Cercetări Agronomice în Moldova
Vol. XLVI , No. 2 (154) / 2013

POLLINATOR FAUNA OF SESAME CROP (*SESAMUM INDICUM* L.) IN ISMAILIA GOVERNORATE, EGYPT

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Received December 25, 2012

ABSTRACT. A survey of insect pollinators associated with sesame, *Sesamun indicum* L. (*Pedaliaceae*), was conducted at the Agriculture Research Farm, Faculty of Agriculture, University of Suez Canal during the growing seasons of 2011 and 2012. All different insect pollinators which found on the experimental site were collected for identification. Sampling was done once a week and three times a day. Three methods were used to collect and identify insects from the sesame plants (a sweep net, pitfall traps, digital camera and eye observation). A total of 29 insect species were collected and properly identified during the survey. Insect pollinators which recorded on the plants were divided into four groups, 18 belonged to *Hymenoptera*, seven to *Diptera*, three to *Lepidoptera* and one to *Coleoptera*. Results revealed that honey-bee, *Apis mellifera*, was the most dominant species in the 2011 season and the second one in the 2012 season. Whereas small carpenter bees, *Ceratina tarsata* was the most dominant species in the 2012 season and the second one in the 2011 season. The percentage of *Hymenoptera* was higher in the two studied seasons by 90.94% and 89.59%, followed by *Diptera* by 3.93% and 5.38%, then *Lepidoptera* by 3.58% and 3.62, and in the last *Coleoptera* by 1.53% and 1.39%, respectively.

Key words: Sesame; Insect pollinators; Relative abundance; Population dynamics.

INTRODUCTION

Sesame (*Sesamum indicum* L.) is one of the important oilseed crops in many tropical and sub-tropical regions in the world. It is perhaps one of the oldest crops cultivated by man, having been grown in the Near East and Africa for more than 5000 years for cooking and medicinal needs (Dudley *et al*., 2000).

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About 7.8 million hectares of the total world crop area are under sesame cultivation (Faostat, 2012). Sesame ranks sixth in the world among vegetable oils. Out of the 3.83 million tons of sesame produced in the world, Asia and Africa account for 2.29 and 1.38 million tons, respectively. Myanmar is the first producer of sesame in the world, followed by India, China, Ethiopia, Sudan, Uganda, Nigeria, Bangladesh, Egypt and Pakistan (Faostat, 2012).

In Egypt, sesame is considering a food crop rather than oilseed crops because most of its seeds consumed directly. It is grown in many Governorates, and ranks first among the cultivated oil crops in Ismailia Gov. (El-Bramawy, 2006). Total area under sesame production in Egypt has increased from 4.730 feddan in 1961 to 15.500 by 2010 and the productivity increased from 481.19 kg/feddan in 2005 to 525.12 kg/feddan in 2010 (Faostat, 2012).

Co-evolution of flowering plants and their pollinators started about 225 million years ago (Price, 1975; Maiti and Maiti, 2011). Insufficient number of suitable pollinators causes decline in fruit and seed production (Partap, 2001). Of the total pollination activities, over 80% is performed by insects and bees contribute nearly 80% of the total insect pollination, and therefore, they are considered the best pollinators (Robinson and Morse, 1989). Sesame's blossom structure facilitates cross-pollination, even though the crop is usually viewed as self-pollinating. The rate of cross-pollination lies between 0.5% and 65% depending on insect activity, environmental conditions and availability of other vegetation (Kumar and Lenin, 2000). Ashri (2007) reported that the cross pollination rates were between 2.7 and 51.7% in Nigeria. The present investigation was undertaken with the following objectives:

1. To collect and identify the pollinator fauna of sesame.

2. To study the population dynamics and relative abundance of insect pollinators through the growing seasons of sesame crop.

MATERIALS AND METHODS

Experimental place and design

This experiment was carried out at the Experimental Farm, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt. Sesame crop was sawn at May 31, 2011 and June 04, 2012. Local culture practices were used during the time of experiments except the studied treatments. The land used measuring about 3/4 feddan was divided into 39 plots of 8 × 2.4 m each, six rows in each plot with 40 cm spacing between rows and 30 cm between plants. Seeds of cultivar of sesame namely (Shandawil 3) were purchased from the Agriculture Research Center, Giza. These seeds were treated with Rizolex-T (3 g/kg seeds) before planting to prevent rot infection.

