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DIVERSITY AND ABUNDANCE OF DIFFERENT FLORAL VISITORS ON EGYPTIAN CLOVER, *TRIFOLIUM ALEXANDRINUM* L.

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SUMMARY

The diversity and abundance of different floral visitors on *Trifolium alexandrinum* was studied at Forage Section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar during 2012 and 2013. A total of 45 insect species were recovered on *T. alexandrinum* flowers, all species belonging to 25 families of six orders. The Hymenopterans floral visitors on *T. alexandrinum* bloom were most important as compared to other floral visitors.

Key words : Abundance, diversity, floral visitors, Egyptian clover, *T. alexandrinum*

Egyptian clover, *Trifolium alexandrinum* L. vernacularly called *berseem* (Family Leguminaceae, sub-family Papilionaceae), gives higher yield viz., green fodder yield (85 t/ha) and multi-cut nature (4-6 cuts) along with qualitative parameters viz., succulency, high palatability, nutritive value (20% crude protein), digestibility (up to 65%) and continuous supply of over seven months (November to May). Apart from supplying green fodder, it enriches soil fertility through nitrogen fixation. In its country of origin–Egypt, it is grown in approximately 3 million acres (Abdalla *et al*., 2012). In India, it is grown in 1.9 million ha with a productivity of 60-110 t/ha (Anonymous, 2002). Egyptian clover is one of the most entomophilic crop requiring insects especially bees for cross pollination. Seed yield increase to the tune of 3496.86 per cent due to honey bee has been reported by Deodikar and Suryanarayana (1977). It is generally recommended to place honey bee colonies in the seed fields to supplement satisfactory seed yields and in their absence, seed yield as drastically reduced (Bakheit, 1989).

MATERIALS AND METHODS

Insect visitors on the flowers of *T. alexandrinum* variety HB-2 were collected by using cone type hand net. Sweeps were made throughout the blooming period (started after three days of the commencement of flowering and continued till 90% flowering was over) at an hourly interval from 0600 to 1800 h to collect insect visitors on *T. alexandrinum* flowers. Caught insects were further transferred to the killing bottle. They were further mounted and spread as per standard protocol for "collection and preservation of insects". These specimens were preserved as dry specimens in the insect collection box. Collected insects were identified by comparing them with reference collection maintained at the Apiculture Laboratory of the Department of Entomology, Hisar (Haryana). Rest of the specimens were got identified from the Division of Entomology, Indian Agriculture Research Institute, New Delhi.

To study the abundance of insect visitors, experimental area was randomly selected and marked at different locations to ensure the maximum flowering. Care was taken to assure similar dimensions with respect to the number of plants, plant spread, phase of flowering and number of flowers. The counts of insect visitors were made in one square meter bloom area for 5 min and replicated thrice. These observations were recorded when the crop was at 30-80 per cent of flowering at two-hourly intervals from 0600 till 1800 h (7 intervals) of the day for 10 calm, clear and sunny days. Any observation on windy, cloudy or otherwise unsuitable day was rejected out-rightly. All the data were statistically analyzed by using randomized block design following the methods given by Free (1993).

TABLE 1
Diversity of flower visitors on *T. alexandrinum* bloom during 2012 and 2013

