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Insect pollinator diversity and abundance in sunflower ecosystem

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ABSTRACT

Insect pollinator diversity and their relative abundance were assessed in the sunflower ecosystem at S. V. Agricultural College, Tirupati during 2009-10. Twenty diurnal species and four nocturnal species were recorded visiting sunflower heads that belonged to orders Hymenoptera, Lepidoptera, Diptera and Coleoptera. Species richness was high in Hymenoptera followed by Lepidoptera and Coleoptera. Hymenoptera comprised of two families, Lepidoptera of four families, Coleoptera of three families and one family under Diptera. The more frequenting insect pollinator in hybrid sunflower was *Apis dorsata* followed by *Trigona irridipenis* and *A. cerana.* Relative abundance of insect visitors to sunflower capitula revealed that *Apis* sp. constituted 88.85% indicating the dominance of hymenopterans in the sunflower ecosystem.

KEY WORDS : Diversity, diurnal and nocturnal foragers, insect pollinators, sunflower

INTRODUCTION

Insect pollinators play a crucial role in improving the productivity of cross pollinated crops. The availability of sufficient number of suitable pollinators during flowering time is essential for achieving optimum pollination. In case of hybrids, cross pollination helps in sustaining the hybrid vigour, creates variation and maintains the gene flow in the ecosystem. Pollination, an essential ecosystem service provided by insect pollinators, is many times taken for granted and little attention is paid to the need of conserving and enhancing the pollinator diversity in crop ecosystem. Majority of insect pollinators belong to three orders viz., Hymenoptera, Lepidoptera and Diptera. In this paper, the diversity and abundance of insect pollinators occurring on sunflower crop in the southern Rayalaseema region of Andhra Pradesh is reported.

Sunflower (*Helianthus annuus* L. Family : Compositae), popularly known as *'Surajmukhi'* or *'Suryakanthi'*, is one of the widely grown oilseed crops in the state of Andhra Pradesh. In India, sunflower occupies the fourth place among different oilseed crops in terms of acreage and production. Andhra Pradesh with an annual production of 437.0 tonnes ranks second followed by Karnataka.

In sunflower, hybrid seed production is brought about by cross pollination between cytoplasmic male sterile (CMS) lines or A line and restorer lines (R lines). Cross pollination is also needed for maintenance of A lines using maintainer lines (B lines). Of late, farmers have resorted to growing of more and more hybrid sunflower in India resulting in growing demand for hybrid seeds (Satyanarayana and Seetharam, 1982). As sunflower depends mainly on insect

pollinators for pollination, and is expanding at faster rate to newer areas, it is essential to generate information on the status of naturally occurring pollinator diversity and abundance, which has direct impact on the yield and quality of seed. With this background, the present studies were undertaken to document insect pollinator diversity and abundance in sunflower in Tirupati region.

MATERIALS AND METHODS

Field studies were carried out to document the pollinator diversity and abundance in sunflower at the Department of Entomology, S.V. Agricultural College, Tirupati (79^0 36' North latitude and 13^0 37' East longitude; 182.9 MSL) during 2009 and 2010. Sunflower *cv.* NDSH 1 was raised with all recommended agronomic practices except insecticidal sprays. The observations were recorded daily on ten randomly selected plants for five minutes at hourly interval from 06.00 to 18.00 h for diurnal insect visitors and from 17.00 to 20.00 h for nocturnal insect visitors throughout the flowering period to document various insect visitors in sunflower hybrid as well as parental lines. Species diversity was documented by collecting insects visiting sunflower heads.

The observations on frequent insect visitors to the sunflower capitulum were recorded daily on ten randomly selected plants for five minutes at hourly interval from 06.00 h to 18.00 h throughout the flowering period to document pollinators' abundance of different insect species on sunflower heads and their abundance was expressed as mean number of pollinators/10 plants/5 min.

Similarly observations were made daily on ten randomly selected plants for five minutes at hourly interval from 17.00 to 20.00 h throughout the flowering period to document nocturnal insect visitors of sunflower heads and their abundance and was expressed as mean number of insects/10 plants/5 min.

The abundance of bees and other insect visitors (including nocturnal insect visitors) on sunflower capitulum was calculated for entire flowering period. The per cent relative abundance of bee species and other insect visitors was calculated to identify the efficient pollinators and the most frequent visitors on sunflower capitulum.

RESULTS

Diurnal insect visitors on sunflower capitulum

On hybrid, NDSH-1 of sunflower, twenty species belonging to four orders *viz.,* Hymenoptera, Lepidoptera, Diptera and Coleoptera were observed visiting sunflower capitulum. Seven species *viz., Apis dorsata, A. cerana, Trigona irridipenis, T. lacviceps, Ceratina unimaculata, Xylocopa fenestrata* and *X. aestuans* from Apidae and two species *viz., Vespa tropica* and *Polistine* sp. from Vespidae were recorded under Hymenoptera. One species, *Eristalis quinquestriatus* from family Syrphidae under Diptera was recorded. Lepidopteran foragers belonged to four families, among which Nymphalidae constituted four insect species *viz., Hypolimnas misippus, Danaus chrysippus, Junonia lemonias* and *J. orithya* and rest three families *viz.,* Pieridae, Hesperidae and Papilionidae constituted one species each *Pieris brassicae*, *Pelopidas mathias* and *Papilio polytes,* respectively were recorded on sunflower heads. Three Coleopteran species *viz., Menochilus*

sexmaculatus, Myllocerus discolor and *Oxycetonia versicolor* belonging to the families Coccinelidae, Curculionidae and Cetonidae, respectively were recorded visiting the flower heads (Table 1).

