Major pollen sources for honey bee colonies in desert Toshka region, Egypt

N. S.Omran[1], A. G. Abdel Rahman[2], A. S.S.Desoky[1]and M.M.H.Kelany[2*]
[1]Plant Protection Department, Faculty of Agriculture, Sohag University, Sohag, Egypt.
[2]Plant Protection Department, Desert Research Centre, Al Matrya, Cairo, Egypt.

Keywords:
Pollen; bee bread; Honey bee;
Desert; Toshka.

Abstract:

Toshka is a desert region of newly reclaimed lands has not been evaluated for beekeeping activities. The present was designed to evaluate the area for the major plant sources of pollen, which is the main source of protein for honeybee. To identify pollen plant sources needed for honeybee colonies throughout the year, four colonies of an equal strength were collected for the present study. Samples of pollen grains were collected from the surrounding plants and used as references to identify the pollen plant sources. Meantime samples of bee bread were collected from the tested colonies every month and microscopically examined and analyzed then the plant sources were identified. The results showed that there were 18 plant sources throughout the year belong to 11 plant families. The family Cucurbitaceae was the most common, which was represented by four plants, followed by both Asteraceae and Fabaceae with three plants each and the others families with one plant only. Spring and April which is the most months of the number of pollen plant sources with seven plants. The summer and June were the lowest in the number of plants with only two plants. The study showed significant differences in the percentages of pollen presence between different pollen grains and time. There were no significant differences in the percentages of pollen presence between both sunflower and fababean, but there were significant differences between sunflower and other plants.

.

Introduction

Toshka is a desert region and newly reclaimed lands with a lack pollen sources for honeybee beekeeping. Honeybees play an important ecological role as pollinators of many plant species (Suwannnapong, *et al*., 2012) Pollen is the main source of protein for all honeybee colonies (Zerbo*et al*., 2001), pollen contain proteins, vitamins, carbohydrates and

fats. Lacking of pollen sources effecting on the brood production and workers mortality (Huang, 2012), and pollens are important during wax cell sealing, as workers mix beeswax with pollens to allow pupal respiration through cell cap and honey bee colonies should have high brood rearing activity during autumn to be able to survive during winter(Abou-shaara, 2015a). By increasing beekeeping activity, it is important to detect the main pollen sources of a region and their values to bee colonies and to pollen production (Andrada and Telleria, 2005).Bee bread is the pollen pellets which the foragers collected from flowers and stored in comb cells. It is mixed with honey and secretion from workers (Herbert and Shimanuki, 1978). Honey bee colonies existed in newly reclaimed lands could suffer greatly during autumn from the shortage of pollen sources and could have low brood production as have been found in desert conditions in Jordanby Al-Ghzawi*et al*. (2001) also, (Zaitoun and Vorwohl, 2003) found that in Jordanian desert region only three plants as pollen sources during September to December. High temperature has already become a noticeable environmental factor for crop production, while plant pollen was the most sensitive organ to high-temperature stress (Lu*et al*.,2009). It is very useful for beekeepers to identifying honey bee plants in specific region and their potential benefit to honey bee colonies as source of pollen, nectar (Abou-Shaara, 2015b). In Fayoum Governorate there are 24 plant species of 16 botanical families from which bees collected pollen (Ismail *et al*., 2013). Map of nectar and pollen sources will help beekeepers to plan for managing their colonies, to move to another area rich with pollen sources (Taha, 2005). Arecaceae, Asteraceae, Fabaceae, Malvaceae, Poaceae and Rubiaceae were among the most important families for the honeybees (Carvalho*et al*., 1999 and Ramalho *et al*., 2007). The present investigation was designed to study to identify the major pollen plant sources and determine the favorite plants to honeybee in Toshka region because no data about the bee pollen sources in this region.

Material and methods

Study area:

The study was carried out in Toshka Research Station, Desert Research Center in Toshka region{(22° 47' 27, 31'N/ 31° 53' 92, 38'E)} (Fig.1), south Egypt from January 2016 till December 2016. The Toshka region is desert lands and the beekeeping is new in this region.

Fig.1: Location of the Toshka Research Station in Egypt

Reference of flowering plants:

A survey of all flowering plants species which observed to be visited by honeybee workers in the Toshka Research Station every month throughout the year then pollen samples collected from these plants used as reference samples to facilitate the identification of bee bread samples collected from bee colonies under microscope.

