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Insect Visitors and Abundance of Four Species of *Apis* on Sunflower *Helianthus annuus* L. in Pakistan

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Abstract: Sunflower (*Helianthus annuus* L.) is an open pollinated crop and the world's fourth important source of edible oil. Two fields, one of them adjacent to an apiary with 40 hives, were sampled weekly for two months. A total of fifteen species of insect pollinators were recorded. Species of the order Hymenoptera were the most abundant (91%), followed by those of Lepidoptera (6%) and Diptera (3%). The relative abundance of four *Apis* species, i.e. *Apis mellifera, A. dorsata, A. cerana* and *A. florea*, varied on hourly and weekly basis. The peak densities of all honeybee species were recorded at 12.00 pm and 02:00 pm while minimum densities were recorded at 08:00 am and 04:00 pm. *Apis mellifera* was the most recorded honeybee species compared to other *Apis* spp. during the study. In both fields the differences were significant.

Keywords: Flowering period, Pollinators, Hybrid seeds, Hymenoptera, Seed production

Introduction

Sunflower (*Helianthus annuus* L.) is an important cash crop which belongs to the family Asteraceae. Two seasons are very suitable for the production of sunflower in Pakistan: spring and summer (Shah *et al*., 2013). It is mainly cultivated for production of seeds. Sunflower is fourth in rank among oil-seed crops. Sunflower seeds are rich of essential fatty acids containing 49% oil. The seed meal formed after oil extraction contains proteins, minerals, carbohydrates and balanced amino acid profile (Nasir *et al*., 2011).

Insects play a major role in pollinating sunflower and increasing its yield. A total number of twenty insects from the orders Hymenoptera, Lepidoptera, Diptera, and Coleoptera visit sunflower. Species richness is high in Hymenoptera (two families) followed by Lepidoptera (four families), Coleoptera (three families), and one family from Diptera (Jadhav *et al*., 2011). The most frequent insect pollinators visiting sunflower are *Apis* bees. Among *Apis* bees *A. mellifera* is thought to be the most efficient pollinator. It increases the yield of sunflower compared to other *Apis* bees and other pollinators (Nderitu *et al*., 2008; Kumar *et al*., 2005).

Relative abundance of insect visitors to sunflower capitula reveals that *Apis* sp. constitutes 88.85% indicating the dominance of hymenopterans among sunflower pollinators (Jadhav *et al*., 2011). Honey bee pollination is, therefore, essential for the production of sunflower hybrid seeds. In earlier studies, it has been reported that seed yield and seed set are greatly increased due to pollination of honeybees (Tan *et al*., 2002). Oz *et al.* (2009) indicate that the use of honey bees for sunflower hybrid seed production improves seed set ratio, 100 seed weight, number of filled seed per head, and seed yield per head.

The flowering period of sunflower varies in different varieties and ranges from two to four weeks (Ion *et al*., 2007). In Pakistan, sunflower is cultivated over an area of 877,000 acre and the production is 473,000 tons seed (MINFAL. 2013).

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The present study was carried out to elucidate and document insect pollinator fauna, their diversity, and the relative abundance of four *Apis* species on sunflower in Swabi district, Khyber Pakhtunkhwa, Pakistan.

Material and Methods

The experiment was carried out in Swabi Khyber Pakhtunkhwa, North Western Pakistan. Two sunflower fields (120 m^2 each) with two kilometers apart were sown using randomised complete block design in April 2013. The hybrid variety Suncross was sown in the two fields of similar loamy soil. An apiary of 40 hives was present next to one of the fields studied. Each field was 30 x 4 m divided into three plots of 10 x 4 m. Row to row distance was 70 cm and plant to plant distance was kept at 25 cm. Weekly average temperature and relative humidity were also recorded. All recommended agronomic practices were applied.

