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DIVERSITY AND ABUNDANCE OF FLOWER VISITING INSECTS ASSOCIATED WITH SESAME

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ABSTRACT

A field experiment was conducted at the Research farm of Department of Entomology, CCS Haryana Agricultural University (CCSHAU) Hisar, Haryana to determine the diversity and abundance of insect pollinators on two varieties of sesame HT-1 and HT-2 during 2017 and 2018. A total of 34 insect species belonging to 18 families from four orders were observed. Of these *Apis dorsata* (4.76 bees/ m²/ 5 min; 26.92% of total flower visitors) followed by *A. mellifera* (2.34 bees/ m²/ 5 min), *M. lanata* (2.23 bees/ m²/ 5 min) and *A. florea* (1.32 bees/ m²/ 5 min) were predominant. Peak activity of the insect visitors was observed at 1000-1200 hr of the day.

Key words: Sesame, pollination, insect visitors, diversity, hymenopterans, coleopterans, lepidopterans, honey bees, solitory bees, relative abundance, peak activity

Pollination is one of the most prized provisioning services chiefly valued for its contribution in sexual reproduction in many angiosperms (Kearns et al., 1998). In India, out of 211 crops, 108 (51.2%) crops are dependent on animal pollination where it was essential for 14 crops, great for 34, moderate for 29 and little for 31 crops. Among them, oilseeds followed by fruits are found to be more dependent. Decline in pollinator contribution in these crops could significantly decrease output (Chaudhary and Chand, 2017). Sesame, ancient oil seed crop, is being cultivated in 78 countries belonging to many tropical countries where 73% of global production come from China, Ethiopia, India, Myanmar, Nigeria, Sudan and Tanzania (FAO, 2017). In India the productivity is only 448 kg ha-1 (CCSHAU, 2017). The crop has observed to show high variance in pollination dependence as its outcrossing rates vary from 10 to 68%, evidencing that it has mixed mating system and produces capsules through self and cross-pollination (Free, 1993; Sarker, 2004). Recent study had also reported it as one of the pollinator dependent crops where the loss of bee pollinators would result in yield gaps between 50 and 87% (Stein et al., 2017). Hence, as a part of good crop production initiatives, conserving and utilizing the available pollinator fauna is of paramount importance. This necessitates the continued research to monitor the pollinator fauna in the sesame crop ecosystem. Information on insect pollinators of sesame in Haryana is also scarce. Hence, the present study with objective of determining the diversity and relative abundance of flower visiting insects/ pollinators in sesame at Hisar, Haryana.

MATERIALS AND METHODS

The present study was conducted at the Research farm (29º10'N,75º 46'E) of Department of Entomology, CCS Haryana Agricultural University (CCSHAU), Hisar, Haryana. All observations on the flower visiting insects were made on the selected varieties, HT-1and HT-2 during kharif season 2017 and 2018. The crop was raised as per the recommended practices of CCSHAU excluding protection measures (Anonymous, 2017). Both the varieties were sown on 12th July (2017) and 16th June (2018) and harvested on 10th October (2017) and 4th October (2018). The flowering period of 34 days (20th August- 22nd September, 2017) and 38 days (1st August- 7th September, 2018) was observed. Plants were observed to collect the flower visiting insects from 0600 to 1800 hr, every two hourly intervals. Cone type hand net measuring 38 cm dia was used and the collected insects were processed as per standard procedures. These specimens were got identified from the Insect Identification Service, Division of Entomology, Indian Agricultural Research Institute, New Delhi. The insects collecting nectar and/ or pollen through were characterized as pollinators, whereas the insects which enter otherwise simply as flower visitors. In addition, individuals working from the top side of flower were considered as top worker, whereas individuals visiting through side route were referred as side worker. For recording the diurnal abundance, 17 frequently visiting insect visitors/ pollinators were considered. The number of insects. m^2 area of crop/ 5 min was counted from four randomly selected areas.

These observations were taken at two hourly intervals, starting from 0600 to 1800 hr and repeated at weekly intervals starting from 10% of the flowering to the end of flowering. The diurnal abundance data was further used to calculate the % relative abundance of an individual species using the following formula-

$$\text{Relative abundance of 'X' spp.} = \frac{\text{No. of visits 'X' spp.}}{\text{Total visits}} \times 100$$

The data for 2017 and 2018 and the pooled data were subjected to statistical analysis following factorial randomized block design using OPSTAT software (Sheoran et al.1998) and the results were compared using LSD (p=0.05).

