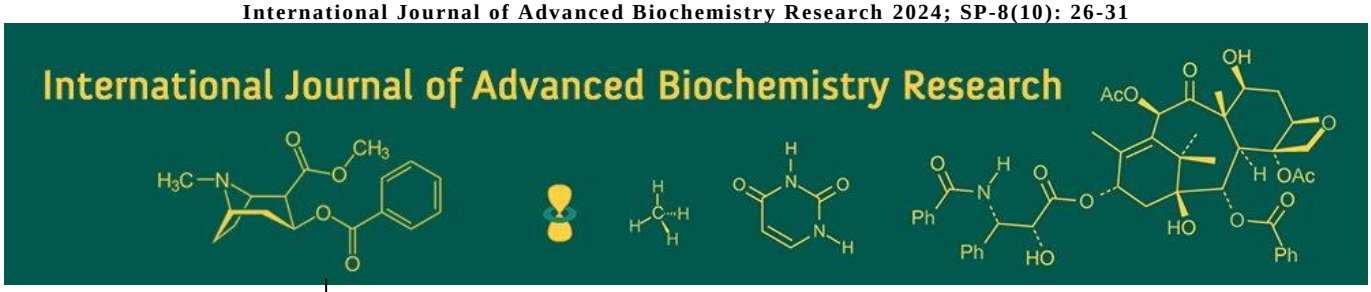

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Abundance and diversity of floral visitors in sunflowers in relation to weather parameters during the kharif season (2022)

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Abstract
This study investigates the abundance, diversity, and dominance of floral visitors on sunflower during different sowing dates in the *kharif* season of 2022 at Main Agricultural Research Station, Raichur, Karnataka, India. The study aimed to identify key pollinators and analyse their activity patterns in relation to various environmental parameters. *Apis dorsata* emerged as the most dominant species, with significant variations in pollinator abundance and diversity observed across different times of the day. Correlation analyses highlighted significant relationships between pollinator activity and weather parameters. These findings provide crucial insights into the dynamics of sunflower pollination, which can inform strategies to optimize crop management and improve yields through effective pollinator conservation.

Keywords: Honey bee, sunflower, *kharif*, abundance, diversity index, weather parameters

Introduction
Sunflowers (*Helianthus annuus*), valued for their seeds and oil, rely heavily on honey bees for pollination, which significantly enhances seed yield and quality. The effectiveness of this pollination partnership is influenced by weather conditions. Sunflowers and bees benefit from moderate temperature, humidity and wind, which aid in growth and pollination, but extremes in these conditions can cause stress and reduce efficiency. Adequate rainfall is necessary for sunflowers, though excessive rain and high winds can impede bee activity. Understanding and managing these weather parameters are crucial for successful sunflower cultivation and the health of honey bee populations.

Materials and Methods
To study the effect of different sowing dates and weather parameters on the abundance and diversity of pollinators in the Sunflower hybrid RSFH-1887 at MARS, UAS, Raichur. Sunflower was sown at fortnightly intervals from June to August. Pollinator Observations or count was carried out on five fully bloomed sunflower heads that were randomly selected and observed for five minutes at two-hour intervals from 0600h to 1800h to record pollinator diversity and abundance. Population abundance of pollinators was counted on five randomly selected plants for five minutes each at two-hour intervals. The diversity sampling was carried out using sweep net; insect pollinators were collected at regular intervals, killed, mounted, and identified in the lab. Further the foraging behaviour of honey bees was observed by recording visitation rate and stay time on twenty randomly selected flower heads six times a day, weekly throughout the flowering season.
To identify the most abundant species visiting sunflower inflorescences, the frequency of visits by each species was recorded. The Shannon-Weiner index of diversity (H) was computed using the formula $H= -\sum pi \times 1npi$ where, pi is the proportion of the i^{th} species. Additionally, the Berger-Parker dominance index (d) was used to determine the dominance of different species, calculated as $d= ni/NT$ where, ni is the number of individuals of the i^{th} species on sampling date and NT is the total number of individuals in the sample (Southwood, 1988) [12].

Results and Discussion

Floral visitor composition on sunflower

The list of floral visitors on sunflower during *kharif* were recorded in which 11 species from four families belonged to order Hymenoptera, six species from three families of Lepidoptera and one species from Syrphidae order of Diptera (Table 1) (Fig.1a and 1b).