Collection and identification of pollinators visiting sesame flowers

Plants were observed weekly at three times on day (early morning – afternoon – before evening), during the flowering period (6-7 weeks) for collection and identification the different of insect pests. Three methods were used to collect insect pollinators from the

sesame plants (A sweep net measuring 40 cm in diameter was used to collect insects flying over the plots, pan traps containing 4% formalin solution were used to trap insects walking on the floor and eye observation and digital camera were used to clear and settled insect pollinators). Observations of pollinators visiting sesame flowers were recorded whenever possible before specimens were collected and preserved for identification. The collected pollinators were killed in a cyanor bottle and transferred to the laboratory. The large insects were pinned, labeled and preserved in the collection box. The smaller insects were mounted, labeled and preserved too. Insects were identified to species when possible through the use of published systematic keys and direct comparisons with museum specimens housed at the Department of Plant Protection, Ismailia. Data were recorded for pollinators belonging to different insect orders.

Population dynamics and relative abundance patterns

Population dynamic and attendance of different pollinators was recorded throughout the flowering period. A sweep net of 40 cm radius was used to collect the pollinating insects at three different times in the day (early morning – afternoon – before evening) by walking slowly and diagonally. Ten sweeps per plot were taken to check and record the number of pollinators during the seven weeks of flowering period.

Meteorological data at the time of experiment

The weather data, namely temperature, relative humidity were recorded during the flowering period of sesame in the two growing seasons (http://www.tutiempo.net/en/Climate/ISMAILIA).

RESULTS AND DISCUSSION

As many as 29 species of insect pollinators were recorded on sesame crop during 2011 and 2012 growing seasons, of these 18 belonging to *Hymenoptera*, seven to *Diptera*, three to *Lepidoptera* and one to *Coleoptera* orders (*Table 1*). Hymenopteras fauna (true pollinators) was divided to 10 species belonging to bees, and eight species belonging to wasps and ants. The ten species of bees was five belonging to Family *Apidae*, three to *Megachilidae*, one to *Anthophoridae* and one to *Halictidae*. While, both of wasps and ants was two belonging to Family *Formicidae*, one to *Crabronidae*, one to *Eumenidae*, one to *Scoliidae*, one to *Ichneumonidae*, one to *Vespidae* and one to *Sphecidae*.

Also, other pollinators found in association with sesame plants during the two successive seasons 2011 and 2012 were *Diptera, Lepidoptera* and *Coleoptera*. The list of *Diptera* pollinators that visited sesame flowers was seven species; two belonging to Family *Muscida*e, two to *Sarcophagidae*, two to *Syrphidae* and one to *Calliphoridae*. Three species of Lepidopterans fauna were collected during this study; one belonging to *Nymphalidae*, one to *Peridae* and one to *Lycanidae*. Finally, Coleopterans fauna recorded only specie from Family *Coccinellidae*. Moreover, data presented in *Table 1* showed that all specimens involved in being pollinators (pollinator – visitor) or (medical – pollinator) or (destructive - pollinator) or (parasitoide – pollinator) or (predator - pollinator) or cleptoparasite – pollinator).

