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Species richness and foraging activity of insect visitors in linseed (*Linum usitatissimum* L.)

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ABSTRACT

Field studies were conducted at S. V. Agricultural College, Tirupati, India to document the diversity, abundance and foraging activity of insect visitors/pollinators on linseed. The species diversity was high with 19 insect species visiting the linseed crop during flowering phase. The insect species included nine lepidopterans, three hymenopterans, three hemipterans, two dipterans, one coleopteran and one orthopteran. Among these, Muscid fly and *Halictus* sp. were the most frequent and abundant visitors to the floral heads of linseed. The abundance of Muscid fly was highest (0.40 flies/ m^2 / 5 minutes) followed by *Halictus* sp. (0.31 bees / m^2 / 5 minutes). Among all insect visitors, Diptera order constituted the major chunk of pollinators (32.00%) followed by Hymenoptera (31.36%), Lepidoptera (21.98%), Hemiptera (10.66%), Orthoptera (0333%) and Coleoptera (0.67%). Of the total insect visitor population, muscid fly constituted maximum proportion (32.00 %), followed by *Halictus* sp. (24.70%) . The peak foraging activity of frequent insect visitors was observed between 08.00 and 09.00 h.

KEY WORDS: Foraging activity, *Halictus* sp., linseed, muscid fly, pollinator diversity

INTRODUCTION

Effective pollination is one of the most important factors in sustenance of the plant species and enhanced yields in agricultural crops. Insect pollinators play a crucial role in effecting optimum pollination of crops thus contributing to both increased productivity and quality. Insect pollinators increase not only yield but also helps in increasing the hybrid vigour, create variation and maintain the gene flow in the ecosystem, there by conserving the crop varietal diversity. Oilseed crops are the diverse group, majority of which are dependent on insects for their pollination. They are the economically important crops grown widely in India, which provide an important constituent of human diet. Among the oilseed crops, Linseed (*Linum usitatissimum* L.) belonging to the family Linaceae is grown from ancient times for the fibre (flax) and for its seed which is rich in oil. Linseed oil is an excellent drying oil used in manufacturing paints and varnishes. The flax fibre is the raw material for linen industry (Sundarraj and Thulasidas, 1993). Linseed is generally considered to be a self-fertile and self pollinated crop but owing to the structure and mechanism of the flowers, cross pollination to varying percentage, have been observed (Sundararaj and Thulasidas, 1993). The amount of self- and cross-pollination is influenced by the position of anthers relative to the stigma. In most of the cultivars, the anthers are above and entirely surround the stigma, favouring self-pollination, whereas, in some the tip of the

stigma extends above the anthers, increasing the chance of cross-pollination (Yermanos and Kostopoulos, 1970).

Honey bees pollination showed 19 % increase in number of seeds per capsule, a 22 % increase in total weight of seeds, and a 2.2 % increase in the weight per seed in Russia (Smirnov, 1956). Gubin (1945) also recorded that bees increased 22.5 to 38.5 % seed production in linseed in Russia. Hence, the role of pollinators cannot be ruled out. The conservation and management of insect pollinators is gaining importance day by day for which studies on insect visitor/pollinator diversity and abundance are essential. Hence, the present investigations have been taken up to generate the information on insect visitor diversity, abundance and their foraging activity in linseed crop.

MATERIAL AND METHODS

Field studies were carried out at the College Farm, S.V. Agricultural College, Tirupati from October to December 2011 to document the diversity, abundance and foraging activity of different insect visitors in linseed. Sweepings using insect collection nets were made throughout the blooming period at two days intervals from morning 0600 to 1200 hrs. The collected insects were preserved as dry specimens and got them identified by Dr. C.A Viraktamath, Emeritus scientist, Division of Entomology GKVK, University of Agricultural Sciences, Bangalore.

The total number of different insect visitors visiting the linseed flowers in a square metre area was observed for five minutes at hourly interval i.e. from 0600 h to 1100 h to determine the peak foraging time and also the abundance of different insect visitors in linseed, using a hand telly counter and stop watch following the method given by Free (1993). These observations were started when the plants were at 50 per cent bloom Later the studies on foraging ecology was restricted to major and frequent insect visitors in linseed. The documented data was then subjected to ANOVA analysis for interpretations.

RESULTS AND DISCUSSION

Diversity of insect visitors / pollinators on linseed flowers

The insect visitors / pollinators collected from linseed crop are listed in Table 1. A total of 18 species belonging to 11 families of six orders was recorded from linseed flowers. The lepidopterans were the largest group of insect visitors comprising of nine species belonging to three families. They were *Euploea core* Cramer, *Acera terpsicore* L., *Trumala limniace exoticus*, *Hypolimnas misippus* L. (nymphalidae), *Eurema blanda* (Boisduval), *Delias eucharis* Drury, *Pieris brassicae* L. (pieridae), *Papilio polytes* L. and *Papilio demolius* L. (Papilionidae). Hymenoptera comprised of three species from three families viz., *Trigona* sp. (Apidae), *Halictus* sp. (Halictidae) and *Delta conoideum* (Gmelin) (Eumenidae). Hemiptera constituted three species from two families *viz., Nezara viridula* L., *Bagrada cruciferarum* (Kirkaldy) (Pentatomidae) and *Chrysocoris stollii* Wolf. (Scutellaridae). Diptera, Coleoptera and Orthoptera comprised of one species each *viz.,* unidentified muscid fly (Muscidae), *Monolepta signata* Oliv. (Chrysomelidae) and *Hieroglyphus banian* Fab. (Acrididae), respectively.