The Samples:

Four colonies (each of 8 combs) of hybrid Carniolan honeybees, *Apis mellifera carnica* were used in this experiment. All colonies were equalized to be in the same strength. Four samples of bee bread were randomly collected from each colony every month, and were put in Ependorf tubes (total of 16 samples/collection time, and 192 samples were examined during the study period).

Slides of collected bee bread samples were prepared for the microscopic analysis using glycerin as a mounting. The microscopic inspection was done using microscope (The Biolar microscope of the PZO, Poland)at 40X.

Statistical analysis

Data of pollen collection were statistically analyzed by ANOVA using SAS 9.1.3 software computer program (SAS Institute, 2005). The means were compared by Duncan's Multiple Range Test.

Results and discussion

Table (1) showed the number of sources of the major plants as pollen sourcesin the region, which are 18 plants and belong to 11 families of plants. Family Cucurbitaceae had four major plants, followed by both families Asteraceae and Fabaceae with three plants each; while the other families had only one plant. The largest number of plants is in April

with 7 plant species and the lowest was in June with only two plants. Spring months were generally regarded as the best months, second in winter, then in fall, and the lowest in plant species was during the summer season, for high temperatures in the Toshka region. According to Carvalho*et al*., 1999 and Ramalho *et al*., 2007 Fabaceae, Asteraceae, Malvaceae and Poaceae are the most important families for honeybee.

Data in Table (2) showed significant differences between some types of pollen and time. It also showed the absence of significant differences between the months and some. In same above Table (2) there were no significant differences found between pollen of sunflower and fababean. But, there were significant differences between sunflower and all other pollen species. There were no significant differences between the fababean and conocarpus, watermelon, leucaena and melon. There were also significant differences between fababean and the pollen of the plants of Egyptian henbane, jaffa groundsel, sesame, coriander, bermuda grass, corn, cucumber, sweet clover, sonchus, Squash plant and Cotton.

Also, there were no significant differences between the conocarpus, melon, leucaena, melon, Egyptian henbane, rocket, jaffa groundsel and sesame.

Table (1) Periods of pollen grains appearance for different plant species which were observed in bee bread samples in Toshka region throughout 2016.

	Plants	Family	Scientific name	Spring			Summer			Autumn			Winter		
				Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Filed crops	Faba bean	Fabaceae	*Viciafaba L.*	■	■									■	■
	Sunflower	Asteraceae	*Helianthus annuus L*			■	■	■							
	Sesame	Pedaliaceae	*Sesamumindicum*				■	■							
	Corn	Poaceae	*Zea mays L.*								■	■	■		
	Cotton	Malvaceae	*Gossypiumbarbadense*							■	■				
Horticulture crops	Vegetable.														
	Rocket	Brassicaceae	*Eruca sativa Mill.*						■	■			■	■	■
	Cucumber	Cucurbitaceae	*Cucumissativus*	■	■	■					■	■	■		
	Squash plant	Cucurbitaceae	*Cucubitapepo*											■	
	Watermelon	Cucurbitaceae	*Citrulluslanatus*						■	■	■		■		
	Melon	Cucurbitaceae	*Cucumismelo*			■		■	■	■					■
	Medical plant														
	Coriander	Apiaceae	*Coriandrumsativum L.*											■	■
	Egyptian henbane	Solanaceae	*Hyoscyamusmuticus*		■	■				■	■				■
Wild plants	Sweet clover	Fabaceae	*MelilotussiculusTurra*	■	■										
	Jaffa groundsel	Asteraceae	*Senecioglaucus*	■	■	■									
	Sonchus	Asteraceae	*Sonchusoleraceas L.*		■										
	Bermuda grass	Gramineae	*Cynodondactylon*										■		
Trees	Leucaena	Fabaceae	*Leucaenaleucocephala*	■	■	■					■	■			■
	Conocarpus	Combretaceae	*Conocarpuslancifolius*		■						■				

Table (2) Means percentages of pollen presence for the majorplant species in bee bread samples in Toshka region throughout 2016.