Among the 11 hymenopteran species recorded, six species belonged to Apidae (*Apis cerana indica* F., *Apis dorsata* F., *Apis florea* F., *Xylocopa aestuans* (L.), *Xylocopa fenestrate* (F.), *Amegilla sp.*), one belonged to Halictidae (*Lasioglossumī* (C.)), two belonged to Vespidae (*Vespa tropica* (L.) and *Ropalidia marginata* (L.)) and two belonged to Megachilidae (*Megachile disjuncta* (F.) and *Megachile lanata* (F.)). Order Lepidoptera was represented by three species under Nymphalidae (*Danaus chrysippus* L.) (*Junonia lemonias* (L.) and *Tirumala limniace* (Cramer), one under Pieridae (*Catopsilia sp* (Hub.) and two under Erebidae (*Amata passalis* (F.) and *Amata cyssea* (Stoll). Order Diptera had one species recorded under Syrphidae family (*Eristalinus sp* (R.)) (Table 1). The similar findings were reported by Manisha *et al.* (2020) [7] who reported, 12 species of pollen and nectar feeders visited on sunflower during the flowering period, of which nine species were recorded from Hymenoptera, one from Diptera and two from Lepidoptera. Similar observations were also reported at Pantnagar by Kumar and Srivastava (2021) [6] who recorded 17 species of *Apis* and non *Apis* bees of which 11 belonged to Hymenoptera, two to Diptera, four to Lepidoptera. Ahmed *et al.* (1988) [1] reported 20 genera of insects belonging to Hymenoptera, Lepidoptera, Diptera and Coleoptera as pollinators on sunflower.

Table 1: List of floral visitors recorded on sunflower

Sl. No	Order	Family	Common name	Scientific name	Composition (%)
1	Hymenoptera	Apidae	Indian bee	*Apis cerana indica* Fabricius	61.11
2			Rock bee	*Apis dorsata* Fabricius	
3			Little bee	*Apis florea* Fabricius	
4			Carpenter bee	*Xylocopa aestuans* (Linnaeus)	
5			Carpenter bee	*Xylocopa fenestrate* (Fabricius)	
6			Digger bee	*Amegilla sp.*	
7		Halictidae	Sweat bee	*Lasioglossum* (Curtis)	
8		Vespidae	Greater Banded Hornet	*Vespa tropica* (Linnaeus)	
9			Paper wasp	*Ropalidia marginata* (Lepeletier)	
10		Megachilidae	Disjunct Resin Bee	*Megachile disjuncta*(Fabricius)	
11			Woolly Wall Bee	*Megachile lanata*(Fabricius)	
12	Lepidoptera	Nymphalidae	Plain tiger	*Danaus chrysippus*Linnaeus	33.33
13			Lemon Pansy	*Junonia lemonias* (Linnaeus)	
14			Blue tiger	*Tirumala limniace*(Cramer)	
15		Pieridae	Migrants	*Catopsilia* Sp (Hubner)	
16		Erebidae	Sandalwood defoliator	*Amata passalis*(Fabricius)	
17			Handmaiden moth	*Amata cyssea* (Stoll)	
18	Diptera	Syrphidae	Hoverfly	*Eristalinussp*(Rondani)	5.56