RESULTS AND DISCUSSION

A total of 34 species under 18 families of four orders viz., Hymenoptera, Diptera, Lepidoptera and Coleoptera were observed to visit the sesame flowers (Table 1). Thus, the species collected did not vary with variety. Hymenoptera constituted a dominant share (62%) followed by Lepidoptera (17%), Diptera (12%) and Coleoptera (9%). Hymenoptera consisted of 21 species under 8 families, while other orders had less numbers. The maximum number of species observed were from the family Apidae (6), followed by Megachilide (5) and Vespidae (3). Of the insects observed, 16 were observed to be pollinators. These visitors were taking the nectar from extrafloral nectaries present at the base of flower, and

Table 1. Flower visiting insects of *S. indicum* (var. HT-1 and HT-2, kharif 2017, 2018)

S.No	Scientific name	Family	Order	Insect pollinator/ Insect visitor	Working behaviour
1	*Apis mellifera* L.	Apidae	Hymenoptera	IP*	T*
2	*Apis cerana indica* F.	Apidae	Hymenoptera	IP	T
3	*Apis dorsata* F.	Apidae	Hymenoptera	IP	T
4	*Apis florea* F.	Apidae	Hymenoptera	IP	T and S
5	*Ceratina smaragdula* F.	Apidae	Hymenoptera	IP	T
6	*Xylocopa iridipennis* Lepeletier	Apidae	Hymenoptera	IP	T and S
7	*Megachile lanata* F.	Megachilidae	Hymenoptera	IP	T
8	*Megachile cephalotes* Smith	Megachilidae	Hymenoptera	IP	T
9	*Megachile bicolor* F.	Megachilidae	Hymenoptera	IP	T
10	*Coelioxys* sp.	Megachilidae	Hymenoptera	IP	T
11	*Anthidium* sp.	Megachilidae	Hymenoptera	IP	T
12	*Nomia curvipes* F.	Halictidae	Hymenoptera	IP	T
13	*Halictus* sp.	Halictidae	Hymenoptera	IP	T
14	*Anthophora cingulata* F.	Anthophoridae	Hymenoptera	IP	T
15	*Sceliphron madrasapatnam* F.	Vespidae	Hymenoptera	IV	S*
16	*Polistes hebraceus* F.	Vespidae	Hymenoptera	IV	S
17	*Vespa orientalis* L.	Vespidae	Hymenoptera	IV	S
18	*Compsomeriella* sp.	Scolidae	Hymenoptera	IV	S
19	*Delta dimidiatipenne* Saussure	Eumenidae	Hymenoptera	IV	S
20	*Odynerus ovalis* Saussure	Eumenidae	Hymenoptera	IV	S
21	*Camponotus* sp.	Formicidae	Hymenoptera	IV	T and S
22	*Episyrphus* sp.	Syrphidae	Diptera	IP	T and S
23	*Ersitalinus* sp.	Syrphidae	Diptera	IP	T and S
24	*Musca* sp.	Muscidae	Diptera	IV	T and S
25	*Calliphora* sp.	Calliphoridae	Diptera	IV	T and S
26	*Danus chrysippus* L.	Nymphalidae	Lepidoptera	IV	T and S
27	*Julonia almana* L.	Nymphalidae	Lepidoptera	IV	T and S
28	*Papilio demoleus* L.	Papillionidae	Lepidoptera	IV	T and S
29	*Pelopidas mathias* F.	Hesperiidae	Lepidoptera	IV	T and S
30	*Antigastra catalaunalis* (Duponchel)	Crambidae	Lepidoptera	IV	T and S
31	*Earias insulana* Boisduval	Nolidae	Lepidoptera	IV	T and S
32	*Oxycetonia versicolor* (F.)	Scarabaeidae	Coleoptera	IV	T
33	*Chiloloba acuta* Wiedemann	Scarabaeidae	Coleoptera	IV	T
34	*Mylabris pustulata* (Thunberg)	Meloidae	Coleoptera	IV	T

