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FORAGING BEHAVIOUR OF SUNFLOWER POLLINATORS

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ABSTRACT

A field experiment was carried out to gather data on the diversity and foraging activity of sunflower pollinators. The result revealed that distinct patterns among the various pollinators. *Apis dorsata* exhibited strong preference for evening foraging with highest visit rate observed at 18.00 hr, reaching an impressive visit of 28.96/ m^2/ min followed by 12.00 hr (4.33/ m^2/ min). *Apis florea* also displayed preference for evening foraging, with its peak visit rate of 0.40/ m^2/ min occurring at 18.00 hrs. In case of *Trigona iridipennis* maximum visit noticed at 12.00 hr (1.43/ m^2/ min) which was at par with visits at 14.00 hr (1.40/ m^2/ min). *Xylocopa fenestrata* exhibited its peak foraging activity at 12.00 hr (0.10/ m^2/ min). In case of lepidoptera, butterfly and skipper were visiting at morning session while moth preferred evening hours. More visits of *Cheilomenes sexmaculata* (0.14/ m^2/ min) were recorded at 16.00 hrs. The diptera species, *Ischiodon scutallaris* exhibited higher activity level at 12.00 hr, with a visit rate of 0.08/ m^2/ min.

Key words: pollinators, diversity, abiotic factors, visiting time, *Apis dorsata, Apis florea, Xylocopa fenestrata, Amata bicincta, Papilio demoleus, Danaus crysippus*, sunflower

Sunflower (*Helianthus annuus* L.) belongs to family Compositae or Asteraceae originated in Mexico and Peru, introduced into India in 16th century. *Helianthus* genus contains 65 species (Andrew et al., 2013). Sunflower is ranked as the fourth most important oilseed crop (Enebe and Babalola, 2018). Cross pollination in entomophilous crops serves as the effective source for enhancing crop yield (Patidar et al., 2017). Studies on pollinators is essential to generate information on the pollinator diversity and abundance. In case of sunflower, the morphophysiological disagreement of stamens and pistils, protandrous nature of the florets and pollen not well adapted to be transported by wind, hinder the process of pollination by anemophily (Dechechi et al., 2011). Sunflower mainly depends on insect pollinators and abiotic factors have direct impact on the pollinators. Hence, the present study to document insect pollinator diversity, abundance and impact of abiotic factors on sunflower pollinators.

MATERIALS AND METHODS

An experiment was conducted during November 2021 to February 2021 at the Experimental Farm, Department of Agricultural Entomology, College of Agriculture, Latur, Maharashtra. Sunflower cv. Morden was raised on an area of 10 x 10 m^2 with spacing 60 cm x 30 cm. All recommended agronomic practices were carried out, except insecticidal sprays. The 10 x 10 m^2 plot was divided into four quadrats, and the observations on frequent insect visitors to the sunflower capitulum (head) from each quadrant was recorded daily on square meter basis for five min at 8:00, 10:00, 12:00, 14:00, 16:00 and 18.00 hr throughout the flowering period. The data was expressed as mean number of pollinators/ m^2/ min. Data on pollinators was correlated with the meteorological data obtained from meteorological observatory at the Oilseed Research Station, Latur and these correlations were worked out using WASP 2.0 software.

RESULTS AND DISCUSSION

Result from Table 1 revealed that more visits of hymenopteran pollinators was observed and their most preferred visiting time was in the afternoon from 12.00 to 14.00 hr. Among the Hymenoptera, *A. dorsata* was the most prevalent. Significantly higher visit rate of *A. dorsata* was at 18.00 hr (28.96/ m^2/ min) followed by 12.00 hr (4.33/ m^2/ min). *A. florea*, displayed a similar trend. Maximum rate of 1.43/ m^2/ min for *T. iridipennis* visiting heads was observed at 12.00 hr and this visit number was at par with the visit at 14.00 hr. In case of *X. fenestrata* at 12.00 hr maximum of 0.10/ m^2/ min visit was recorded. No visits by *X. fenestrata* were observed at 8.00 hr, 16 hr and 18.00 hr. Wasps were found more active during afternoon hours maximum of 0.04 wasps/ m^2/ min were found visiting heads at

Table 1. Pollinators on sunflower

Foraging behaviour

Timing	Number of visiting pollinators (Visits/ m²/ min)											
	Apis dorsata	*Apis florea*	*Trigona iridipennis*	*Xylocopa fenestrata*	Wasp	*P. demoleus*	*D. crisippus*	*A. bicincta*	*R. manae*	Ladybird beetle	Syrphid fly	Green lacewing
8.00	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)#
10.00	0.02 (0.72)	0.00 (0.70)	0.37 (0.92)	0.04 (0.73)	0.00 (0.70)	0.04 (0.73)	0.02 (0.72)	0.00 (0.70)	0.02 (0.73)	0.06 (0.74)	0.02 (0.72)	0.00 (0.70)
12.00	4.33 (2.16)	0.12 (0.78)	1.43 (1.38)	0.10 (0.77)	0.04 (0.73)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.10 (0.76)	0.08 (0.75)	0.02 (0.72)
14.00	3.06 (1.88)	0.06 (0.74)	1.40 (1.37)	0.02 (0.72)	0.04 (0.73)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.12 (0.78)	0.04 (0.73)	0.02 (0.72)
16.00	0.00 (0.70)	0.08 (0.76)	0.37 (0.92)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.02 (0.72)	0.00 (0.70)	0.14 (0.79)	0.02 (0.72)	0.02 (0.72)
18.00	28.96 (5.41)	0.40 (0.94)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.04 (0.73)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
SE±	0.10	0.02	0.05	0.01	0.01	0.006	0.005	0.008	0.005	0.02	0.01	0.009
(p= 0.05)	0.33	0.07	0.15	0.03	0.03	0.01	0.01	0.02	0.01	0.06	0.03	0.02
CV (%)	11.35	6.30	10.08	3.60	3.16	1.80	1.56	2.51	1.56	5.58	3.51	2.63