Month	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	G-Mean

Plant	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D	
Faba bean	**37.5±14.44**	**25±20.41**	**62.5±43.31**	**18.75±23.94**									**11.979AB**
Sunflower					**37.5±32.28**	**81.25±23.9**	**56.25±31.4**					**12.5±25**	**15.625 A**
Sesame						**18.75±23.9**	**31.25±37.5**						**4.167 DEFG**
Corn									**6.25±12.5**	**6.25±12.5**	**12.5±14.44**	**12.5±14.44**	**3.125 EFG**
Cotton									**6.25±12.5**				**0.521 G**
Rocket	**12.5±25**	**50±35.36**						**12.5±14.44**				**6.25±12.5**	**6.771 CDE**
Cucumber			**6.25±12.5**	**6.25±12.5**						**6.25±12.5**	**6.25±12.5**	**6.25**	**2.604 EFG**
Squash plant	**12.5±14.44**												**1.042 G**
Watermelon								**31.25±47.3**	**50±35.36**	**6.25±12.5**		**18.75±37.5**	**8.854BCD**
Melon		**6.25±12.5**			**12.5±25**		**12.5±25**	**56.25±42.7**					**7.292 BCDE**
Coriander	**37.5±32.27**	**6.25±12.5**											**3.646 EFG**
Egyptian henbane		**6.25±12.5**		**6.25±12.25**	**12.5±14.44**				**37.5±14.4**	**12.5±25**			**6.250 CDEF**
Sweet clover			**18.75±37.5**										**1.563 FG**
Jaffa groundsel			**6.25±12.5**	**18.75±23.94**	**31.25±47.33**								**4.688 CDEFG**
Sonchus				**18.75±23.94**									**1.563 FG**
Bermuda grass												**43.75±51.5**	**3.646 EFG**
Leucaena		**6.25±12.5**	**6.25±12.5**	**26±27.76**	**6.25±12.5**					**25±28.87**	**18.75±37.5**		**7.375 BCDE**
Conocarpus				**6.25±12.5**						**43.75±12.5**	**62.5±32.28**		**9.375BC**
%	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	100

Fig.1 shows the distribution of pollen species in the collected bee bread samples during January which was only 4 plants as pollen sources, that both fababean and coriander were the main sources with 37.5% each, while rocket and squash plants were 12.5% during each this month.

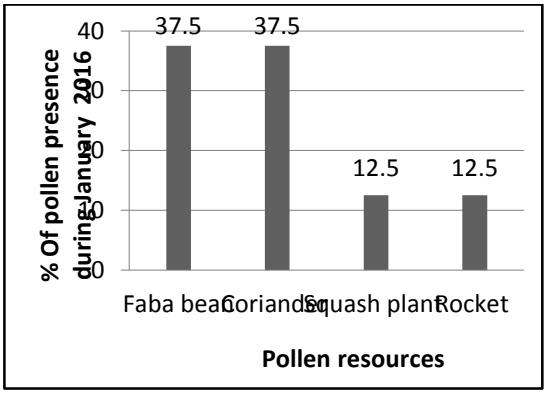

Fig.(1) Distribution of pollen species during January 2016.

Fig. 2 shows the percentage distribution of pollen species in February, which are 6 plants as pollen sources, and their distribution during this month, such as the major plant was the rocket with presence 50%, as well as the presence of fababean by 25%, and melon, leucaena, Egyptian henbane and coriander were 6.25% for each one.

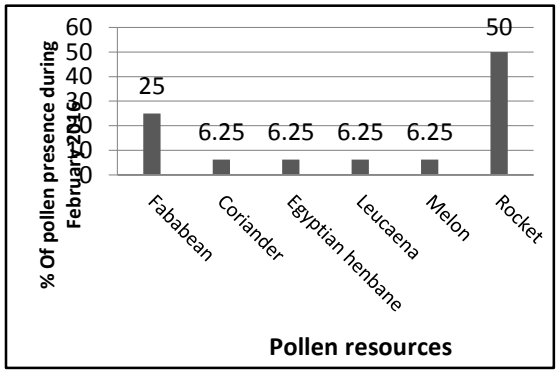

Fig.(2)Distribution of pollen species during February 2016.

In Fig.3, the distribution of pollen species in March was 5 plants as pollen sources, indicating that fababean pollen is the major with 62.5% and sweet clover was 18.75% and while for both Jaffa groundsel and cucumber was 6.25% for each one.