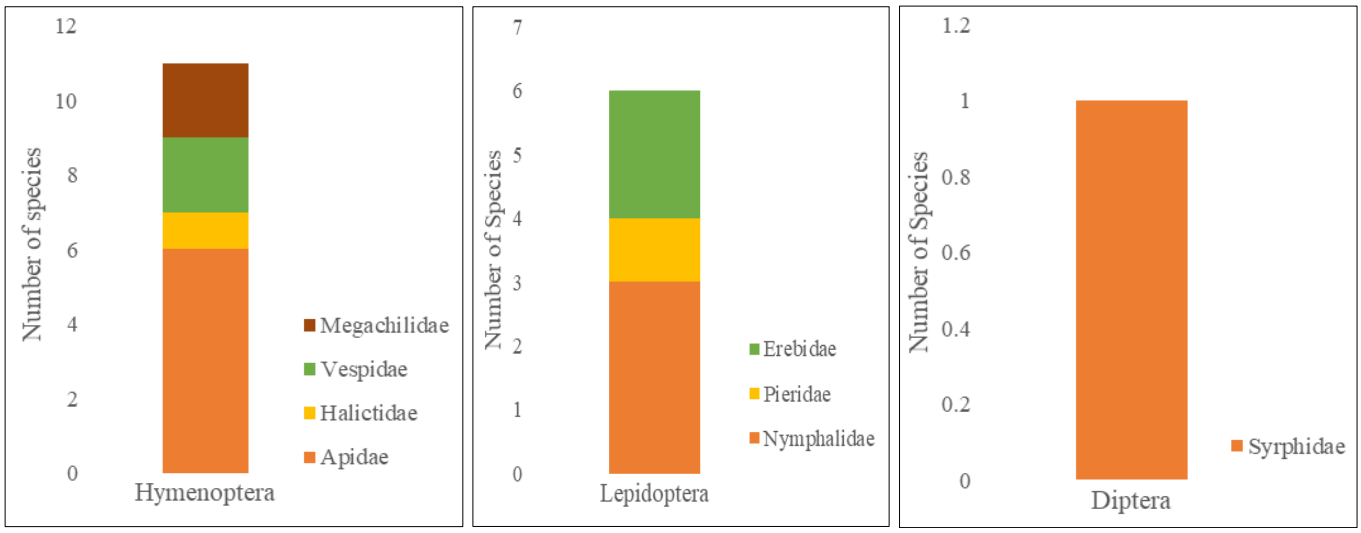

Fig 1a: Diversity of pollinator families visited sunflower

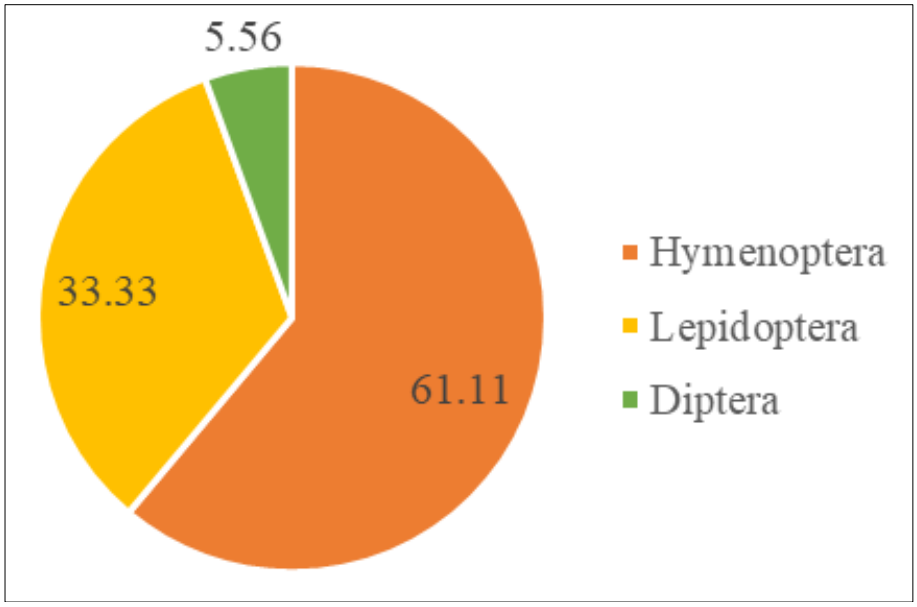

Fig 1b: Proportion of pollinator abundance visited sunflower

Abundance and diversity of floral visitors during different dates of sowing in sunflower

The data on the abundance of floral visitors to sunflowers, recorded over six different sowing dates at fortnightly intervals from June to August, has been compiled. The mean values of these observations are presented in Table 2 and illustrated in Figure 2. The pooled data was calculated by combining the means of each pollinator in the respective dates of sowings. The pooled data studies depicted that among all the pollinators recorded *A. dorsata* was abundant with a mean value of (44.17±23.19 bees/5 heads/5 min) which was key pollinator of sunflower crop. This was followed by *A. cerana* (31.22±18.18 bees/5 heads/5 min) and *A. florea* (8.56±8.83 bees/5 head/5 min). Similarly, among non- *Apis* pollinators the other hymenopterans were abundant with a mean of (4.25±5.04 bees/5 heads/5 min) followed by lepidopterans and dipterans with means of (0.58±0.46 bees/5 heads/5 min) respectively. The total pollinators count was 536.17 bees/5 heads/5 min, where in 503.67 bees/5 heads/5 min were *Apis* and 32.50 bees/5 heads/5 min were non-*Apis*.