Correlation with weather parameters

Weather parameters	Correlation coefficient ('r' values)									
	A. dorsata	*A. florea*	*T. iridipennis*	*X. fenestrata*	*Wasp*	*P. demoleus*	*A. bicincta*	Ladybird beetle	Syrphid fly	Green lace wing
Rainfall (mm)	-0.142	-0.086	- 0.214	- 0.184	-0.141	- 0.086	- 0.086	- 0.201	- 0.086	- 0.086
Maximum Temperature (°C)	0.152	0.049	0.353	0.317	0.141	0.130	0.049	0.272	0.049	0.049
Minimum temperature (°C)	- 0.301	-0.150	- 0.412	- 0.341	-0.293	- 0.161	-0.150	-0.422	- 0.150	- 0.150
Morning relative humidity (%)	- 0.012	0.158	0.164	0.185	-0.032	0.004	0.158	0.039	0.158	0.158
Evening relative humidity (%)	0.109	-0.052	0.326	0.292	0.097	0.115	-0.052	0.337	- 0.052	- 0.052
Wind speed (km/ hr)	0.458	0.286	0.702*	0.615*	0.0543	0.337	0.286	0.730*	0.286	0.286

Figures in parentheses $\sqrt{x + 0.5}$ transformed values

14.00 hr and 12.00 hr. From Lepidoptera, *A. bicincta*, *P. demoleus*, *D. crysippus* and *R. manae* were the four pollinators; *P. demoleus* was recorded only at 10.00 hr (0.04 visit/ m^2/ min); *D. crysippus and R. manae* showed somewhat similar visit timing. A maximum visit of both *D. crysippus* and *R. manae* were observed at 10.00 hr (0.02 visit/m^2/min, each). Evening hours were found more suitable for the visit of *A. bicincta*.

From Coleoptera, only *Cheilomenes sexmaculata* was found visiting the sunflower heads; more visits (0.14/ m^2/ min) were recorded at 16.00 hr. From Diptera, more visits of *I. scutallaris* (0.08/ m^2/ min) were recorded at 12.00 hr. From Neuroptera, only the green lacewing was found visiting sunflower heads. More visit of green lacewing (0.02/ m^2/ min) were recorded at 12.00, 14.00 and 16.00 hr. These findings are in line with the finding of Basavaraj et al. (2016) on Hussain et al. (2015) reported that minimum densities of honeybee were recorded at 08:00 am and 04:00 pm. Roy et al. (2014) stated that peak activity of the insect visitors was mainly observed at the middle of the day i.e., from 12 noon to 2 P.M. Tale (2016) found that the intensity of *A. indica, A. florea, A. mellifera, A. dorsata, Trigona* spp. and other pollinators reached peak during 10.00 - 12.00 hr.

Correlation between pollinators and abiotic factors revealed that *T. iridipennis* shows positive significant correlation with wind speed (r= 0.702*). *X. fenestrata* and ladybird beetle shows positive significant correlation with wind speed (r= 0.615*), (r= 0.730*), respectively. Bajiya and Abrol (2017) observed that *X. fenestrata* shows positive significant correlation with wind speed (r= 0.301*). Maity et al., (2014) reported that the honeybee abundance increased with maximum temperature (r =0.631) and with sunshine hours (r = 0.696). But relative humidity and wind speed showed negative correlation with honeybee (r = –0.736 and –0.837, respectively). Reddy et al., (2015) reported that relative humidity showed positive impact on the frequency of worker bees moving out of hive (r = 0.69) and those coming in with nectar (r = 0.68) but negatively affected the number of pollen collectors. Paikara and Painkra (2020) observed that *A. dorsata* showing negative but non-significant correlation with minimum temperature (r= -0713*) and *A. florea* shows negative non-significant correlation with minimum temperature (r= -0.31). Bano et al., (2023) reported that *Xylocopa* showing negative significant correlation with rainfall (r= -0.811*). More et al., (2022) reported that *A. dorsata* show negative non-significant correlation with morning relative humidity and *A. florea* shows negative non-significant correlation with minimum temperature and morning relative humidity (r=-0.329 and -0.131), respectively.

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AUTHOR CONTRIBUTION STATEMENT

Gore S H, More D G and More A V conceptualized and designed the study, conducted the study, analyzed the data, and authored the report under the supervision of More D G.

CONFLICT OF INTEREST

No conflict of interest.

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