Fig .4 shows the percentage distribution of pollen species during April, which was 7 plant species, which is the highest month in the number of plant sources and distribution, such as the major plant was leucaena with 25%, and the presence of fababean, sonchus, Jaffa groundsel was 18.75% each while for cucumber, Egyptian henbane, and conocarpus was 6.25%. The present results came in agreement with that of Shower (1987) in Kafr El-Sheikh, Egypt who found that the major plant source was fababean for months from January to April.

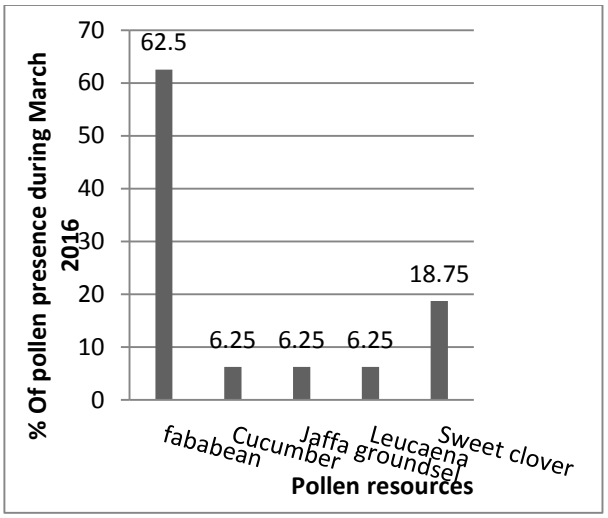

Fig.(3) Distribution of pollen species during March 2016.

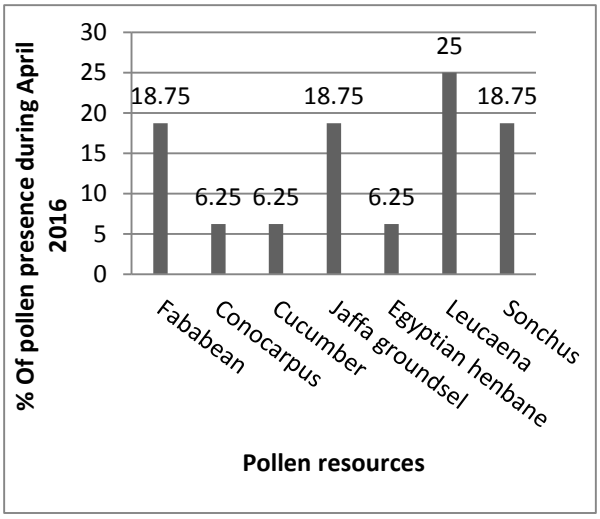

Fig.(4) Distribution of pollen species during April 2016.

Fig .5 shows the percentage distribution of pollen species during May, which were 5 plants as pollen sources. The major was sunflower with 37.5% and then the Jaffa groundsel by 31.5% and both melon and Egyptian henbane by 12.5% each and the presence of leucaena was 6.25%.Fig .6 shows the distribution of pollen plant species in June which showed the lowest month of the number of plant sources of only two plants where the major plant was sunflower with 81.25% and sesame with 18.75%.

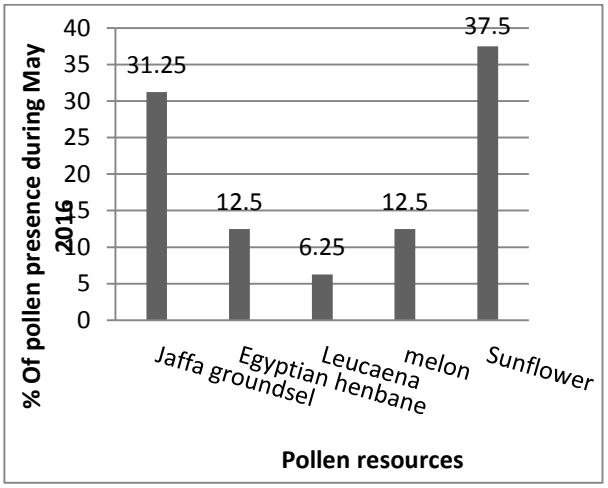

Fig.(5) Distribution of pollen species during May 2016.