Shannon diversity index (H value) ranged from 0.83 to 1.32. The highest H value was calculated at 1000 to 1200 hours (1.32) and lowest was calculated at 0600 to 0800 hours (0.83). The Simpsons diversity index ranged from 0.53 to 0.69 and it was found that the highest (1-D) value was calculated at 1000 to 1200 hours of the day (0.69). The lowest (1-D) was calculated at 0600 to 0800 hours of the day (0.53). BPI(d) ranged from 0.01 to 0.494, where in the maximum BPI (d) was observed in *A. dorsata* with BPI (d) of (0.494) followed by *A. cerana* (0.349) and *A. florea* (0.095) which in turn contributed to 0.94 to total BPI(d) of *Apis* pollinators. Among non *Apis*, other hymenopterans, BPI(d) was highest (0.050) followed by lepidopterans (0.01) and dipterans (0.01). The total BPI (d) among non *Apis* pollinators was 0.06. The highest per cent composition was observed in *A. dorsata* (49.42%), followed by *A. cerana* (34.94%) and *A. florea* (9.57%). Among non *Apis* other hymenopterans contributed to 4.76 per cent composition, lepidopterans (0.65%) and dipterans (0.65%). The total per cent composition of *Apis* pollinators was 93.94 and non *Apis* pollinators was 5.42.

In the present study the most abundant pollinator was found to be *A. dorsata* followed by *A. cerana* and *A. florea*. Our results are corroborated with the findings of Patil (2013) [9] recorded that, total of four species of Hymenoptera and four species of Lepidoptera were found pollinating on sunflower. Among honey bees, *A. dorsata* was the predominant forager with 33.26 per cent of the pollinators followed by *A. cerana* (10.31%) and *A. florea* (8.32%). Devaramane *et al.* (2018) [4] who also recorded *A. dorsata* was most abundant pollinator of 60.64 per cent followed by *A. cerana* with 15.39 per cent, *A. florea* (13.22%). Similarly, Manjunath (2003) [8], also reported that *A. dorsata* was the dominant pollinator with (52.71%) followed by *A. mellifera* (31.25%), *A. cerana* (10.42%) and other pollinators (5.61%) in Dharwad.

Across the time period of flowering duration in different dates of sowing of *kharif* 2022, the highest number of floral visitors were recorded between 1000 to 1200 hours. This was because of the pollinator activity tends to increase with rising temperatures were typically warmer, which stimulated foraging behaviour in pollinators, leading to higher abundance. There is ample day light which provides an extended window of time for pollinators to forage and gather resources. The results were similar to Delaude *et al*, 1978 [3], who reported that activity of the pollinators was more frequent in the forenoon (0900-1100 hours) and in the late afternoon (1600-1700 hours). Vaish *et al*, 1978 [13] also reported that the pollinator activity was higher between 1000 to 1200 hours compared to 1400 to 1600 hours of the day.

The results of the present study on diversity indices are similar to the findings of Biswanath and Kakali (2015) [2] who reported that Shannon-Wiener diversity index H was 1.49 for order Hymenoptera, 1.4 for the species of order Diptera and 1 for the species of order Lepidoptera in West Bengal. Sajjanar *et al.* (2023) [10] reported that he maximum Shannon-Wiener index of diversity (H=1.32) of floral visitors on R line of sunflower was recorded at 1700-1800 hr of the day and least (H=1.03) was at 0800-0900 hr. *Apis dorsata* recorded highest Berger Parker dominance both in CMS line (d=0.471) and in R line (d=0.392).

