. The activity of all these pollinators were more between morning 09 a.m., to 12 p.m., The initial evidence of *A. dorsata* activity was seen between 07 and 08 a.m., gradually increasing to a peak between 9 and 10 a.m., then decreasing to a second peak between 02 and 03 pm., then gradually decreased at the end of the day. *A. Cerana* activity peaked between 11 a.m., to 12 noon. *A. florea* activity began at 09 a.m., and lasted till to 3:30 p.m., *Trigona* species foraging visits began at 09 a.m., and continued till 02 p.m., to 3:30 p.m., Its busiest hours are 10 a.m., to 11 a.m., When compared to other foragers, *A. dorsata* foraged for the longest period of time. *A. cerana* was only active for 8 hours. *Trigona sp.* for 6 hours and *A. florea* for 6 hours. *Xylocopa s*p. a non-Apis bee, foraged for 6 hours, but Dipterans and other foragers only foraged for 5 hours. In sunflowers, *A.dorsata* appeared to be the most prominent pollinator.

Keywords: abundance, diversity, honey bees, pollinators, sunflower

Introduction
Sunflower, also known as 'Suryakanthi' or 'Surajmukhi,' is one of the most frequently produced oil seed crops in India, covering 8.3 million hectares in the country. Sunflower production was estimated to be 8.50 lakh tonnes per year, with an average yield of 705 kg per hectare. In terms of acreage and production, it ranks fourth among oilseed crops. Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu are the top sunflower producers. Karnataka takes the lead with 3.04 lakh tonnes produced on 7.94 lakh hectares (AICRP, 2014) [1].
Sunflower is an allogamic plant that relies on pollinators for seed production during flowering, specifically honeybees. Individual sunflower florets typically self-pollinate with sticky heavy pollen and require pollen transfer from neighbouring florets, which can be accomplished with the help of honeybees (Furgala, 1954) [2] (Free, 1963) [3]. The most significant insects in the sunflower pollination process are honey bees. Unlike all the other insects that visit flowers expressly for the purpose of food themselves, bees visit a greater number of flowers in order to meet the demands of their colony (Müller *et al.*, 2006) [4]. The feeding strategy of bees on sunflower flowers is a significant theme in pollination research.

Material and Methods
Sunflower hybrid KBSH-53 plants raised plant in an area of one hectare at Hirehalli, Tumkur was selected for study. During the peak flowering period 20 heads were sampled for 15 min frequency for every single hour from 06 a.m., to 06 p.m., Observations on different pollinators visiting sunflower was recorded during this period. Total numbers of visitors were recorded and the relative abundance of each visitor was worked out

Results
Foraging pattern of bees on KBSH-53 hybrid in relation to time
Ad-libitum sampling of 20 heads in 15 minutes duration for every one hour from 6.00 hrs to 20.00 hrs on revealed the abundance and diversity of The abundant diversity of *A. cerana*, *Xylocopa latipus*, *A. florea*, *Apis dorsata*, *X. aestuans* and *Trigona* sp. in the full bloom stage of sunflower crop such as KBSH-53 inflorescence
In general, the activity of all these pollinators was more between 9.00 and 12.00 hrs. The first sign of *A. dorsata* activity was observed during 7.00-8.00 hrs (0.30±0.44) which gradually increased and reached a peak during 9.00-10.00 hrs (8.30±1.74), then decreased subsequently and reached a second peak during 14.00-15.00 hrs (4.70±0.74) and gradually decreased towards the end of the day. *A. cerana* activity first commenced from 9.00-10.00 hrs (0.20±0.24) and continued even up to 16.00 -17.00 hrs (0.20±0.40), with a peak in its activity during 11.00-12.00 hrs (1.50±0.00). Activity of *A. florea* commenced from 9.00-10.00 hrs (0.60±0.44) and continued till 14.00-15.00 hrs (0.20±0.40), with greater foraging activity during 9.00-10.00 hrs (0.60±0.44) and 11.00-