Table 1 - Pollinator fauna of sesame in the growing season 2011 and 2012

No.	Order	Family	Common name	Scientific name	Specimen
1	*Hymenoptera*	*Apidae*	Honey bee	*Apis mellifera* L.	Pollinator, Visitor
		Apidae	Large carpenter bee	*Xylocopa pubescens* Spinola	Pollinator, Visitor
		Apidae	Small carpenter bee	*Ceratina tarsata* Morawitz	Pollinator, Visitor
		Apidae	Blue-banded bee	*Amegilla* spp.	Pollinator, Visitor
		Apidae	Cuckoo bee	*Thyreus hyalinatus* (Vachal)	Cleptoparasite, pollinator,visitor
		Megachilidae	Mason bee	*Osmia* spp.	Pollinator, Visitor
		Megachilidae	Leafcutter bee	*Megachile* spp.	Pollinator, Visitor
		Megachilidae	Wool-Carder bee	*Anthidium* spp.	Pollinator, Visitor
		Anthophoridae	Mining bee	*Anthophora albigena* Priesner	Pollinator, Visitor
		Halictidae	Nomia bee	*Nomia* spp.	Pollinator, Visitor
		Sphecidae	Sand wasp	*Bembix priesneri* Priesner	Pollinator, Visitor
		Crabronidae	Beewolf wasp	*Philanthus triangulum abdelkader*	Pollinator, Visitor
		Eumenidae	Potter wasp	*Eumenes maxillosus* (De Geer)	Pollinator, Visitor
		Scoliidae	Digger wasp	*Dielis collaris* (Fabr.)	Pollinator, Visitor
		Vespidae	Yellow wasp	*Polistes gallicus* (L.)	Pollinator, Visitor
		Formicidae	Desert dwelling ant	*Cataglyphis bicolor* Fabricius	Pollinator, Visitor
		Formicidae	Wood ant	*Formica* sp.	Pollinator, Visitor
		Ichneumonidae	Scorpion wasp	*Diadegma* sp.	Parasitoide, pollinator, visitor
2	*Diptera*	*Muscidae*	House fly	*Musca domestica* L.	Medical, Pollinator
		Muscidae	Little-House fly	*Fannia canicularis* (L.)	Medical, Pollinator
		Sarcophagidae	Flesh fly	*Sarcophaga* sp.	Medical, Pollinator
		Sarcophagidae	Flesh fly	*Wohlfahrtia* sp.	Medical, Pollinator
		Calliphoridae	Blow fly	LUCILIA SERICATA (Meigen)	Medical, Pollinator
		Syrphidae	Hover fly	*Syrphus* sp	Predator, Pollinator
		Syrphidae	Drone fly	*Eristalis* sp.	Pollinator, visitor
3	*Lepidoptera*	*Peridae*	Cabbage butterfly	*Pieris rapae* L.	Destructive, Pollinator
		Nymphalidae	Monarch butterfly	*Danaus Chrysippus* L.	Destructive, Pollinator
		Lycaenidae	Bean butterfly	*Cosmolyce baeticus* L.	Destructive, Pollinator
4	*Coleoptera*	*Coccinellidae*	Lady beetle	*Coccinella undecimpunetata* L	Pollinator, Predator

Table 2 - Number of insect pollinators during the seven weeks of sesame flowering in the growing season of 2011 and 2012 with the references to temperature, relative humidity and wind speed recorded in the flowering period

Insect pollinators	1st week		2nd week		3rd week		4th week		5th week		6th week		7th week		Total	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Apis mellifera L.	30	15	61	27	109	53	111	66	89	73	71	34	17	13	488	281
Xylocopa pubescens Spinola	10	5	21	23	27	35	42	47	43	30	35	21	21	17	199	178
Osmia spp.	18	9	43	17	61	33	77	41	45	32	31	22	25	9	300	163
Megachile spp.	17	6	29	13	42	27	40	39	32	29	21	18	19	6	200	138
Anthidium spp.	3	0	11	5	17	11	20	17	14	20	9	9	2	2	76	64
Anthophora albigena Priesner	5	1	12	10	20	13	17	27	15	21	11	11	8	3	88	86
Ceratina tarsata Morawitz	27	21	53	38	87	56	83	78	61	79	53	39	37	17	401	328
Nomia spp.	1	0	3	0	3	0	7	5	9	8	5	3	3	2	31	18
Amegilla spp.	3	0	17	0	17	5	20	11	13	14	14	8	6	4	90	42
Thyreus hyalinatus (Vachal)	25	10	38	21	55	34	47	45	45	41	36	30	30	9	276	190
Bembix priesneri Priesner	14	0	9	7	23	17	27	13	25	12	21	5	13	1	132	55
Philanthus abdelkader	2	2	5	8	7	15	6	17	3	9	2	6	2	4	28	61
Eumenes maxillosus (De Geer)	4	0	10	0	14	8	11	11	11	15	13	7	11	5	74	46
Dielis collaris (Fabr.)	28	10	45	13	70	17	60	22	62	33	53	27	31	25	349	147
Polistes gallicus (L.)	0	0	4	7	5	7	5	7	4	5	5	4	6	1	29	31
Cataglyphis bicolor Fabricius	3	1	8	5	6	9	4	10	5	10	5	11	2	7	33	53
Formica sp.	0	0	4	0	8	3	11	8	2	7	3	10	3	7	31	35
Diadegma sp.	0	0	0	0	4	3	5	3	4	5	1	0	2	2	16	13
Musca domestica L.	4	8	5	5	5	6	1	7	2	4	4	7	4	3	25	40
Fannia canicularis (L.)	2	2	2	4	6	1	3	2	6	4	5	5	5	3	29	21