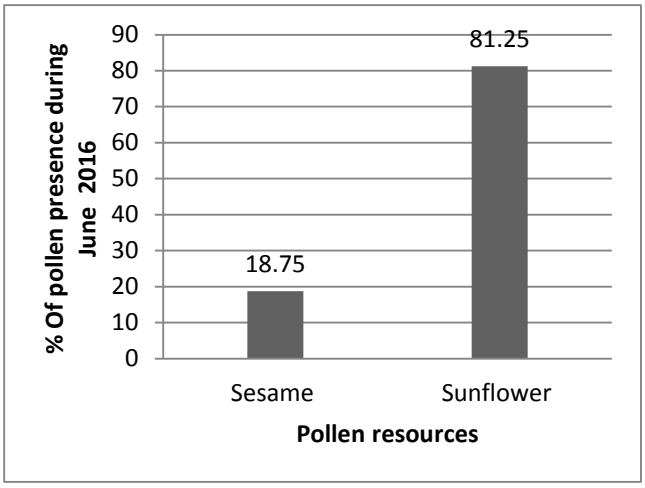

Fig.(6) Distribution of pollen species during June 2016.

Fig .7 shows the percentage distribution of pollen species during July, which was only three plants as pollen sources and distributed as follows, the major was

sunflower with 56.25%, then sesame by 31.25%, and melon was 12.5%.

Fig .8 shows the percentage distribution of pollen species during August, which was also only 3 plant species and distributed as the major was melon with 56.25%, then watermelon 31.5%, and rocket was 12.5%. As shown in Figures 6, 7 and 8 in summer months, June, July and August were the lowest in the plant sources of pollen. This may be due to high temperatures, which may sometimes reach 45 ° C in the shade and may affect quality of pollen in plants. The findings of the present study may be supported by the study of Thompson (1975) and Herrero& Johnson 1980) who observed that high temperature could affect pollination success.

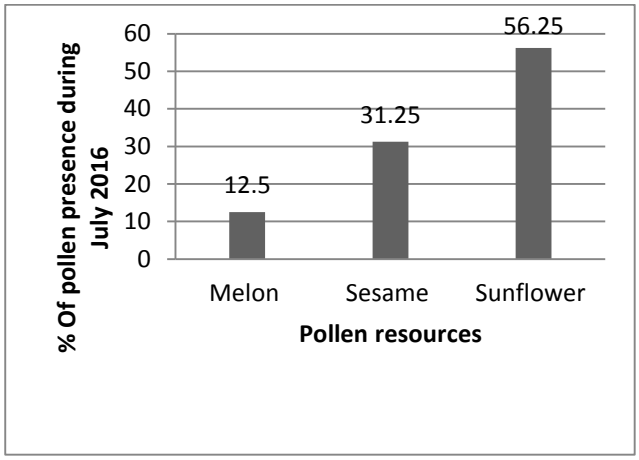

Fig.(7) Distribution of pollen species during July 2016.

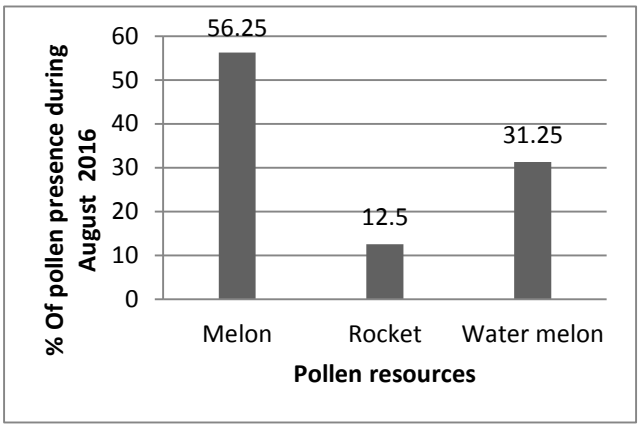

Fig.(8) Distribution of pollen species during August 2016.

Fig .9 shows the percentage distribution of pollen species during September, which were four types of plants. The major plant was watermelon with 50% followed by Egyptian henbane37.5% then both corn and cotton was 6.25% for each.

Fig. 10 shows the percentage distribution of pollen species during October, which are 6 plant species, the major plant was conocarpus trees with 43.75%, the Leucaena trees were 25%, the Egyptian henbane was 12.5% while cucumber, corn and watermelon was 6.25% each

.