Among these insect visitors, muscid fly and *Halictus* sp. were the most frequent visitors. The present findings are in near conformity with Sabir *et al*. (1999) who

reported that honey bees, flies (Syrphidae, Muscidae), butterflies (Pieridae), ladybird beetles (Coccinellidae), thrips (Thripidae) and wasps (Vespidae) visited the linseed flowers in Sheikupura, Pakistan.

Abundance of insect visitors / pollinators

Percent contribution to abundance of different pollinator species on linseed flowers at different hours of the day during October to December 2011 are depicted in table 2. Among all insect visitors, Diptera alone constituted 32.00% of the total population of the insect visitors followed by Hymenoptera (31.36 %), Lepidoptera (21.98%), Hemiptera (10.66 %), Orthoptera (3.33 %) and Coleoptera (0.67%). Out of total insect visitors the Muscidae was the dominant family constituting 32.00 % followed by Halictidae (24.70 %), Nymphalidae (13.99%), Pentatomidae (7.33%), Pieridae (5.33 %), Aapidae (5.33 %), Scutellaridae (3.33%), Acrididae (3.33%), Papilionidae (2.66%), Eumenidae (1.33 %) and Chrysomelidae (0.67%).

The abundance of different insect visitor species revealed that muscid fly (32.00%) was the dominant species followed by *Halictus* sp. (24.70%). The moderately abundant species were *Trigona* sp. (5.33%), *B. cruciferarum* (5.33%), *A. terpsicore* (4.66%), *E. core* (4.00%), *C. stollii* (3.33%), *H. banian* (3.33%), *H. limniace* (3.33%), *P. brassicae* (2.67 %), *N. viridula* (2.00%), *E. blanda* (2.00%) and *T. limniace* (2.00%). All other insect visitors' population was low.

The species richness of insect floral visitors was high in the linseed crop ecosystem and species evenness was also found to be high allowing the co-existence of dipterans, hymenopterans and lepidopterans constituting nearly 85% of the total insect visitor population. As far as the orders are concerned, Diptera and Hymenoptera exhibited lesser species evenness as muscid fly and *Halictus* were the predominant species, respectively. In Lepidoptera, the species evenness was high among the different species. The implications have to be explored with further studies.

The studies on foraging ecology of frequent and abundant insect visitors i.e. muscid fly and *Halictus* sp. on linseed flowers at different hours of the day showed variations in abundance over time (Table 3). The muscid fly started its foraging activity from 0600 h and maximum activity was observed from 0700 h to 0900 h (0.55 to 0.45 flies/m^2/5 minutes) with peak activity at 0800 h (0.75 flies / m^2 / 5 minutes). The lowest activity was observed at 1000 h (0.10 flies/m^2/5 minutes). The foraging activity of *Halictus* sp. was initiated at 0700 h and continued upto 1000h, with peak activity at 0900 h (0.65 bees / m^2 / 5 minutes). The lowest activity was observed at 1100 h (0.15 bees / m^2 / 5 minutes). The present findings are in conformity with the findings of Smirnov (1954) who observed the most intense visitation of honeybees in linseed between 0800 and 1100 h. Sabir *et al.* (1999) also observed that the honeybees visitation started from 0700 h and continued upto 1500h with most intense visitation from 11.00 h to 12.00 h. This variation may be attributed to the differences in weather conditions and geographical limitations. The decrease in insect visitors activity after 11.00 was due to the fact that the most petals shed by noon and thereafter insect visitors were not in a position to get a support of petals during foraging (Gubin, 1945).

The abundance of bees on flowering crops depends on so many factors such as

anthesis, weather parameters, competing flora, nests of wild bees in vicinity of the flowering crops, nectar concentration and its volume (Free, 1993). At peak flowering, the availability of flowers is more than commencement and cessation of flowering, and maximum number of insects would visit the crop during this period to increase the pollination process. Therefore, the flower number clearly influences the pollinator abundance, and in turn, the level of pollination.

CONCLUSION

Though the linseed crop is self fertile, considerable number of species was found to visit the flowers, which include both generalists and specialists. In the present study an unidentified muscid fly was the dominant visitor, which appears to be more specific to the linseed flower. The traits or the set of characters of linseed flower that are attractive to the flies have to be explored to arrive at the pollination syndrome. The present study revealed rich diversity of insect visitors in linseed in Tirupati region which may be attributed to supporting flora around nourished foothills of Tirumala, Andhra Pradesh.