The floral rewards offered to the pollinators were mainly pollen and nectar. The foragers of families Apidae (order Hymenoptera) and Cetonidae (order Coleoptera) were found to forage on both pollen and nectar whereas all the insects of remaining families were found to forage on nectar alone (Table 1).

Table 1: Diurnal insect visitors on sunflower capitulum (hybrid, NDSH-1)

Insect species	Family	Order	Forage source
Apis dorsata Fab.	Apidae	**Hymenoptera**	PN
Apis cerana Fab.			PN
Trigona irridipenis Fab.			PN
Trigona lacviceps Smith			PN
Ceratina unimaculata Smith			PN
Xylocopa fenestrata Fab.			PN
Xylocopa aestuans Linn.			PN
Vespa tropica Fab.	Vespidae		N
Polistine sp.			N
Eristalis quinquestriatus Fab.	Syrphidae	**Diptera**	N
Pieris brassicae Linn.	Pieridae		N
Hypolimnas misippus Linn.	Nymphalidae	**Lepidoptera**	N
Danaus chrysippus Linn.			N
Junonia lemonias Linn.			N
Junonia orithya Linn.			N
Pelopidas mathias Fab.	Hesperidae		N
Papilio polytes Linn.	Papilionidae		N
Menochilus sexmaculatus Fab.	Coccinelidae	**Coleoptera**	N
Myllocerus discolor Boh	Curculionidae		N
Oxycetonia versicolor Fab.	Cetonidae		PN

N : nectar foragers

PN : pollen and nectar foragers

Nocturnal insect visitors on sunflower capitulum

On hybrid, NDSH-1, total four species from two families (Pieridae and Noctuidae) of order Lepidoptera were recorded visiting sunflower during night hours. From the family Pieridae one species (*Pieris* sp.) and from the family Noctuidae, three species (*Achaea janata, Spodoptera litura* and *Helicoverpa armigera*) were recorded (Table 2).

Table 2: Nocturnal insect visitors on sunflower capitulum (hybrid, NDSH-1)

Insect species in NDSH 1 (Hybrid)	Family	Order	Forage source
Pieris sp.	Pieridae	Lepidoptera	N
Achaea janata Linn	Noctuidae		N
Spodoptera litura Fab.			N
Helicoverpa armigera Hubner			N

N : nectar foragers

Relative abundance of bees and other insect visitors on sunflower hybrid, NDSH-1

On hybrid sunflower, the per cent relative abundance of bee species was in the order of *Apis dorsata* (35.49%), *Trigona irridipenis* (27.66%), *A. cerana* (15.85%), *Xylocopa fenestrata* (4.58), *Ceratina unimaculata* (2.56%), *X. aestuans* (1.76%), and *T. lacviceps* (0.95%). Similarly, the per cent relative abundance of other insect pollinators (*Non Apis* sp.) was found to be 11.15%, which included members of Vespidae (Hymenoptera), Lepidoptera (also included four nocturnal pollinator species *viz., Pieris* sp., *A. janata, S. litura* and *H. armigera*), Diptera and Coleoptera. Of the total pollinators visited the sunflower hybrid during entire flowering period, the members of the family Apidae alone accounted to 88.85 per cent as compared to all other insect pollinators, which constituted 11.15 per cent (Table 3). Similar observations were also made by Skinner (1987) who revealed that *A. mellifera* made 98.9% visits to sunflower heads.

DISCUSSION

Observations made on hybrid, NDSH-1 revealed that species diversity was high in the sunflower ecosystem with 24 insect species belonging to four orders *viz.,* Hymenoptera, Lepidoptera, Diptera and Coleoptera visitation as diurnal and nocturnal foragers. Of them 9 species belonged to order Hymenoptera, 7 to Lepidoptera, 1 to Diptera and 3 species to Coleoptera. The major diurnal pollinators recorded in present study were *A. dorsata, T. irridipenis, A. cerana, X. fenestrata* and *C. unimaculata* in hybrid sunflower which is in conformity with the findings of Satyanarayana and Seetharam (1982) and Moreti *et al.* (1996) who documented major insect pollinators on sunflower capitula as *A. dorsata, A. cerana, A. florea, Milipona* sp., *Xylocopa* sp. etc.