S. No.	Scientific name	Family	Order
1.	*Apis dorsata* F.***	Apidae	Hymenoptera
2.	*A. mellifera* L.***	-do-	-do-
3.	*A. florea* F.**	-do-	-do-
4.	*A. cerana* F.*	-do-	-do-
5.	*Tetralonia duvaucelii* Lepeletier*	-do-	-do-
6.	*Thyreus ramosus* Lepeletier*	-do-	-do-
7.	*Ceratina viridissima* Dalla Torre*	-do-	-do-
8.	¦*Megachile* sp.*	Megachilidae	-do-
9.	¦*Megachile* sp.*	-do-	-do-
10.	*Megachile bicolor* F.*	-do-	-do-
11.	*Eumenes dimidiatipennis* Saussure*	Vespidae	-do-
12.	*Polistes olivaceus* De Geer**	-do-	-do-
13.	*Campsomeriella colloris colloris* F.	Scoliidae	-do-
14.	#Gen. & sp.*	Ichneumonidae	-do-
15.	#Gen. & sp.*	-do-	-do-
16.	*Metopius rufus* Cameron*	-do-	-do-
17.	*Bembix* sp.*	Sphecidae	-do-
18.	*Sceliphron madraspatanum pictum* F. Smith*	-do-	-do-
19.	*Brachymeria* sp.*	Chalcididae	-do-
20.	#Gen. & sp.*	-do-	-do-
21.	*Phidole* sp.	Formicidae	-do-
22.	*Dieucoila indica* Mani*	Figitidae	-do-
23.	*Anatrichus pygameus* Lambi *	Chloropilidae	Diptera
24.	*Melanagromyza obtusa* Malloch*	Agromyzidae	-do-
25.	*Cylindromyia* sp.*	Tachinidae	-do-
26.	#Gen. & sp.*	Mycetophilidae	-do-
27.	¦*Eristalinus* spp. ***	Syrphidae	-do-
28.	¦*Eristalinus* spp.*	-do-	-do-
29.	¦*Eristalinus* spp.*	-do-	-do-
30.	*Musca* sp.*	Muscidae	-do-
31.	*Papilio demoleus* L.**	Papilionidae	Lepidoptera
32.	*Vanessa sp.**	Nymphalidae	-do-
33.	*Danaus chrysippus* L.*	-do-	-do-
34.	*Pieris brassicae* L.**	Pieridae	-do-
35.	*Helicoverpa armigera* H.**	Noctuidae	-do-
36.	*Utethesia pulchella*	Arctiidae	-do-
37.	#Gen. & sp.*	Miridae	Hemiptera
38.	*Andrallus spinidens* F.*	Pentatomidae	-do-
39.	*Dolycoris indicus* Stal*	-do-	-do-
40.	*Piezodorus hybneri* Gmelin*	-do-	-do-
41.	*Menochilus sexmaculta* F.**	Coccinellidae	Coleoptera
42.	*Coccinella septempunctata* L.**	-do-	-do-
43.	*Anthia* sp.*	Carabidae	-do-
44.	*Acrida* sp.*	Acrididae	Orthoptera
45.	*Catantops* sp.**	-do-	-do-

*Less frequent visitors, **Frequent visitors,***Most frequent visitors, # Gen. & Sp.–Unidentified species, ¦ same genes different species.

RESULTS AND DISCUSSION

Diversity of Insect Visitors

T. alexandrinum proved to be a truly entomophilous crop with as many as 45 insect species belonging to six orders and 25 families (Table 1). The major visitors were from order Hymenoptera (22 species from 9 families) and family Apidae (7 species) was most diverse including honeybees, *Apis dorsata* F., *A. mellifera* L., *A. florea* F. and *A. cerana* and solitary leaf-cutting bee, *Megachile* sp. Diptera was the next most diverse order (6 families and 8 species), the syrphid fly, *Eristalinus* sp. being the most important floral visitor. It was followed by Lepidoptera (6 species from 5 families), the important visitors were moths *Papilio demoleus* L., *Pieris brassicae* L. and *Helicoverpa armigera* Hub. Bug, *Andrallus spinidens* F. was the important hemipteran (4 species from 2 families) followed by Coleoptera (3 species from 2 families) and Orthoptera (2 species). Similarly, El-Borollosy *et al.* (1975) reported 50 species visiting *T. alexandrinum* bloom. The present studies find favour with the observations of Narayanan *et al*. (1961) who reported Hymenoptera as the most frequent floral visitor (3 species) followed by Diptera (3), Coleptera (1) and Hemiptera (8 species) and Wafa and Ibrahim (1960) who observed Lepidoptera (4 species), Diptera (14), Coleoptera (16) and Hymenoptera (35) as important visitors. The present findings of bees as the most frequent visitors are in conformity with many other workers (Hassanein, 1953; Narayanan *et al*., 1961; Hussein and Abdel Aal, 1982; Shawer *et al.*, 1989; Malaviya *et al*., 1999; Singh *et al*., 2012) but in contrast to El-Borollosy *et al.* (1975) who reported *Musca* spp. and *Chalicodoma* spp. as most frequent visitors.

Diversity of bee species, however, was location and year specific. The sequence of diversity of honey bee species (*A. indica*, *A. dorsata* and *A. florea*) as reported by Narayanan *et al*. (1961), however, does not match with those reported in present studies (*A. dorsata*, *A. mellifera* and *A. florea*) but the reported dominance of *A. dorsata* (Singh *et al*., 2012) and *A. florea* (Batra, 1977; Malaviya *et al.*, 1999) is in line with present studies. The studies during post *A. mellifera* introduction era or from Europe (Shawer *et al.*, 1989; Malaviya *et al.*, 1999; Singh *et al*., 2012) arguably depict it as more frequent visitor of *T. alexandrinum* as in the present investigations.