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Table 1: List of insect visitors / pollinators of linseed flowers at Tirupati region

S No.	Common Name	Scientific Name	Family	Order
1	Stingless bee	*Trigona* sp.	Apidae	Hymenoptera
2	Sweat bee	*Halictus* sp.	Halictidae	
3	Red backed red mud wasp	*Delta conoideum* (Gmelin)	Eumenidae	
4	common crow	*Euploea core* Cramer	Nymphalidae	Lepidoptera
5	Tawny coster	*Acrea terpsicore* L.		
6	Blue tiger	*Tirumala limniace* exoticus		
7	Danaid eggfly	*Hypolimnas misippus* L.		
8	Three spot grass yellow	*Eurema blanda* (Boisduval)	Pieridea	
9	Common jezebel	*Delias eucharis* Drury.		
10	Cabbage butterfly	*Pieris brassicae* L.		
11	Citrus butterfly	*Papilio polytes* L.	Papilionidae	
12	Citrus butterfly	*Papilio demolius* L.		
13	Muscid fly	Unidentified fly	Muscidae	Diptera
14	White-spotted leaf beetle	*Monolepta signata* Oliv.	Chrysomelidae	Coleoptera
15	Green plant bug	*Nezara viridula* L.	Pentatomidae	Hemiptera
16	Painted bug	*Bagrada cruciferarum (*Kirkaldy*)*		
17	Jewel bug	*Chrysocoris stollii* Wolf.	Scutellaridae	
18	Rice grasshopper	*Hieroglyphus banian* Fab.	Acrididae	Orthoptera

Table 2: Relative abundance of bees and other insect visitors on linseed (*Linum usitatissimum)* flowers

Order	Family	Scientific Name	Species abundance (%)	Order abundance (%)
Hymenoptera	Apidae	*Trigona* sp.	5.33	31.36
	Halictidae	*Halictus* sp.	24.70	
	Eumenidae	*Delta conoideum* (Gmelin)	1.33	
Lepidoptera	Nymphalidae	*Euploea core* Cramer	4.00	21.98
		Acrea terpsicore L.	4.66	
		Tirumala limniace exoticus	2.00	
		Hypolimnas misippus L.	3.33	
	Pieridae	*Eurema blanda* (Boisdual)	2.00	
		Delias eucharis Drury.	0.66	
		Pieris brassicae L.	2.67	
	Papilionidae	*Papilio polytes* L.	1.33	
		Papilio demolius L.	1.33	
Diptera	Muscidae	Unidentified fly	32.00	32.00
Coleoptera	Chrysomelidae	*Monolepta signata* Oliv.	0.67	0.67
Hemiptera	Pentatomidae	*Nezara viridula* L.	2.00	10.66
		*Bagrada cruciferarum (*Kirkaldy*)*	5.33	
	Scutelleridae	*Chrysocoris stollii* Wolf.	3.33	
Orthoptera	Acrididae	*Hieroglyphus banian* L.	3.33	3.33

Table 3: Foraging activity of major insect visitors / pollinators in linseed

Time (h)	Mean number of pollinators/ m^2/5 min	
	***Halictus* sp.**	**Muscid fly**
0600	0.00 (1.00)^{d}	0.20 (1.06)^{cd}
0700	0.10 ((1.04)^{d}	0.55 (1.23)^{ab}
0800	0.40 (1.16)^{bc}	0.75 (1.28)^{a}
0900	0.65 (1.27)^{a}	0.45 (1.18)^{abc}
1000	0.55 (1.22)^{ab}	0.35 (1.14)^{bcd}
1100	0.15 (1.06)^{cd}	0.10 (1.04)^{d}
Mean	0.31	0.40
S.Em±	0.05	0.06
CD at 5%	0.10	0.13
CD at 1%	0.14	0.17

- Each value represents mean of 20 observations at each sampling time
- Figures in the parenthesis are √x+1 transformed values
- Means followed by same letter in a column do not differ significantly by DMRT at 5 per cent level.

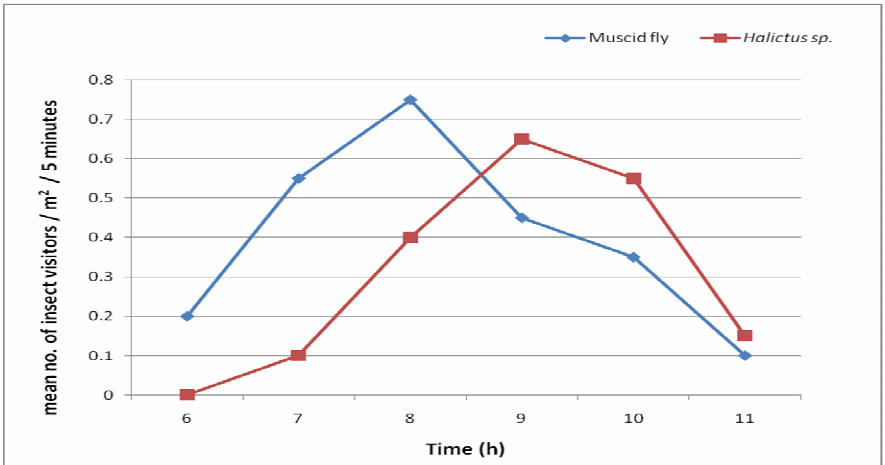

Fig.1: Foraging activity of major insect vsitors in linseed

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