Table 3: Relative abundance of bees and other insect visitors on sunflower hybrid, NDSH-1

Order	Family	Species	Abundance (%)	Total abundance (%)
		Apis dorsata Fab.	35.49	88.85
		Apis cerana Fab.	15.85	
		Trigona irridipenis Fab.	27.66	
Hymenoptera	Apidae	*Trigona lacviceps* Smith	0.95	
		Ceratina unimaculata Smith	2.56	
		Xylocopa fenestrata Fab.	4.58	
		Xylocopa aestuans Linn	1.76	
	Vespidae	*Vespa tropica* Fab.	0.33	
		Polistine sp.	0.17	11.15
Diptera	Syrphidae	*Eristalis quinquestriatus* Fab.	0.12	
	Pieridae	*Pieris brassicae* Linn	0.36	
		Pieris sp.	2.04	
Lepidoptera	Nymphalidae	*Hypolimnas misippus* Linn	0.54	
		Danaus chrysippus Linn	0.59	
		Junonia lemonias Linn	0.05	
		Junonia orithya Linn	0.08	
	Hesperidae	*Pelopidas mathias* Fab.	1.00	
	Papilionidae	*Papilio polytes* Linn	0.26	
	Noctuidae	*Achaea janata* Linn	1.96	
		Spodoptera litura Fab.	1.74	
		Helicoverpa armigera Hubner	1.59	
Coleoptera	Coccinelidae	*Menochilus sexmaculatus* F.	0.28	
	Curculionidae	*Myllocerus discolor* Boh	0.02	
	Cetonidae	*Oxycetonia versicolor* Fab.	0.02	

The findings on insect pollinators visiting sunflower hybrid in the present study are also in agreement with the findings of Deodikar *et al.* (1976), Vaish *et al.* (1978) at Udaipur (India) and Satyanarayana and Seetharam (1982) who reported that several insect pollinators from sunflower capitulum belonged to order Hymenoptera (*Apis* and non-*Apis* species), Lepidoptera (Moths and butterflies) and Diptera. Dimitrov *et al.* (1992) reported that major pollinators of sunflower belonged to four families and five genera of Hymenoptera and the most frequenting bee species was *Apis.* Arya *et al.* (1994) recorded 20 insect species from sunflower capitulum in which 12 species belonged to Hymenoptera, 5 to Diptera and 3 species to Lepidoptera. Similar observations were also made by Singh and Singh (1993) at North East India and Kumar *et al* (1994) at Maharashtra.

Among nocturnal visitors of sunflower, 4 species were recorded from two families (Pieridae and Noctuidae) of Lepidoptera. The visitation of *H. armigera* to sunflower capitula in present findings is in conformity with Radford *et al.* who also recorded *H. armigera* as nocturnal visitor from different crops.

Among all the insect visitors, the pollen gatherers *viz., A. dorsata, T. irridipenis, A. cerana, C. unimaculata, X. aestuans* and *X. fenestrata,* can be considered as effective pollinators as they were foraging actively and abundant during the day coinciding with the floral anthesis and availability of viable pollen early in the day. The nectar collectors mainly *P. mathias* and *P. brassicae* may not have role in pollination as they land on the ray florets and take the nectar from long coiled proboscis.

During the study period on hybrid, NDSH-1 of sunflower, it was observed that the insects belonging to family Apidae were the most frequent visitors on sunflower capitulum. The abundance of 7 species of the family Apidae alone constituted 85.85 per cent during the entire flowering period whereas the abundance of remaining all 17 insect species together was 11.15 per cent. From Apidae, *A. dorsata* was found to be the most frequent visitor and predominant species on sunflower capitula followed by *T. irridipenis* and *A. cerana*. The abundance of *X. fenestrata* was slightly higher than *C. unimaculata*, which can be attributed to the presence of colonies of these species near the vicinity of experimental site.

The dominance of bees can be attributed to the floral rewards like attractive colour, presence of nectar guides, availability of forage source and tripping efficiency. The present findings are in conformity with observations made by Swaminathan and Bharadwaj (1982) that recorded the most frequenting bee species as *A. dorsata.* Deodikar *et al.* (1976), Panchabhavi and Devaiah (1977), and Satyanarayana and Seetharam (1982) also reported that *A. dorsata* was the most frequent visitor of sunflower though other insects *viz., A. cerana, A. florea, Milipona* sp., *Xylocopa* sp. butterflies and moths did pollinate the sunflower crop. Dimitrov *et al.* (1992) also reported that bees as the most frequenting visitors on sunflower.

With respect to nocturnal insect visitors, though their abundance was considerable, their efficiency in pollination has to be ascertained as there was lack of synchronization between floral anthesis (05.00 h to 08.00 h) and their foraging activity. The present findings are in conformity with the observations made by Radford *et al.* (1979) who reported that the moths potentially transferred pollen at a time of the day when stigmas were least

receptive; it was unlikely that they do effectively pollinate sunflower. In addition, the larval stages of nocturnal visitors enlisted in the study are of economic importance to the sunflower crop as pests. The role of these insects in pollination has to be ascertained with further studies.

CONCLUSION

It is clear from present finding that the sunflower capitulum in bloom is highly attractive to multitude of insect species, especially those belonging to Hymenoptera and Lepidoptera. These insects obtain good amount of nectar from tiny florets and *Apis* sp. are able to collect abundant pollen from blooms and in the process effects pollination and contributes to biodiversity. Hence, conservation of bee species by encouraging increased forage crops in the vicinity of cropped areas is recommended which enriches biodiversity along the line.

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