Among all these insects *A. dorsata*, *A. mellifera*, *A. florea* and *Eristalinus* spp. were the most frequent visitors. *Polistes olivaceus* De Geer, *Papilio demoleus* L., *Pieris brassicae* L., *Helicoverpa armigera* H., *Menochilus sexmaculta* F. and *Catantops* sp. were the frequent species and rest were less frequent floral visitors.

Abundance of Insect Visitors

While considering the abundance of important floral visitors of *T. alexandrinum*, the dominance of hymenopterans was abundantly clear along with the fact that insect abundance is dynamic over species, locations, years and time (Table 2 and Figs. 1 & 2). Hymenopterans comprised 57.75 per cent of all insect visitors during 2012 and were lower during 2013 (49.50%). The present trend is in line with the finding of many workers (Wafa and Ibrahim, 1960; Shawer *et al*., 1989; El-Borollosy *et al*., 1975). The apoidea comprising bees was observed as the most abundant group with a mean proportion of 50.18 per cent during 2012 and 40.80 per cent during 2013. The four honey bee species comprised 46.33 per cent of total visitors during 2012 and 36.73 per cent during 2013 but this proportion was significantly lower than those recorded for honey bees (60.0-96.9%) on *T. alexandrinum* by Hassanein (1953), Narayanan *et al*. (1961), Hussein and Abdel Aal (1982) and Malaviya *et al.* (1999).

Among the honey bees, *A. dorsata* was the most abundant floral visitor of *T. alexandrinum* with a mean abundance of 21.26 per cent that was higher (24.99%) during 2012 but declined significantly in 2013 to 17.17 per cent. It was followed by *A. mellifera* and their proportion remained almost similar during both the years (13.72 and 14.55%, respectively). The observations of Sharma and Singh (2003) are in support of present findings who also reported that *A. dorsata* was the most abundant forager at Hisar (Haryana) with a mean intensity of 6.55 bees/m^2/5 min followed by *A. mellifera* (4.4 bees) and *A. floera* (1.52). In contrast, Malaviya *et al.* (1999) from Jhansi and Singh *et al.* (2012) from Punjab reported maximum abundance of *A. mellifera* (3.80 bees/m^2/min) followed by *A. dorsata* (1.13) and *A. cerana*. Goodman and Williams, (1994) on *T. repens* also recorded higher proportion of *A. mellifera* (88%) compared to the native pollinators (4.3%). The little bee, *A. florea* though was moderate in abundance (7.52%)

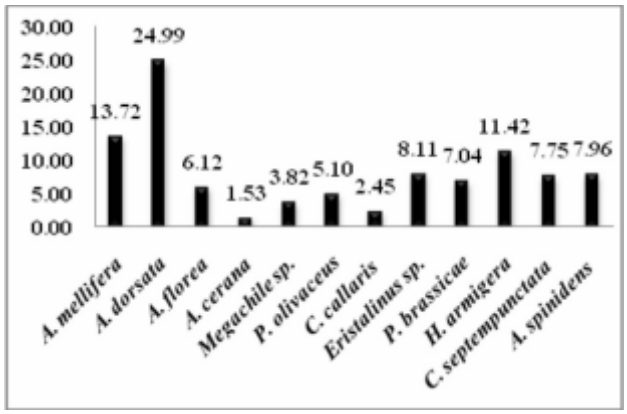

Fig. 1. Abundance of important floral visitors of *T. alexandrinum* during 2012.

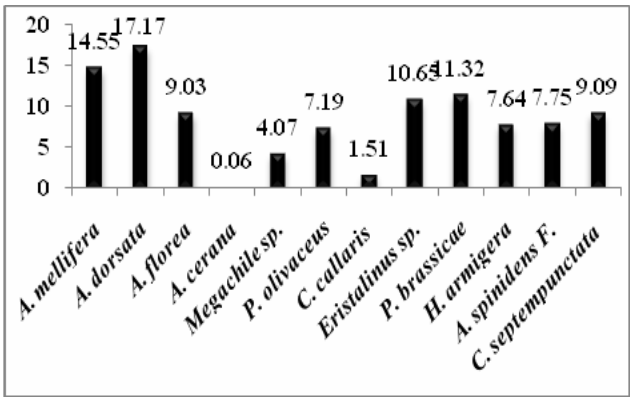

Fig. 2. Abundance of important floral visitors of *T. alexandrinum* during 2013.