Table 2: Abundance, diversity and dominance of floral visitors on sunflower *kharif* 2022 (pooled data)

Time of observation	Number of floral visitors/5 heads/5 minutes								Total pollinator	Diversity Indices	
	Apis pollinators				Non-*Apis* pollinators						
	A. dorsata	*A. cerana*	*A. florea*	Total *Apis sp.*	Hymenoptera	Diptera	Lepidoptera	Total Non *Apis sp*		H	(1-D)
0600 to 0800	36.50	29.67	3.00	69.17	0.00	0.00	0.00	0.00	69.17	0.83	0.53
0800 to 1000	62.83	45.00	7.33	115.17	2.17	0.50	0.50	3.17	118.33	0.98	0.56
1000 to 1200	81.83	60.33	22.17	164.33	11.33	1.33	1.33	14.00	178.33	1.32	0.69
1200 to 1400	33.17	13.67	16.50	63.33	10.00	0.33	0.33	10.67	74.00	1.25	0.66
1400 to 1600	21.33	16.00	1.50	38.83	0.67	0.83	0.83	2.33	41.17	1.05	0.58
1600 to 1800	29.33	22.67	0.83	52.83	1.33	0.50	0.50	2.33	55.17	0.94	0.55
Total	265	187.33	51.33	503.67	25.50	3.50	3.50	32.50	536.17		
Mean ± SD	44.17±23.19	31.22±18.18	8.56±8.83	83.94±47.08	4.25±5.04	0.58±0.46	0.58±0.46	5.42±5.56			
BPI(d)	0.494	0.349	0.095	0.94	0.05	0.01	0.01	0.06			
% Composition	49.42	34.94	9.57	93.94	4.76	0.65	0.65	6.06			

*H Value = Shannon-Weiner Diversity Index; 1-D= Simpson's Diversity Index; BPI (d) =Berger Parker Dominance I

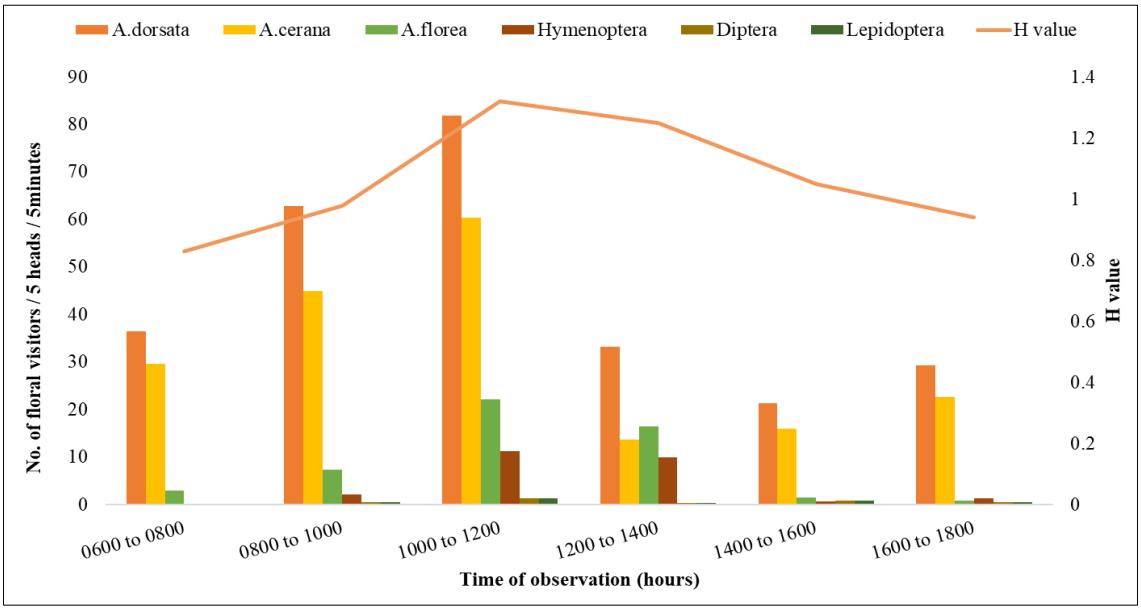

Fig 2: Abundance and diversity of floral visitors in sunflower in *kharif* 2022

Foraging activity of *Apis* pollinators sunflower during *kharif* 2022

The data on foraging activity of *Apis* pollinators was pooled to study the overall foraging duration spent by bees on sunflower across *kharif* season 2022. During *kharif* 2022, the overall mean of foraging duration in *A. cerana* was 41.45±7.96 seconds/flower**,** *A. dorsata* was 38.87±6.57 seconds/flower and *A. florea* was 30.54±9.42 seconds/flower. Maximum foraging activity was recorded between 1000 to 1200 hours (Table 3) (Fig.3).