Insect visitors/pollinators were collected from the two fields every two hours from 8:00 am until 4:00 pm. Weekly sampling was performed randomly across the two fields using sweeping net. Insect/bees loaded with pollen pellets on their legs were considered as pollen collectors while bees without pollen were considered as nectar foragers. For some species both pollen and nectar collector were observed. The collected insects/bees were identified following Ascher and Rasmussen (2010) while Vespidae species were identified using Khalid *et al.* (2012).

sThe relative abundance of four *Apis* species, *Apis mellifera*, *A. dorsata, A.cerana*, and *A. florea* was recorded weekly. Three m^2 areas were randomly selected in each field (1 m^2 for each plot). Observations were recorded during the first 10 min of each hour from 08:00 am to 04:00 pm using a stopwatch. Observations were conducted weekly throughout flowering season (from mid-June to mid-July). Relative abundance of bees was calculated to identify the most frequent bee species visiting the sunflower. For *Apis* species, one m^2 area was selected in each plot. The recorded data were subjected to statistical analysis (one-way ANOVA) using the software Statistix 8.1, and means were separated using LSD test at 0.05 significance level (Steel and Torrie, 1980).

Results

Observations have shown that sunflower crop was visited by different insects. The list of these insect pollinators/visitors is presented in Table 1. A total of 15 insect species belonging to three main orders *i.e.* Hymenoptera (three families, nine species), Lepidoptera (three families, four species) and Diptera (two families, two species) were recorded. Among the three orders, hymenopterans represents 91% of all the recorded species followed by Lepidoptera (6%) and Diptera (3%, Fig. 1). The relative abundance of each insect family on the tested sunflower fields is presented in Fig. 2. Family Apidae occupied the 1st rank (86.5 %) followed by Halictidae (3.8%) and Hesperiidae (2.3%), while Vespidae represented (0.7%) of all visitors/pollinators recorded.

Table 2 shows the relative abundance of four *Apis* spp. during four weeks in the first sunflower field. Significant differences were found among species and timings. During all four weeks *Apis mellifera* population was significantly higher followed by *Apis dorsata*, *Apis florea* and *Apis cerana*. At different observed timings (hours) the population density observed for all species varied significantly. At 08:00 am and 04:00 pm the recorded number of individuals of all fours species was significantly different compared to the other timings. The peaked abundance of species was remarkable at 12:00 pm during the 1st, 2nd and 3rd weeks.

Relative abundance of *Apis* species at the 2nd sunflower field is represented in Table 3. In the 2nd field the relative abundance of *A. mellifera* was significantly higher than the ones of other Apis species during all observed weeks. The relative abundance of *A. dorsata* was significantly higher than *A. florea* and *A. cerana* during all weeks. *Apis cerana*'s relative abundance was low in both fields. The peak abundance for this field of all four species was observed at 12:00 pm and 02:00 pm.

Discussion

In the present study 15 pollinators /visitors of sunflower were recorded. They belong to three insect orders: Hymenoptera, Lepidoptera and Diptera. Out of 15, nine species belong to Hymenoptera. Our results are similar to those of Jadhav *et al.* (2011) who observed nine Hymenopterans on sunflower. However, they recorded a total number of 24 insect visitors from four orders. Nderitu *et al.* (2008) observed 14 insect species visiting sunflower floral heads for Kenya. In another study Kasina *et al.* (2007) recorded 14 insect species belonging to four main orders *i.e.* Hymenoptera, Lepidoptera, Diptera and Coleoptera. No Coleopteran species was found in the present study, possibly due to location, time period, environment or the distribution of Coleopterans in the area. Moreti *et al.* (1996) also

Table 1. Sunflower insect pollinators/visitors on sunflower at Swabi, Pakistan during flowering season, 2013

Order	Family	Insect species	Foraging purpose
Hymenoptera	Apidae	*Apis mellifera*	Nectar and Pollen
		A. dorsata Fab.	
		A. florea Fab.	
		A. cerana Fab.	
		Xylocopa (*Koptortosoma*) *pubescens*	
		Ceratina (*Pithitis*) *smaragdula* Fab	
	Halictidae	*Halictus* (*Halictus*) *brunnescens*	
		Halictus (*Argalictus*) *senilis*	
	Vespiade	*Polistes* spp.	Nectar
Lepidoptera	Hesperiidae	*Pelopidas mathias*	Nectar
	Nymphalidae	*Hypolimnas misippus*	Nectar
		Junonia lemonias	
	Pieridae	*Pieris brassicae*.	
Diptera	Muscidae	*Rhynchomydaea* spp.	Nectar
	Syrphidae	*Phytomia* spp.	