12.00 hrs (0.60±0.24). The foraging visits of *Trigona* sp. commenced from 9.00-10.00 hrs (0.50±0.48) and lasted till 14.00-15.00 hrs (0.20 ±0.40), with its peak activity during 10.00-11.00 hrs (0.80±0.24).
Both *X. aestuans* and *X. latipus* commenced their foraging visits from 8.00-9.00 hrs (0.20±0.40 and 0.40±0.24 respectively) and their activity ended by 13.00-14.00 hrs (0.20±0.40 and 0.10 ± 0.40 respectively). However, peak activity of *X. aestuans* was observed during 10.00-11.00 hrs (0.70±0.61), whereas *X. latipus* exhibited two foraging peaks during 8.00-9.00 hrs and 11.00-12.00 hrs (0.40±0.24 and 0.40±0.48 respectively). The activity of Dipterans and other foragers initiated at 8.00-9.00 hrs (0.20±0.40) and lasted till 12.00-13.00 hrs (0.20±0.40) with their peak activity at 9.00-10.00 hrs (0.40±0.48).
This study revealed that *A. dorsata* foraged for maximum time (7.00-8.00 hrs to 19.00-20.00 hrs) compared to other foragers. *A. cerana* was active for only 8 hrs (9.00-10.00 to 16.00-17.00 hrs), *A. florea* for 6 hrs (9.00-10.00 to 14.00-15.00 hrs) and *Trigona* sp. for 6 hrs (9.00-10.00 to 14.00-15.00 hrs). The non Apis bee *Xylocopa* sp. foraged for 6 hrs (8.00-9.00 to 13.00-14.00 hrs) whereas Dipterans and other foragers foraged for only 5 hours (8.00-9.00 hrs – 12.00-13.00 hrs). *A.dorsata* appeared to be the most predominant pollinator on sunflower under study area conditions (Table 1).

Relative abundance of insect pollinators on Sunflower
The total number of visitors for every 10 minutes interval from 9:15 am to 11:20 am revealed that, the species composition was maximum from 9.15 - 9.25 AM (19.54%) followed by 9.45 – 9.55 AM (15.78%) and minimum during 11.00 to 11.20 AM (2.25%). *A. dorsata* was the dominant with species composition of 71.42% followed by *A. cerana* (17.42%), *A. florea* (5.3%), *Xylocopa sp*. (4.54%) and Dipterans (1.51%) (Table 2).

Table 1: Foraging pattern of bees on Sunflower (KBSH -53) in relation to time of the day (Kharif 2013)

Time of observation	*A. dorsata*	*A. cerana*	*A. florea*	*Trigona* sp.	*X. aestuans*	*X. latipus*	*Dipterans/Others.*
6.00 to 7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.00 to 8.00	0.30 ± 0.44	0.00	0.00	0.00	0.00	0.00	0.00
8.00 to 9.00	2.8 ± 0.68	0.00	0.00	0.00	0.20 ± 0.40	0.40 ± 0.24	0.20 ± 0.40
9.00 to 10.00	8.30 ± 1.74	0.20 ± 0.24	0.60 ± 0.44	0.50 ± 0.48	0.60 ± 0.48	0.20 ± 0.24	0.40 ± 0.48
10.00 to 11.00	5.69 ± 1.51	0.50 ± 0.48	0.50 ± 0.64	0.80 ± 0.24	0.70 ± 0.61	0.20 ± 0.40	0.20 ± 0.40
11.00 to 12.00	4.50 ± 1.14	1.50 ± 0.00	0.60 ± 0.24	0.60 ± 0.48	0.60 ± 0.48	0.40 ± 0.48	0.20 ± 0.40
12.00 to 13.00	3.40 ± 1.21	0.80 ± 0.60	0.40 ± 0.48	0.40 ± 0.48	0.20 ± 0.40	0.20 ± 0.40	0.20 ± 0.40
13.00 to 14.00	2.80 ± 0.40	0.50 ± 0.64	0.50 ± 0.48	0.40 ± 0.44	0.20 ± 0.40	0.10 ± 0.40	0.00
14.00 to 15.00	4.70 ± 0.74	0.20 ± 0.24	0.20 ± 0.40	0.20 ± 0.40	0.00	0.00	0.00
15.00 to 16.00	2.00 ± 0.66	0.20 ± 0.40	0.00	0.00	0.00	0.00	0.00
16.00 to 17.00	1.90 ± 0.51	0.20 ± 0.40	0.00	0.00	0.00	0.00	0.00
17.00 to 18.00	1.10 ± 0.37	0.00	0.00	0.00	0.00	0.00	0.00

Table 2: Relative abundance of insect pollinators on sunflower (CV KBSH 53) (Kharif 2013)