Insect pollinators	1st week		2nd week		3rd week		4th week		5th week		6th week		7th week		Total	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Sarcophaga sp.	0	0	2	0	0	2	3	2	1	4	2	3	2	2	10	13
Wohlfahrtia sp.	1	2	0	1	0	2	2	0	1	0	3	3	0	2	7	10
Lucilia Sericata (Meigen)	0	0	0	0	2	0	4	2	3	2	2	3	4	0	15	7
Syrphus sp	3	0	2	1	1	1	5	4	3	1	2	0	4	2	20	10
Eristalis sp.	3	3	3	0	2	0	2	4	4	2	3	3	0	3	17	15
Pieris rapae L.	2	2	7	0	5	3	1	2	1	1	1	2	0	0	16	10
Danaus Chrysippus L.	8	2	11	4	13	5	9	3	6	7	3	1	2	3	52	25
Cosmolyce baeticus L.	0	3	5	9	5	10	11	8	7	5	9	5	7	3	44	43
Coccinella undecimpunetata L	4	0	5	5	10	5	8	3	8	6	9	8	4	3	48	30
Temperature ºC	**29.5**	**30.4**	**29.3**	**30.6**	**29.7**	**32.7**	**28.8**	**28.4**	**29.6**	**30.6**	**28.4**	**29.7**	**29.3**	**29.7**	-	-
Relative humidity (RH, %)	**52**	**61**	**59**	**61**	**63**	**48**	**63**	**63**	**50**	**49**	**55**	**60**	**54**	**50**	-	-

Population dynamics of insect pollinators in collections out of seventh weeks of flowering period through the growing season of 2011 and 2012 is presented in *Table 2*. Data revealed that the types as well as the number of insect visitors changed with time during the flowering span of the sesame crop. Insect pollinators increased by increasing the percentage of flowers. A great majority of the sesame flowered between third and fifth week. The flowering lasted 42-50 days and this period was remarkably constant from year to year. Most pollinators were recorded when the number of flowers per plant was maximum (at the fourth week of flowering). Also, population of pollinators decreased with diminishing of flowers per plant due to advancing age of the crops. It is observed that all numbers of insect pollinator collected in 2012 season were lower than 2011 season. This result may due to increasing the mean of temperature through the seventh week of flowering (period of insect pollinators activity). The ration (%) of pollinator species in collections out of total number of sampled specimens in 2011 and 2012 is presented in *Table 3*. Honey-bee, *Apis mellifera,* was the most dominant species in the 2011 season, constituting 15.61% and the second one in the 2012 season, constituting 13.05% of the total pollinators. Whereas small carpenter bees, *Ceratina tarsata,* was the most dominant species in the 2012 season, constituting 15.23% and the second one in the 2011 season, constituting 12.82 % of the total pollinators. The Digger wasp, *Dielis collaris,* was the most abundance wasp species with a total number of 349 wasps, constituting 11.16% of the total pollinators in the first season and 147 wasps, constituting 6.82% in the second one. Also, results from *Table 4 and 5* revealed that four groups of pollinators visited the sesame belonging to order *Hymenoptera, Diptera, Lepidoptera* and *Coleoptera* of class *Insecta,* during the flowering period. The percentage of *Hymenoptera* was higher in the two studied seasons by 90.94% and 89.59%, followed by *Diptera* by 3.93% and 5.38 %, then *Lepidoptera* by 3.58% and 3.62, and in the last *Coleoptera* by 1.53% and 1.39%, respectively.