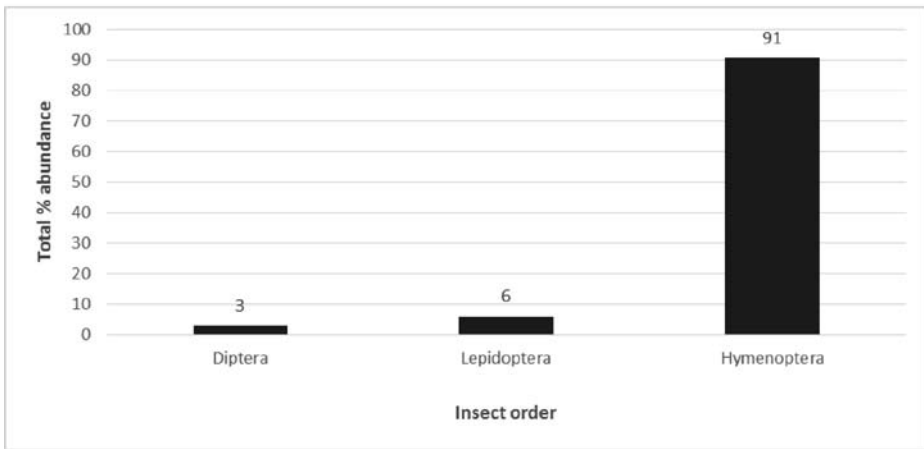

Fig. 1. Relative abundance (%) of sunflower pollinator insects orders at Swabi Pakistan during flowering season, 2013

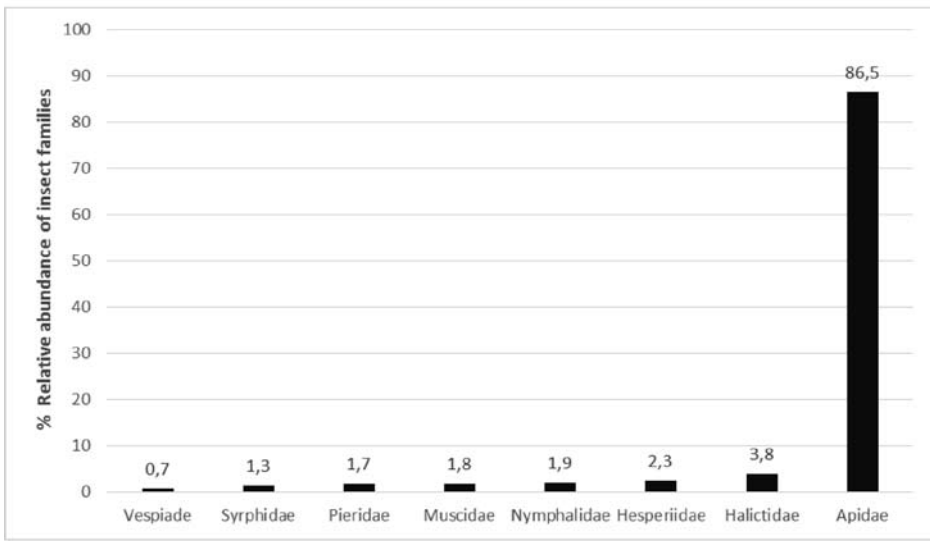

Fig.2. Relative abundance (%) of each insect family at Swabi Pakistan during flowering season, 2013

Table 2. Relative abundance of four *Apis* spp. at 1st sunflower field at Swabi, Pakistan, during flowering season, 2013