Sl. No.	Total No. of visitors /10 mins. (Time interval)	% Composition w.r.t. time	No. of visitors from each species				
			Apis dorsata	*Apis cerana*	*Apis florea*	*Xylocopa* spp.	*Dipterans*
1	26 (9.15 - 9.25AM)	19.54	19	3	1	1	1
2	20 (9.25 – 9.35 AM)	15.09	16	2	1	1	1
3	11 (9.35 – 9.45 AM)	8.27	5	3	1	2	0
4	21 (9.45 – 9.55 AM)	15.78	15	3	1	2	0
5	13 (9.55 - 10.05 AM)	9.77	10	2	0	0	0
6	13 (10.05-10.15 AM)	9.77	10	2	1	0	0
7	11 (10.25 – 10.35 AM)	8.27	9	1	1	0	0
8	6 (10.35 – 10.45 AM)	4.51	3	3	1	0	0
9	6 (10.45 - 10.55 AM)	4.51	4	2	0	0	0
10	3 (11.00 - 10.10 AM)	2.25	2	1	0	0	0
11	3 (11.10 – 11.20 AM)	2.25	2	1	0	0	0
Total	133	100	95	23	7	6	2
Range	3-26	-	8.6 ± 5.58	20.9 ± 0.79	0.63 ± 0.48	0.54 ± 0.78	0.18 ± 0.38
Mean ± SD	12.09 ± 7.25	-	2-20	1-3	0-1	0-2	0-1
% species composition	-	-	71.42	17.42	5.30	4.54	1.51

Discussion

Individuals from five bug species (2 orders, 4 families) have been observed in in the study area (Table 1). The majority of the species were from the Diptera and Orders Hymenoptera, as well as the families Apidae, *Xylocopidae, Trigonidae,* and *Syrphidae* are diverse in the study area. *A. dorsata* was the most numerous and essential floral visitor in effecting pollination among the different flower visitors of sunflower (Arya *et al.*1994) [5]. Sunflower capitulum had 20 insect species, 12 of which were *Hymenoptera* and 5 of which were *Diptera* in North East India (Singh and Singh 1993) [6] and Maharashtra also (Kumar et al. 1994) [7].

Apis dorsata was the most common insect pollinator in hybrid sunflower, followed by *A. florae, A. cerana, Xylocopa sp*., and Dipterans. *Apis dorsata* comprised 71.42% of the relative abundance of insect visits to sunflower capitula, suggesting the prevalence of hymenopterans in the sunflower environment. During our study on the sun flower hybrid KBSH 53, it was shown that insects from the *Apidae* family alone accounted for 94.14% of all pollinating insects, whereas all other insect pollinators accounted for 6.05% (Table 2). Observations similar to these were also made by Skinner (1987) [8], they discovered that *A. mellifera was a* dominating species visited sunflower heads 98.9% of the time.

Even modest numbers of bee visits were reported early in the morning and late in the evening, indicating that the sunflower attracted bee visitors throughout the day. Further, it was also confirms findings by Free (1964) [9] that throughout the day, sunflower pollen and nectar attract a variety of insect pollinators. Pollinator activities increased around 9 a.m. and 10 a.m. and again during 2 p.m. and 3 p.m. Similar studies were also conducted by Kumar *et al*. (1994)[7] reported that, a peak period of *A. mellifera* is between 9 a.m. and 10 a.m. in India and it was a dominant species of the study area.

In the present study we have observed that the most predominant diurnal pollinators are *A. cerana, X. latipus, A. dorsata, A. florea, Xylocopa aestuans and Trigona sp*. Similar findings were also reported by Moreti *et al.* (1996) [10] and Satyanarayana and Seetharam (1982) [11] they were recognized major insect pollinators on sunflower capitula as, *A. cerana, A. dorsata, A. florea, Xylocopa sp*. *Milipona sp.* etc. Ali *et al.* (2015) [12] stated that *Hymenopteran* spp. are the most frequent visitors to sunflower.

The floral rewards of appealing colour, existence of nectar guides, availability of feed supply, and tripping efficiency are all factors in bee dominance. The current findings are consistent with Swaminathan and Bharadwaj's (1982) [13] observations. A. dorsata was identified as the most common bee species (Deodikar *et al.* 1976; Panchabhavi and Devaiah 1977; Satyanarayana and Seetharam 1982) [14, 15, 16]. Although, various insects visited sunflower such as *Xylocopa sp. A. florea, Milipona sp.* and *A. cerana.* However, the most common visitor was *A. dorsata.* The sunflower crop was pollinated by butterflies and moths, with bees being the most frequent visitors (Dimitrov *et al.* 1992) [17]. On the Morden variety of sunflower, A. dorsata was the most numerous pollinator, accounting for 97.33 % of all pollinators, with the remaining pollinators accounting for 2.67 % Srikanta Nath (2008) [18]. Bhat and Jagadish (1995) [19] discovered that the variety Morden had higher *A. dorsata* activity, with an average of 25.07 bees per 5 heads every 5 minutes.

Conclusion

The sunflower capitulum in bloom is highly attractive to a variety of insect species, particularly hymenopterans. *A. cerana, A. dorsata, A. florea, X. aestuans, T. irridipenis,* and X. latipus which are able to collect abundant pollen from blooms, increasing the sunflower pollination and contributing to biodiversity. As a consequence, it is advised that bee species be conserved by supporting greater fodder crops in the proximity of farmed regions, which improves biodiversity.

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