The variation in foraging duration among *Apis* species in sunflower might be due to the fact that each of the *Apis* pollinators differ in their ability to forage and collect resources based on their evolutionary factors. The maximum foraging duration was recorded in *A. cerana* across the seasons because of it's ability to forage on sunflower is justified because of its optimum body size and the colonies present in the vicinity of the experimental site. *A. dorsata* on the other hand is also competent forager after *A. cerana*. *A. florea* was found to be lesser dominant forager because of its smaller size compared to *A. cerana* and *A. dorsata*. These results are in line with Sajjanar *et al.* (2023) [10] who reported that *Apis dorsata* recorded peak foraging activity at 1000-1200hr (49 bees/5 capitum/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 peak foraging activity among pollinators was recorded was recorded between 1000 to 1200 hours. This may be due to fact that in sunflower there was increase in nectar production in mid to late morning and in the late evening. This was in confirmation with the results of Silva and Dean (2004) [11], who reported that nectar appears to be reabsorbed by the flowers in the afternoon and overnight hours. The results were also in line with Free (1963) [5] who reported that pollinator activity was more during morning hours may be attributed to the abundant availability of pollen and also nectar in the sunflower florets. The available pollen gradually decreased due to foraging, thereby resulting in decreased bee activity. In the evening probably the stigma would have pushed remaining pollen out of anther tube resulting in increased bee visits to sunflower heads.

Table 3: Foraging activity of honey bee species on sunflower crop under field conditions *kharif* 2022 (pooled data)

Time of observation	Mean time spent (sec/head)		
	Kharif -2022 sown crop		
	A. cerana	*A. dorsata*	*A. florea*
0600 to 0800	42.35	42.18	23.58
0800 to 1000	46.44	40.89	38.65
1000 to 1200	50.52	47.90	42.55
1200 to 1400	43.33	38.62	35.37
1400 to 1600	28.25	28.68	21.94
1600 to 1800	37.17	34.93	21.16
Mean ± SD	41.45±7.96	38.87±6.57	30.54±9.42