			Time of observation (Hours)						
Weeks	**Species**	**08:00am**	**10:00am**	**12:00pm**	**02:00pm**	**04:00pm**	**Mean**	**Temp**	**Humidity**
	Apis mellifera	35.4	47.1	50.9	43.5	33.6	42.1a		
1st	*A. florea*	12.2	15.3	18.4	16.1	8.4	14.1c	35 °C	50%
	A. dorsata	15.2	21.1	23.2	18.3	14.7	18.5b		
	A. cerana	4.3	10.4	14.3	11.3	5.2	9.1d		
	Mean	16.7c	23.4b	26.7a	22.3b	15.4c			
	A. mellifera	41.3	52.3	58.8	45.1	35.4	46.5a		
2nd	*A. florea*	13.1	17.3	22.7	19.4	10.9	16.6c	40 °C	48%
	A. dorsata	18.5	28.1	30.4	22.6	17.3	23.3b		
	A. cerana	5.3	12.8	19.2	17.8	8.6	12.7d		
	Mean	19.5c	27.6a	32.7a	26.2a	18.1c			
	A. mellifera	38.7	58.6	61.4	55.2	37.3	50.2a		
	A. florea	17.1	22.8	26.7	22.4	12.5	20.3c	38 °C	58%
3rd	*A. dorsata*	21.4	30.1	32.3	24.9	19.1	25.5b		
	A. cerana	7.3	k14.5	16.5	15.9	9.2	12.6d		
	Mean	21.1b	31.5a	34.2a	29.6a	19.5c			
	A. mellifera	32.4	48.8	43.4	45.6	31.7	40.3a		
	A. florea	14.8	19.4	20.1	18.2	10.3	16.5c	39 °C	60%
4th	*A. dorsata*	18.6	23.5	24.8	20.4	16.2	20.7b		
	A. cerana	5.6	13.1	11.3	13.5	8.8	10.4d		
	Mean	17.8c	26.2a	24.9a	24.4a	16.7c			

Standard error of a mean (Time/hours) 0.70 Standard error of a mean (Species) 0.78
Standard error (Time/hours) 1.00 Standard error (Comparison of two means) (Species) 1.10

* Means followed by the same letter in columns or rows are non-significant at 5% level of probability.

documented similar insect pollinators on sunflower. The present results are also very similar to those of Arya *et al.* (1994) who recorded 20 insect species on sunflower belonging to Hymenoptera (12 species), Lepidoptera (three species) and Diptera (five species). Ion *et al.* (2009) recorded insect visitors of sunflower in Romania mainly belonging to four insect orders: Hymenoptera, Lepidoptera, Diptera and Hemiptera.

Among all families, Apidae (Hymenoptera) was the most abundant with 86.5% tailed by Halictidae (3.8%). Our observations are very similar to the ones of **Guilherme** *et al.* (2002) who recorded 88.47% Apidae and 2.65% Halictidae. Similar observations were found by **Jadhav** *et al*. (2011) and **Satyanarayana** and Seetharam (1982) who recorded Apidae in high numbers. However, they showed that the relative abundance of *A. dorsata* was higher than that of other *Apis* species. They also did not record *A. florea* and *A. mellifera* specimens in their experiment. In our study *A. mellifera* was abundant visitor on sunflower, while *A. dorsata* was 2nd in rank followed by *A. florea* and *A. cerana*. The same authors did not record any species from family Halictidae. Dimitrov *et al.* (1992) found that *Apis* bees were efficient pollinators of sunflower. These findings were also confirmed by Nderitu *et al.* (2008).

The activity and density of *Apis* bees on sunflower were high at 12:00 pm to 02:00 pm in the tested fields. Mean numbers of *A. mellifera* had the highest relative abundance compared to other bee species. These findings were in line with Nderitu *et al.* (2008) who found that the relative abundance peak of *Apis* bees was at 12:00 pm. Schinohara *et al*. (1987) also concluded that *A. mellifera* were the most frequent bees mainly during the afternoon timings. Kasina *et al*. (2007) recorded the peaked density of *Apis* on sunflower between 10:00 am and 02:00 pm. Unlike our observations Kumar *et al.* (1994) recorded peak periods of *A. mellifera* between 09:00 am and 11:00 am in India. In the present study *A. mellifera* had high relative abundance followed by *A. dorsata*, *A. florea* and *A. cerana*. Kumar *et al*. (2005) also observed that *A. mellifera* was dominant visitor/pollinator on sunflower. They recorded maximum foraging activity at 11:00 am, which is partially matching our findings. The reason for the recorded differences may be the observation months: their study was carried out in January and February while our observations were done in June and July. Another