*IP –Insect Pollinator and IV – Insect Visitor; T – Top Worker and S – Side Worker

Table 2. Diurnal abundance of insect visitors/ pollinators on flowers of *S. indicum* (Cv. HT-1 and HT-2, kharif 2017, 2018)

S. No.	Insect visitor/ pollinator	Mean no. of insects / m^2 / 5min															% Relative abundance
		HT-1							HT-2								
		0600-0800 hr	0800-1000 hr	1000-1200 hr	1200-1400 hr	1400-1600 hr	1600-1800 hr	Mean	0600-0800 hr	0800-1000 hr	1000-1200 hr	1200-1400 hr	1400-1600 hr	1600-1800 hr	Mean	Pooled mean	
1.	*A. mellifera*	1.94 (1.71)	2.63 (1.91)	3.94 (2.22)	2.82 (1.95)	1.54 (1.59)	0.75 (1.32)	2.27 (1.81)	1.97 (1.72)	2.78 (1.94)	3.84 (2.20)	2.91 (1.98)	1.88 (1.70)	1.03 (1.42)	2.40 (1.84)	2.34 (1.83)	13.24
2.	*A. cerana*	0.51 (1.23)	1.10 (1.45)	1.66 (1.63)	0.53 (1.24)	0.53 (1.24)	0.07 (1.03)	0.73 (1.32)	0.47 (1.21)	0.81 (1.35)	1.53 (1.59)	0.75 (1.32)	0.38 (1.17)	0.16 (1.08)	0.68 (1.30)	0.71 (1.31)	4.02
3.	*A. dorsata*	3.60 (2.14)	5.35 (2.52)	9.37 (3.22)	4.75 (2.40)	3.07 (2.02)	1.82 (1.68)	4.66 (2.38)	3.41 (2.10)	5.63 (2.57)	9.63 (3.26)	4.81 (2.41)	3.66 (2.16)	2.03 (1.74)	4.86 (2.42)	4.76 (2.40)	26.92
4..	*A. florea*	0.10 (1.05)	1.16 (1.47)	2.76 (1.94)	2.54 (1.88)	1.03 (1.42)	0.44 (1.20)	1.34 (1.53)	0.03 (1.01)	1.44 (1.56)	2.41 (1.85)	2.34 (1.83)	1.16 (1.47)	0.38 (1.17)	1.29 (1.51)	1.32 (1.52)	7.47
5.	*C. smaragdula*	0.00 (1.00)	1.82 (1.68)	1.97 (1.72)	2.00 (1.73)	0.69 (1.30)	0.16 (1.08)	1.11 (1.45)	0.06 (1.03)	1.22 (1.49)	1.66 (1.63)	2.19 (1.79)	0.66 (1.29)	0.16 (1.08)	0.99 (1.41)	1.05 (1.43)	5.94
6.	*X. iridipennis*	0.35 (1.16)	0.16 (1.08)	0.25 (1.12)	0.32 (1.15)	0.00 (1.00)	0.00 (1.00)	0.18 (1.09)	0.13 (1.06)	0.41 (1.55)	0.09 (1.04)	0.47 (1.21)	0.03 (1.01)	0.00 (1.00)	0.19 (1.09)	0.19 (1.09)	1.07
7.	*M. lanata*	0.13 (1.06)	2.38 (1.84)	3.29 (2.07)	4.00 (2.24)	1.78 (1.67)	1.03 (1.42)	2.10 (1.76)	0.00 (1.00)	2.66 (1.91)	3.56 (2.14)	4.16 (2.27)	2.06 (1.75)	1.47 (1.57)	2.35 (1.83)	2.23 (1.80)	12.61
8.	*M. cephalotes*	0.00 (1.00)	1.38 (1.54)	1.82 (1.68)	2.22 (1.79)	1.19 (1.48)	0.69 (1.30)	1.22 (1.49)	0.00 (1.00)	1.41 (1.55)	1.91 (1.71)	2.34 (1.83)	1.38 (1.54)	0.81 (1.35)	1.31 (1.52)	1.27 (1.51)	7.18