Investigations carried out on the pollinator fauna (*Hymenoptera* and others) revealed that four groups of pollinators visited the sesame belonging to order *Hymenoptera, Diptera, Lepidoptera* and *Coleoptera* of class *Insecta,* during the flowering period. Insect pollinators observed belonging different insect families, of which Hymenopterans (18 species) were the most abundant group, followed by Dipterans (seven species), Lepidopterans (three species), and Coleopterans (one species). These findings are in close agreement with Viraktmath *et al.,* (2001), who studied the relative abundance of pollinator fauna of sesame during two successive seasons. 29 insect species recorded, 15 belonged to *Hymenoptera*, eight to *Diptera* and six to *Lepidoptera*. Also, Kamel (1997) reported nine species of Hymenopterans as predominant visitors of sesame flowers.

Table 3 - Relative abundance percentage of insect pollinators during the growing season of 2011 and 2012 in sesame crop

No	Insect pollinators (2011 and 2012)	Relative abundance (%)		Orders	
		2011	2012	2011	2012
1	*Apis mellifera* L.	15.61	13.05	*Hymenoptera* 90.94%	*Hymenoptera* 89.59%
2	*Xylocopa pubescens* Spinola	6.36	8.26		
3	*Osmia* spp.	9.59	7.57		
4	*Megachile* spp.	6.39	6.40		
5	*Anthidium* spp.	2.39	2.97		
6	*Anthophora albigena* Priesner	2.81	3.99		
7	*Ceratina tarsata* Morawitz	12.82	15.23		
8	*Nomia* spp.	0.99	0.83		
9	*Amegilla* spp.	2.87	1.95		
10	*Thyreus hyalinatus* (Vachal)	8.82	8.82		
11	*Bembix priesneri* Priesner	4.22	2.55		
12	*Philanthus triangulum abdelkader*	0.89	2.83		
13	*Eumenes maxillosus* (De Geer)	2.36	2.13		
14	*Dielis collaris* (Fabr.)	11.16	6.82		
15	*Polistes gallicus* (L.)	0.92	1.43		
16	*Cataglyphis bicolor* Fabricius	1.05	1.68		
17	*Formica* sp.	0.99	1.11		
18	*Diadegma* sp.	0.51	0.60		
19	*Musca domestica* L.	0.79	1.85	*Diptera* 3.93%	*Diptera* 5.38%
20	*Fannia canicularis* (L.)	0.92	0.97		
21	*Sarcophaga* sp.	0.31	0.60		
22	*Wohlfahrtia* sp.	0.22	0.46		
23	Lucilia Sericata (Meigen)	0.47	0.32		
24	*Syrphus* sp	0.63	0.46		
25	*Eristalis* sp.	0.54	0.69		
26	*Pieris rapae* L.	0.51	0.46	*Lepidoptera* 3.58%	*Lepidoptera* 3.62%
27	*Danaus Chrysippus* L.	1.66	1.16		
28	*Cosmolyce baeticus* L.	1.40	1.99		
29	*Coccinella undecimpunetata* L	1.53	1.39	*Coleoptera* 1.53%	*Coleoptera* 1.39%

Table 4 - Relative abundance percentage of insect pollinators during the growing season of 2011 in sesame

No	Insect pollinators	Relative abundance (%)	Orders
1	*Apis mellifera* L.	15.61	
2	*Xylocopa pubescens* Spinola	6.36	
3	*Osmia* spp.	9.59	
4	*Megachile* spp.	6.39	
5	*Anthidium* spp.	2.39	
6	*Anthophora albigena* Priesner	2.81	
7	*Ceratina tarsata* Morawitz	12.82	
8	*Nomia* spp.	0.99	
9	*Amegilla* spp.	2.87	*Hymenoptera* 90.94%
10	*Thyreus hyalinatus* (Vachal)	8.82	
11	*Bembix priesneri* Priesner	4.22	
12	*Philanthus triangulum abdelkader*	0.89	
13	*Eumenes maxillosus* (De Geer)	2.36	
14	*Dielis collaris* (Fabr.)	11.16	
15	*Polistes gallicus* (L.)	0.92	
16	*Cataglyphis bicolor* Fabricius	1.05	
17	*Formica* sp.	0.99	
18	*Diadegma* sp.	0.51	
19	*Musca domestica* L.	0.79	
20	*Fannia canicularis* (L.)	0.92	
21	*Sarcophaga* sp.	0.31	
22	*Wohlfahrtia* sp.	0.22	*Diptera* 3.93%
23	Lucilia Sericata (Meigen)	0.47	
24	*Syrphus* sp	0.63	
25	*Eristalis* sp.	0.54	
26	*Pieris rapae* L.	0.51	
27	*Danaus Chrysippus* L.	1.66	*Lepidoptera* 3.58%
28	*Cosmolyce baeticus* L.	1.40	
29	*Coccinella undecimpunetata* L	1.53	*Coleoptera* 1.53%