TABLE 2
Abundance of important floral visitors of *T. alexandrinum*

Orders/Floral visitors	2012		2013		Overall	
	Mean population	Mean proportion (%)	Mean population	Mean proportion (%)	Mean population	Mean proportion (%)
Hymenoptera						
Apoidea						
A. mellifera	2.69*	13.72	2.61	14.55	2.65	14.10
A. dorsata	4.90	24.99	3.08	17.17	3.99	21.26
A. florea	1.20	6.12	1.62	9.03	1.41	7.52
A. cerana	0.30	1.53	0.01	0.06	0.16	0.84
Megachile sp.	0.75	3.82	0.73	4.07	0.74	3.93
Total Apoidea	9.84	50.18	7.32	40.80	8.95	47.65
Other Hymenoptera						
P. olivaceus	1.00	5.10	1.29	7.19	1.14	6.09
C. callaris	0.48	2.45	0.27	1.51	1.59	8.49
Total Other Hymenoptera	1.48	7.55	1.56	8.70	2.74	14.57
Total Hymenoptera	11.32	57.73	8.88	49.50	11.68	62.23
Diptera						
Eristalinus sp.	1.59	8.11	1.91	10.65	1.75	9.32
Total Diptera	1.59	8.11	1.91	10.65	1.75	9.32
Lepidoptera						
P. brassicae	1.38	7.04	2.03	11.32	1.71	9.09
H. armigera	2.24	11.42	1.37	7.64	1.81	9.63
Total Lepidoptera	3.62	18.46	3.40	18.95	3.51	18.72
Hemiptera						
A. spinidens F.	1.52	7.75	1.39	7.75	1.45	7.74
Total Hemiptera	1.52	7.75	1.39	7.75	1.45	7.74
Coleoptera						
C. septempunctata	1.56	7.96	1.63	9.09	1.59	17.94
Total Coleoptera	1.56	7.96	1.63	9.09	1.59	17.94
Mean total population	19.61		17.94		18.77	

*Mean of 30 observations (10 days x 3 replications).

but its proportion increased from 6.20 in 2012 to 9.03 per cent in the following year. Narayanan *et al*. (1961) also did not record *A. florea* during first year (1957) but during 1960, it acquired major status (40.7%) and was still more abundant during windy conditions (82.19%) than *A. indica* (16.43%). In contrast, during an earlier study Batra (1977) found *A. florea* to be especially abundant in Punjab. The proportion of Indian hive bee *A. cerana* was low (1.53%) during 2012, but it declined further to become negligible (0.06%) in 2013. Narayanan *et al*. (1961) in contrary recorded that *A. indica* accounted for 63 and *A. dorsata* for 21 per cent of flower visitors. The abundance of leaf cutter bee (*Megachile* sp.) was low during both the years (3.82 and 4.03%, respectively) and that of *Polites olivaceus* De Geer was moderate (5.10 and 7.19%, respectively) though Richards (1995) in contrast reported *M. rotundata* as the most abundant pollinator of alfalfa, arrow leaf clover (*T. vesiculosum)*, crimson clover (*T. incarnatum)* and Persian clover (*T. resupinatum*).

Lepidoptera was the second largest order of floral visitors with a mean proportion of 18.72 per cent and retained static position during both the years (18.46 and 18.95%, respectively). The moths of *Helicoverpa armigera* Hubner were more abundant during 2012 (11.42%, 3rd rank) but declined in 2013 (7.64%, 8th rank) followed by *Pieris brassicae* with inverse trend i. e. lower during 2012 (7.04%, 7th rank) and higher (11.32%, 3rd rank) during 2013. These moths being nectar feeders have a questionable pollination status. Dipterans were third most abundant order visiting *T. alexandrinum*, the syrphid fly, *Eristalinus* spp. comprised 8.11 per cent (4th rank) visitors but its proportion increased during 2013 (10.65%). The findings are in contrast to El-Borollosy *et al.* (1975) reporting *Musca* spp. as the most common (38%). The fourth largest contributor of floral visitors to the bloom of *T. alexandrinum* was order Coleoptera with predator lady bird beetle, *Coccinella septempunctata* L. ranking fifth (17.94%). Its proportion too was lower during 2012 (7.96%) but increased in 2013 (9.09%) but being predator of soft bodied insects their role as pollinators is arguable. Wafa and Ibrahim (1960), El-Borollosy *et al.* (1975) and Shawer *et al*. (1989), however, reported Coleoptera, Diptera and Lepidoptera order as most abundant visitors.

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