9.	*M. bicolor*	0.00 (1.00)	0.19 (1.09)	0.57 (1.25)	1.60 (1.61)	0.10 (1.05)	0.10 (1.05)	0.42 (1.19)	0.00 (1.00)	1.00 (1.41)	1.19 (1.48)	0.63 (1.28)	0.19 (1.09)	0.13 (1.06)	0.52 (1.23)	0.47 (1.21)	2.66
10.	*Coelioxys* sp.	0.00 (1.00)	0.07 (1.03)	0.13 (1.06)	0.22 (1.10)	0.03 (1.01)	0.00 (1.00)	0.07 (1.03)	0.00 (1.00)	0.06 (1.03)	0.34 (1.16)	0.41 (1.19)	0.03 (1.01)	0.00 (1.00)	0.14 (1.07)	0.11 (1.05)	0.62
11.	*N. curvipes*	0.00 (1.00)	1.03 (1.42)	1.82 (1.68)	1.85 (1.69)	0.50 (1.22)	0.16 (1.08)	0.89 (1.37)	0.00 (1.00)	0.66 (1.29)	1.63 (1.62)	1.91 (1.71)	0.94 (1.39)	0.31 (1.14)	0.91 (1.38)	0.90 (1.38)	5.09
12.	*Halictus* sp.	0.00 (1.00)	0.60 (1.26)	0.75 (1.32)	0.85 (1.36)	0.10 (1.05)	0.00 (1.00)	0.38 (1.17)	0.00 (1.00)	0.50 (1.22)	1.16 (1.47)	0.91 (1.38)	0.06 (1.03)	0.00 (1.00)	0.44 (1.20)	0.41 (1.19)	2.32
13.	*A. cingulata*	0.07 (1.03)	0.32 (1.15)	0.38 (1.17)	0.41 (1.19)	0.00 (1.00)	0.00 (1.00)	0.20 (1.10)	0.09 (1.04)	0.28 (1.13)	0.34 (1.16)	0.22 (1.10)	0.03 (1.01)	0.00 (1.00)	0.16 (1.08)	0.18 (1.09)	1.02
14.	*Compsomeriella* sp.	0.16 (1.08)	0.56 (1.25)	0.41 (1.19)	0.13 (1.06)	0.10 (1.05)	0.00 (1.00)	0.23 (1.11)	0.13 (1.06)	0.34 (1.16)	0.25 (1.12)	0.13 (1.06)	0.03 (1.01)	0.00 (1.00)	0.15 (1.07)	0.19 (1.09)	1.07
15.	*M. pustulata*	1.91 (1.71)	1.35 (1.53)	0.63 (1.28)	0.35 (1.16)	0.07 (1.03)	0.53 (1.24)	0.80 (1.34)	1.78 (1.67)	1.16 (1.47)	0.53 (1.24)	0.06 (1.03)	0.16 (1.08)	0.50 (1.22)	0.70 (1.30)	0.75 (1.32)	4.24
16.	*O. versicolor*	0.03 (1.01)	0.85 (1.36)	0.69 (1.30)	0.28 (1.13)	0.16 (1.08)	0.16 (1.08)	0.36 (1.17)	0.19 (1.09)	0.53 (1.24)	0.56 (1.25)	0.22 (1.10)	0.28 (1.13)	0.22 (1.10)	0.33 (1.15)	0.35 (1.16)	1.98
17.	*Eristalinus* sp.	0.63 (1.28)	0.91 (1.38)	0.66 (1.29)	0.57 (1.25)	0.53 (1.24)	0.03 (1.01)	0.55 (1.24)	0.72 (1.31)	0.88 (1.37)	0.75 (1.32)	0.38 (1.17)	0.34 (1.16)	0.03 (1.01)	0.52 (1.23)	0.54 (1.24)	3.05
	Total***	9.38 (1.25)	22.16 (1.52)	31.23 (1.68)	25.54 (1.58)	11.60 (1.30)	6.07 (1.16)	17.46 (1.42)	8.97 (1.24)	21.75 (1.51)	31.38 (1.69)	24.81 (1.57)	13.25 (1.33)	7.22 (1.19)	17.90 (1.43)	17.68 (1.43)	-

Table 2 contd...

Table 2 contd...