Table 5 - Relative abundance percentage of insect pollinators during the growing season of 2012 in sesame

No	Insect pollinators	Relative abundance (%)	Orders
1	*Apis mellifera* L.	13.05	
2	*Xylocopa pubescens* Spinola	8.26	
3	*Osmia* spp.	7.57	
4	*Megachile* spp.	6.40	
5	*Anthidium* spp.	2.97	
6	*Anthophora albigena* Priesner	3.99	
7	*Ceratina tarsata* Morawitz	15.23	
8	*Nomia* spp.	0.83	
9	*Amegilla* spp.	1.95	*Hymenoptera* 89.59%
10	*Thyreus hyalinatus* (Vachal)	8.82	
11	*Bembix priesneri* Priesner	2.55	
12	*Philanthus triangulum abdelkader*	2.83	
13	*Eumenes maxillosus* (De Geer)	2.13	
14	*Dielis collaris* (Fabr.)	6.82	
15	*Polistes gallicus* (L.)	1.43	
16	*Cataglyphis bicolor* (Fabr.)	1.68	
17	*Formica* sp.	1.11	
18	*Diadegma* sp.	0.60	
19	*Musca domestica* L.	1.85	
20	*Fannia canicularis* (L.)	0.97	
21	*Sarcophaga* sp.	0.60	
22	*Wohlfahrtia* sp.	0.46	*Diptera* 5.38%
23	Lucilia Sericata (Meigen)	0.32	
24	*Syrphus* sp	0.46	
25	*Eristalis* sp.	0.69	
26	*Pieris rapae* L.	0.46	
27	*Danaus Chrysippus* L.	1.16	*Lepidoptera* 3.62%
28	*Cosmolyce baeticus* L.	1.99	
29	*Coccinella undecimpunetata* L	1.39	*Coleoptera* 1.39%

These results were in agreement with (Kamel 1997), who stated that sand wasps and digger wasps are the most abundant insects visiting sesame flowers. *A. mellifera* comprised 30 and 32% of the foraging population on sesame crops in Egypt where species of *Megachile, Polistes,* and *Eristalis* were also important (Rashad *et al*., 1979).

Insect pollinators are mostly abundant on the sesame flowers between 11.00-1.00 pm and 1.00-3.00 pm. This is because nectar flow is copious in the sesame crop especially in the middle period of the day; there

after the nectar concentration gradually diminishes.

It should be noted that bees visit sesame flowers for nectar and pollen, but wasps, ants, flies, butterflies and lady beetles visit flowers for feeding on nectar only or waiting for their preys or feeding on different parts of sesame and sometimes just for resting.

Sesame is considered a self-pollinated crop; but this is mainly because pollinating insects prefer flowers of other species if available (Ashri, 2007). Where insect activity is high, out-crossing can reach high level, but cross-pollination is under 1% when sesame is surrounded by other flowering crops. In Moreno, California, as high as 68% out-crossing was registered in fields where sesame was the only flowering plant in a semi arid area with minimal other vegetation.

CONCLUSIONS

Crop pollination studies are rare compared to those of non-crop plants, especially in Africa in comparison to developed countries. In Egypt, for example, only a few studies have been done on crop pollination requirements and for a very small number of crops. Hence, there is a need to improve the knowledge about pollination requirements of crops and not only to rely on information from studies done elsewhere in the world, as they may not be applicable in Egypt. This depends on more study should be carried out in the future to study the pollinator fauna of other crops, plants, trees as well. However, we should wondering about the impact of climate change on the pollinator fauna and agriculture ecosystem.

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