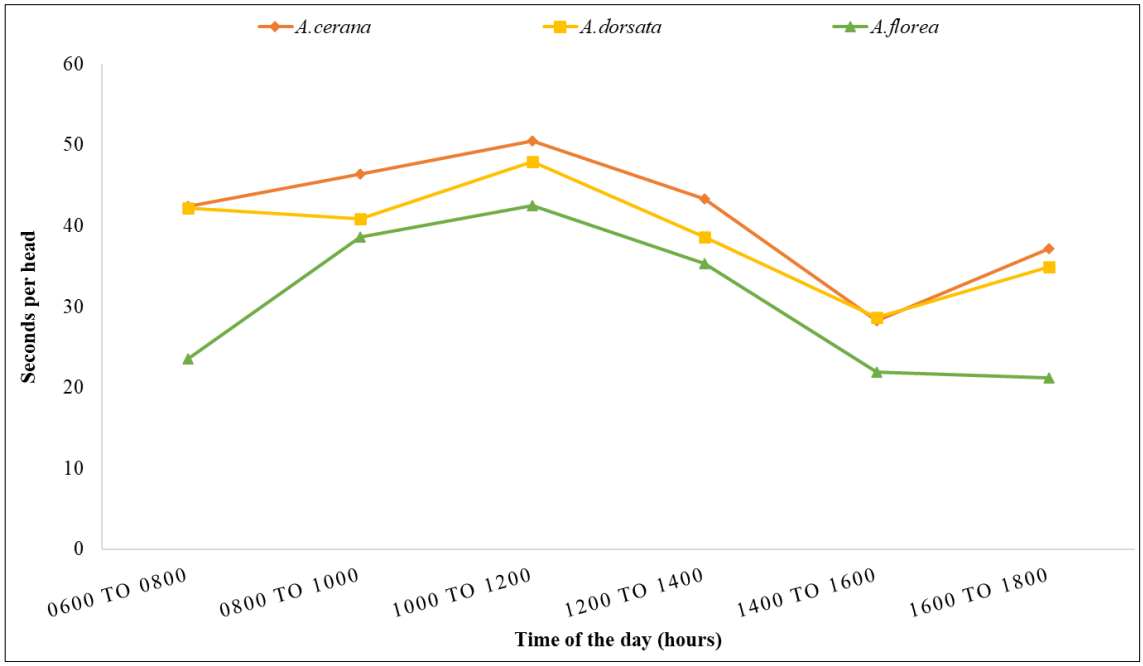

Fig 3: Foraging activity of honey bee species on sunflower crop under field conditions in *kharif* 2022 (pooled data)

Correlation studies between weather parameters and floral visitors on sunflower during flowering period (*kharif* 2022)

The means of floral visitors recorded on sunflower in the six dates of sowing during *kharif* season (peak flowering duration) were correlated with the means of weather parameters *viz.*, temperature, relative humidity, rainfall and sunshine hours recorded during the same period of time. The correlation matrix between floral visitors and weather parameters are presented in Table 4.

The results of the correlation studies between *A. dorsata* and weather parameters revealed a positive and significant correlation between maximum temperature (r = .523, $p<0.05$) and sunshine hours (r =.632, $p<0.05$). A negative and significant correlation was recorded between minimum temperature (r = -.590, $p<0.05$). Relative humidity (maximum, r = -.137; minimum, r = -.638) and rainfall (r = -.676) were found to be negatively and non-significantly correlated with *A. dorsata*.

The results of the correlation studies between *A. cerana* and weather parameters revealed a positive and significant correlation between maximum temperature (r = .566, $p<0.05$) and sunshine hours (r =.612, $p<0.05$). A negative and significant correlation was recorded between minimum temperature (r = -.565, $p<0.05$). Relative humidity (maximum, r = -.104; minimum, r = -.508) and rainfall (r = -.310) were found to be negatively correlated with *A. cerana*.

The results of the correlation studies between *A. florea* and weather parameters revealed a positive and significant correlation between maximum temperature (r = .563, $p<0.05$) and sunshine hours (r =.544, $p<0.05$). A negative and significant correlation was recorded between minimum temperature (r = -.572, $p<0.05$). Relative humidity (maximum, r = -.246; minimum, r = -.277) and rainfall (r = -.509) were found to be negatively correlated with *A. florea*.

The results of the correlation studies between hymenoptera, diptera, lepidoptera and weather parameters revealed a positive and non-significant correlation between maximum temperature (r = .481, r = 283, r= 423, $p<0.05$) and sunshine hours (r =.534, r = 447, r = .280, $p<0.05$). A negative and non-significant correlation was recorded between minimum temperature (r = -.588, r = -.521, r = -.462, $p<0.05$). Relative humidity (maximum, r = -.137, r = -.145, r =-.297; minimum, r = -.638, r = -.194, r = -.144, r =-.371) and rainfall (r = -.345. r = .110, r = -.523) were found to be negatively correlated with hymenoptera, diptera and lepidoptera respectively at 5 per cent level of significance.

Table 4: Correlation studies between weather parameters and floral visitors on sunflower during flowering period (*kharif* 2022)

Floral visitors	'r' values					
	Temperature (ºC)		Relative Humidity (%)		Rainfall (mm)	Sunshine hours (hr/day)
	Maximum	Minimum	Maximum	Minimum		
Apis dorsata	.523*	-.590*	-.137	-.638	-.676	.632*
Apis cerana	.566*	-.565*	-.104	-.508	-.310	.612*
Apis florea	.563*	-.572*	-.246	-.277	-.509	.544*
Hymenoptera	.481	-.588	-.145	-.194	-.345	.534
Diptera	.283	-.521	-.239	-.144	.110	.447
Lepidoptera	.423	-.462	-.297	-.371	-.523	.280

* indicates significance of values at $p<0.05$

This study on sunflower pollination during the *kharif* season of 2022 reveals significant insights into the influence of different sowing dates and weather parameters on floral visitors. *Apis dorsata* emerged as the dominant pollinator, with peak activity observed during mid-morning hours under favorable weather conditions characterized by higher temperatures and sunshine. The study underscores the importance of optimal sowing timing in maximizing

pollination efficiency and crop yield. Correlation analyses highlighted positive relationships between pollinator abundance and maximum temperature, as well as sunshine hours, while negative correlations were noted with minimum temperature and relative humidity. These findings emphasize the need for strategic agricultural practices that align with natural pollinator behaviour to enhance sunflower cultivation sustainability and productivity.