Factors	CD (p≤0.05)		
	2017	2018	Pooled
Variety	NS	NS	-
Year	0.05	0.06	0.06
Insect Visitor	0.02	0.03	0.03
Time	0.03	0.03	0.03
Insect Visitor × Time	0.12	0.06	0.14
Variety × Year	-	-	NS
variety × Time	-	-	NS
Variety × Year × Time	-	-	NS
Insect Visitor × Time × Year	-	-	0.20

*Each value represents a mean of four weekly observations; **Data subjected to √n+1 transformation; ***Transformation on the basis of respective mean

there were 15 top and 6 side workers, and 13 worked as both top and side workers. These observations revealed that the number of insects of collected were significantly higher in comparison to earlier reports on sesame- only 12 insect visitors in Hisar, Haryana (Sachdeva et al., 2003), 13 species in Dharwad, Karnataka (Patil, 1999), 22 species in Bengaluru, Karnataka (Pashte and Shylesha, 2013a) and eight species in Bhubaneswar, Orissa (Mohapatra and Sontakke, 2012). The observation that hymenopterans were the most dominant visitors of sesame corroborates with earlier results- Patil (1999) at Dharwad, Karnataka reported 13 species with 8 of Hymenoptera. Mahfouz et al. (2012) observed Hymenoptera (86%) as the predominant flower visitors. Sajjanar and Eswarappa (2015) at Raichur, Karnataka and Kamel et al. (2013) at Ismailia, Egypt are also in agreement with present results.

The data on diurnal abundance of the 17 pollinators revealed moderate to low abundance (Table 2); with no significant variation in relation to variety. Mishra (1994) also observed such insignificance in abundance of honey bees in varieties, as observed by Chandran (2009) with honey bees at Dharwad, Karnataka. In general, the diurnal abundance was more in 2018 than 2017. This small but measurable variation might be due to differential foraging rate of flower visitors/ pollinators which was in turn depended on weather factors (Reddy et al. 2015). Among the 17 flower visitors/pollinators, *Apis dorsata* was found to be the most abundant followed by others, with the four species forming a share of 60.24 % of the total abundance. Significant number of *M. cephalotes* (1.27), *C. smaragdula* (1.07) and *N. curvipes* (0.90) were also noted. *Coelioxys* sp., *A. cingulata, Compsomeriella* sp., and *X. iridipennis* visited the crop rarely and of a very low abundance values of < 0.20 insects/ m²/ 5 min. Sachdeva et al. (2003) also made similar observations while recording the abundance of flower visitors on *S. indicum* cv. HT- 1 at Hisar, Haryana. The honey bees *viz*., *A. dorsata* (7.53 bees/ m^2 / 5 min), *A. mellifera* (4.73 bees/ m^2 / 5 min) and *A. florea* (4.20 bees/ m^2 / 5 min) were observed as predominant. Similarly, in Hisar, Nagpal (2016) on flowers of Indian mustard *B. juncea* also reported the dominance of the honey bees. in southern and eastern parts of India higher abundance of *A. cerana* over *A. dorsata*, *A. mellifera* and *A. florea* in *S. indicum* was observed (Mohapatra and Sontakke, 2012; Sajjanar and Eswarappa, 2015). In Egypt, Kamel et al. (2013) recorded *A. mellifera*, *Ceratina tarsata*, *Xylocopa pubescens* and *Osmia* sp. as dominant species in sesame, while wasps, syrphid flies and butterflies as least abundant species.

The observations on visits of flower visitors/ pollinators at different time intervals of the day indicate a unimodal diurnal activity of the all the species as there was single visiting peak at 1000-1200 hr, irrespective of variety. The number of flower visiting insects increased from early morning to mid day (0600 to 1400 hr) and then there existed a declining trend with least activity from 1600 to 1800 hr. These observations are in agreement with results of Mohapatra and Sontakke (2012). Pashte and Shylesha (2013b) also observed the peak activity of nectar as well as pollen foragers at 1000 and 1100 hr of the day. Said et al. (2013) observed peak activity of pollinators between 1100 -1300 hr nd 1300-1500 hr. Thus, the results of the study indicate that the true attractiveness of sesame crop towards myriad of flower visitors/ pollinators is for 34 species of four orders viz., Hymenoptera, Diptera, Lepidoptera and Coleoptera. Among these, 17 were frequent visitors with a peak activity at 1000-1200 hr of the day; and *A. dorsata* was most abundant.

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