Table 3. Relative abundance of *Apis* spp. at 2nd sunflower field at Swabi, Pakistan, during flowering season, 2013

			Time of Observation (Hours)						
Weeks	**Species**	**08:00am**	**10:00am**	**12:00pm**	**02:00pm**	**04:00pm**	**Mean**	**Temp**	**Humidity**
	Apis mellifera	42.4	52.1	60.8	58.5	39.3	50.6a		
1st	*A. florea*	14.2	18.8	23.7	20.1	11.4	17.6c	36 °C	52%
	A. dorsata	18.2	26.7	31.4	29.9	19.5	25.1b		
	A. cerana	6.1	12.4	16.6	17.4	11.1	12.7d		
	Mean	20.2c	27.5a	33.1a	31.4a	20.3c			
	A. mellifera	38.7	46.3	59.4	61.2	42.6	49.6a		
2nd	*A. florea*	11.9	17.7	25.4	21.2	14.3	18.1c	41°C	46%
	A. dorsata	16.2	28.4	34.4	32.5	20.5	26.4b		
	A. cerana	7.3	11.6	18.1	15.2	9.1	12.2d		
	Mean	18.5c	26.0a	34.3a	32.5a	21.6c			
	A. mellifera	41.1	49.8	56.7	62.4	38.5	49.7a		
3rd	*A. florea*	9.2	11.3	15.1	16.2	12.3	12.8c	34 °C	56%
	A. dorsata	15.4	20.1	18.8	20.5	18.5	18.6b		
	A. cerana	6.4	9.8	11.1	9.2	8.7	9.0d		
	Mean	18.0c	22.7a	25.4a	27.0a	19.5c			
	A. mellifera	32.4	41.8	49.6	50.1	34.1	41.6a		
4th	*A. florea*	6.9	12.4	13.5	12.8	10.6	11.2c	39 °C	64%
	A. dorsata	12.4	18.7	19.1	14.3	10.2	14.9b		
	A. cerana	7.1	8.9	8.1	7.5	6.4	7.6d		
	Mean	14.7c	20.4c	22.5a	21.1b	15.3c			

Standard error of a mean (Time/hours) 0.93 Standard error of a mean (Species) 0.81
Standard error (Time/ hours) 1.32 Standard error (Comparison of two means) (Species) 1.14

* Means followed by the same letter in columns or rows are non-significant at 5% level of probability

inconsistency between our studies and the results of Kumar *et al.* (2005) was the relative abundance of *A. cerana*. The recorded abundance of *A. cerana* was higher compared to *A. dorsata* and *A. florea,* while in our findings *A. cerana* population was significantly less abundant than other *Apis* bees. This may be due to the distribution of *A. cerana* in the area, which is common in hilly areas in Pakistan and the experiment was conducted at plain areas where *A. dorsata* nests are frequently distributed.

Manoj *et al*. (2002) found higher relative abundance of *A. mellifera* compared to other *Apis* bees. Butignol (1984) also verified that *A. mellifera* were the predominant bees on the sunflower and were found in higher numbers than other collected insects.

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References

Arya D. R, R. C. Sihag, P. R. Yadav 1994. Diversity, abundance and foraging activity of insect pollinators of sunflower (*Helianthus annuus* L.) at Hissar (India). – *Indian Bee Journal.,* **56** (3/4): 172-178.

Ascher J. S., C. Rasmussen 2010.The bee fauna and pollination in Pakistan. Food and Agriculture Organization (UN), 59 p.

Butignol, C. A. 1984. Insetos polinizadores em capítulos de girassol em quatro horários e quatro estádios de florescimento. – In: Enc. Soc. Ent. Brasila., 79-80.

Dimitrov P., Z. Dimitrov, A. Piskov 1992. Study of bee pollinators (Hymenoptera, Apoidea) in the hybrid seed production of sunflower. – *Selskostopanska Nauka*, **30** (1-3): 22-26.

Jadhav A., K. Sreedevi., P. Rajendra Prasad 2011. Insect pollinator diversity and abundance in sunflower ecosystem. – *Current Biotica*, **5** (3): 344-350.