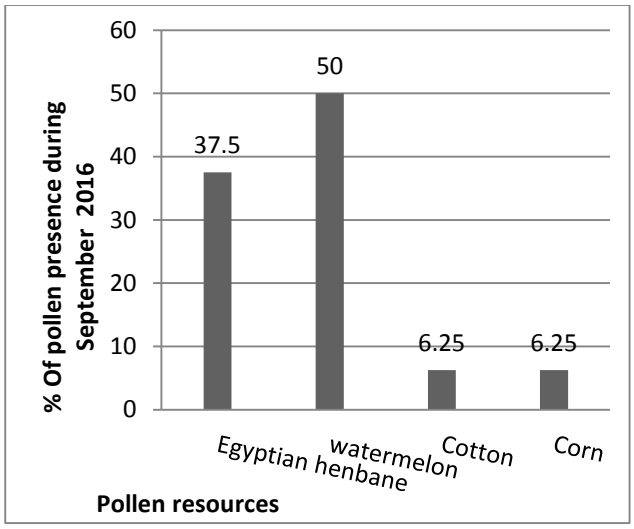

Fig.(9) Distribution of pollen species during September 2016.

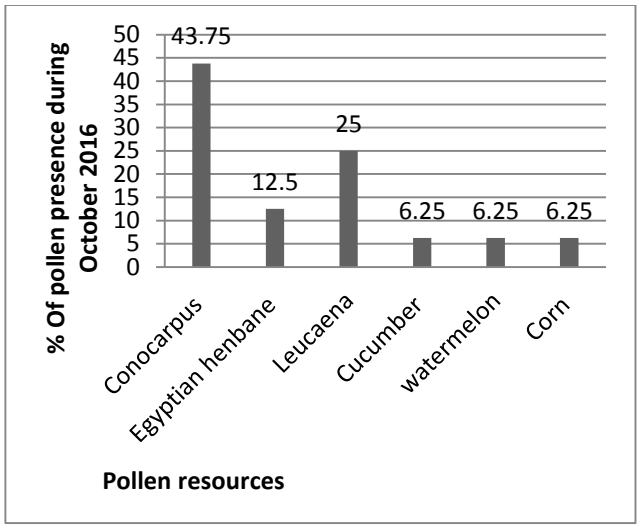

Fig.(10) Distribution of pollen species during October 2016.

Fig. 11shows the percentage distribution of pollen species in November, which were 4 plant species the highest presence, was recorded for conocarpus trees with 62.5%, followed by leucaena 18.75%, corn 12.5% and cucumber 6.25%. Fig. 12 shows the percentage distribution of pollen species during December, which were 6 plant species and their distribution was the Bermuda grass weed was the major plant in this month with 43.75%, watermelon 18.75%, both sunflower and corn 12.5%, while both rocket and cucumber 6.25%. The present results showed that the period from September to December there were only 4-6 plants as pollen sources such as numbers of pollen sources have been reported by various researchers at the same period, Zaitoun and Vorwohl, (2003) in Jordanian desert, Abou-shaara,(2015a) in the Egyptian desert and Esmael, etal., (2016) in the Egyptian West Nile Delta.

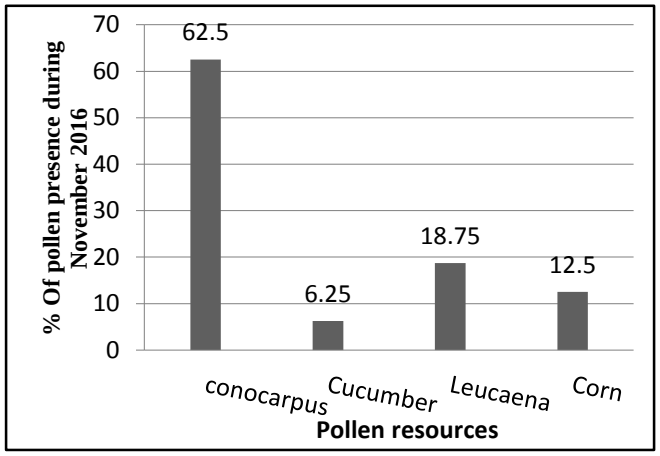

Fig.(11) Distribution of pollen species during November 2016.