Conclusion

The study on floral visitor composition and their abundance on sunflower during the kharif season revealed a diverse range of pollinators, with 11 species from Hymenoptera, six from Lepidoptera, and one from Diptera. Among these, *Apis dorsata* was identified as the most abundant pollinator, followed by *Apis cerana* and Apis florea, highlighting the dominance of Apis species in sunflower pollination. Pollinator activity was highest between 1000 to 1200 hours, correlating with increased temperatures and daylight. Correlation analysis showed a positive relationship between pollinator abundance and maximum temperature and sunshine hours, while minimum temperature, relative humidity, and rainfall were negatively correlated with pollinator activity. These findings underscore the critical role of Apis species in sunflower pollination and the influence of weather parameters on their foraging behavior.

References

1. Ahmed HMH, Siddiq MA, El-Sarrag MSA. Honey bee pollination of some cultivated crops in Sudan. Proc. 4th Int. Conf. on Apic. in Tropical Climates. Cairo, Egypt. 6-10 November; 1988.
2. Biswanath B, Kakali B. Insect pollinators and their role on crop yield and quality of sunflower (*Helianthus annuus*, PAC-361) from West Bengal, India. International Journal of Current Science. 2015;18:76-87.
3. Delaude A, Tasel JN, Roller M. Pollinators insects of sunflower (*Helianthus annuus* L.) in France, pollination of male sterile lines of hybrid seed production. In: Proc. IV Int. Symp. on Pollination, Maryland. 1978. p. 29-40.
4. Devaramane R, Jagadish KS, Srinivasa Reddy KM, Belavadi VV, Shadakshari YG, Bhojaraja Naik K. Abundance and diversity of pollinator fauna of sunflower (*Helianthus annuus* L.). Journal of Entomology and Zoology Studies. 2018;6(5):211-216.
5. Free JB. The behaviour of honey bees on sunflower (*Helianthus annuus* L.). Journal of Applied Ecology. 1963;1(1):19-27.
6. Kumar R, Srivastava P. Abundance and diversity of pollinator fauna of sunflower (*Helianthus annuus* L.) at honey bee research and training center, Pantnagar, Uttarakhand. The Pharma Innovation Journal. 2021;10(10):845-848.
7. Manisha, Zameeroddin, Khader HK. Studies on flower visitors and their foraging activity on sunflower (*Helianthus annuus* L.). International Journal of Chemical Studies. 2020;8(3):1616-1620.
8. Manjunath K. Field scale evaluation of bee attractants for their efficacy in sunflower [M.Sc. (Agri.) thesis]. Dharwad (India): University of Agricultural Sciences; 2003.
9. Patil SK. Optimization of *Apis cerana* Fab. colonies for pollination in sunflower [M.Sc. thesis]. Dharwad (India): University of Agricultural Sciences; 2013.
10. Sajjanar SM, Thippaiah M, Prabhuraj A, Jagadish KS. Floral visitors and foraging activity of pollinators on parental lines of sunflower hybrid (KBSH-44). Mysore Journal of Agricultural Sciences. 2023;57(3):297-304.
11. Silva EM, Dean BB. Patterns of floral nectar production in onion (*Allium cepa* L.) and the effects of environmental conditions. Journal of the American Society for Horticultural Science. 2004;129(3):299-302.
12. Southwood TRE. Ecological methods. 3rd ed. London: Methuen; 1988.
13. Vaish OP, Agarwal SC, Joshi MJ. Frequency of insect visitors for pollen foraging of sunflower in relation to daily temperature and humidity. Proc. 8th Int. Sunflower Conf. Minneapolis, Minnesota, USA. 1978. p. 148-157.