Guilherme J. P., Y. V. Terada, A. A. Toledo 2002. Behavior of *Apis mellifera* L. Africanized honeybees in sunflower (*Helianthus annuus* L.) and evaluation of *Apis mellifera* L. colony inside covered area of sunflower. – *Acta Scientiarum.,* **24** (4): 851-855.

Ion V., V. Stefan, I. Nicoleta 2007. Results on the flowering stage

in the Romanian-grown sunflower hybrids. – *Zootehnie si Biotehnologii*., **40 (2)**: 91-99.

Ion V., V. Stefan, N. Ion 2009. Necessity of pollination by *Melliferous* bees at Sunflower hybrids actually cultivated in Romania. – *USAMV Bucharest*, Series A, **2:** 338-343.

Kasina M., J. Nderitu, G. Nyamasyo, M. L. Oronje 2007. Sunflower pollinators in Kenya: Does diversity influence seed yield? – *African Crop Science Conference Proceedings*, **8**: 1149-1153

Khalid M., M. Ullah, A. Aziz, S. A. Hasan, M. Inayatullah. 2012. To the knowledge of Vespidae (Hymenoptera) of Pakistan. – *Zootaxa*, **3318**: 26-50

Kumar R., Chaudhary O. P., and J. K. Lenin 1994. Studies on the foraging behavior of honeybees and their role as pollinators of sunflower (*Helianthus annuus* L.). – *Indian Bee Journal,* **56**: 207-210.

Kumar N., R. Singh 2005. Relative abundance of *Apis* sp. on rabi season sunflower (Helianthus annus L.). – *Journal of Entomological Research*, **29 (1)**: 65-69.

Manoj K. C. Hari, S. Ramashrit, M.S Ali 2002. Effect of different modes of honeybee pollination on oil content in seeds of sunflower (*Helianthus annus* L.). *Journal of Entomological Reserach*, **26** (3): 219-221.

MINFAL 2011-2012. Economic Survey of Pakistan. Finance Division Economic Advisory Wing Islamabad Pakistan. p. 23.

Moreti A. C, Silva R. M. B, Silva E. C. A, Alves M. L. T., I. P. Otsuk 1996. Increase of sunflower (*Helianthus annuus* L.) seed production by pollinating insect action. – *Scientia Agricola*, **53** (2/3): 280-284.

Nderitu J., G. Nyamasyo, M. Kasina, M. L. Oronje 2008. Diversity of sunflower pollinators and their effect on seed yield in Makueni District, Eastern Kenya. – *Spanish Journal of Agricultural Research,* **6** (2): 271-278

Nisar, M. S. Hussain, Nausheen, N. Khan, M. S. Faheem 2011. Chemical composition of open pollinated and hybird population of sunflower (*Helianthus annuus* L.). – *Pakistan Journal of Botany*, **43(1):** 157-163.

Oz M., A. Karasu, I. Cakmak, A. T. Goksoy, Z. M. Turan 2009. Effects of honeybee (*Apis mellifera*) pollination on seed set in hybrid sunflower (*Helianthus annuus* L.) – *African Journal of Biotechnology*, **8** (6):1037-1043.

Satyanarayana A. R., A. Seetharam 1982. Studies on the method of hybrid seed production in oil seed sunflower (*Helianthus annuus* L.) 3. Role and activity of insect visitors in pollination and seed set. – *Seed Science and Technology,* **10**: 13-17.

Schinohara R. K. 1987. Importancia da polinizaçao entomofila na cultura do girassol. – *Zootecnia, São Paulo*, **25** (3): 275-287.

Shah N. A., K. M. Aujla, M. Ishaq, A. Farooq 2013. Trends in sunflower production and its potential in increasing domestic edible oil production in Punjab, Pakistan. – *Sarhad Journal of Agriculture*, **29** (1): 7-13.

Steel R. G. D., J. H. Torrie 1980. Principals and procedures of statistics: A biological approach. 2nd Ed. McGraw Hill Book Co. New York, p. 481.

Tan A. S, A. I Ozturk, U. Karaca 2002. Effect of honeybee pollination on seed yield and quality of sunflower. – *Anadolu University Science Journal,* **12** (1): 1-26.

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