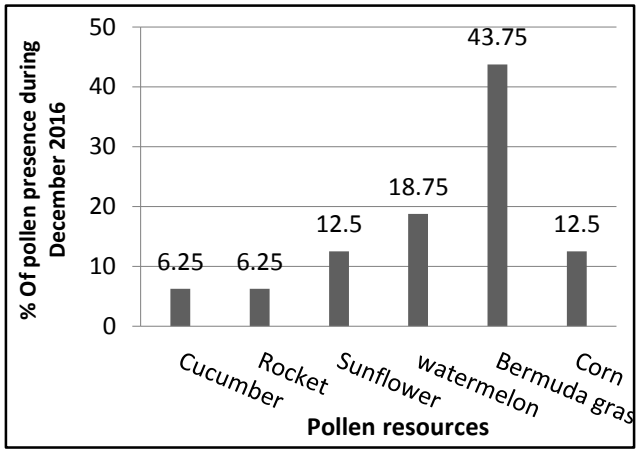

Fig.(12) Distribution of pollen species during December 2016.

Conclusion

The present study showed that there were 18 plants as sources of pollen belonging to 11 plant families. The most family was cucurbitaceae, which had four plants as sources of the major pollen during the year. The plants were arranged in descending order (sunflower, fababean, conocarpus, watermelon, leucaena, melon, Egyptian henbane, rocket, Jaffa groundsel, sesame, coriander, bermuda grass, corn, cucumber, Sweet clover, sunchus, squash plant and cotton.Spring months are generally regarded as the best months, followed by winter, then fall, and the lowest in plant species was the summer season, and this may be because of the high temperature degrees in the Toshka region .

References

Abou-Shaara, H.F. 2015a. Pollen sources for honey bee colonies at land with desert nature during dearth period. Cercetări Agronomiceîn Moldova, 48(3):73-80.

Abou-Shaara, H.F. 2015b. Potential honey bee plants of Egypt. Cercetări Agronomiceîn Moldova, 48 (2): 99- 108.

Al-Ghzawi, A.M.A., Zaitoun, S.T. and Shannag, H.K. 2001. Seasonal cycles of *Apis mellifera syriaca* under Jordanian desert conditions. J Apic Res, 40(2):45-51.

Andrada, A.C. and Telleri´a 2005.Pollen collected by honey bees (*Apis mellifera* L.) from south of Calde´n district (Argentina):

botanical origin and protein content. Grana 44(2) 115–122.

Carvalho CAL, Marchini, L.C and Ros, P.B 1999. Pollen sources used by *Apis mellifera* L. and trigonini (apidae) species in piracicaba, state of São Paulo, Brazil-bragantiuge. 58(1): 49-56.

Esmael, M.E.M., Salem, M.H.A., Mahgoub, M.S.E. and El-Barbary, N.S.S. 2016. Photographer Guide of Pollen Grains Collected from Apiaries Beheira Governorates -in Alexandria and El(West Nile Delta, Egypt). Alex. J. Agric. Sci. 61(3): 267-290.

Herbert, Jr.E.W. and Shimanuki, H. 1978. Chemical composition and nutritive value of the bee collected and bee-stored pollen. Apidologie 9(1): 33-40.

Herrero, M. P. and Johnson, R. R. 1980. High temperature stress and pollen viability of maize. Crop Sci. 20(1): 796 - 800.

Huang, Z. 2012. Pollen nutrition affects honey bee stress resistance. Terr Arthro Rev, 5:175-189.

Ismail, A.M., Owayss, A.A., Mohanny, K.M. and Salem, R.A. 2013. Evaluation of pollen collected by honey bee, *Apis mellifera* L. colonies at Fayoum governorate, Egypt. Part 1: Botanical origin. J Saudi Soc AgriSci, 12:129-135.

Lu, M.H, Gong, Z.H, Chen, R.G., Huang, W. and Li, D.W. 2009. High temperature stress on crop pollen: A review. Ying Yong Sheng Tai XueBao. 20(6):1511-6.

Ramalho M, Silva MD and Carvalho CAL (2007): Harvesting Dynamics of Pollen Sources by *Meliponascutellaris* Latreille (Hymenoptera: Apidae): a Comparative Analysis with *Apis mellifera*L. (Hymenoptera: Apidae) in the Atlantic Forest Domain. Neotrop Entomol 36: 38-45.

SAS Institute, 2005.The SAS System Version 9.1.3. SAS Institute. Cary.NC.

Shawer, M.B. 1987. Major pollen sources in Kafr El-Sheikh, Egypt and the effect of pollen supply on brood area and honey yield. Journal of Apicultural Research; 26(1):43-46.

Suwannapong, G., Eiri, D.M. and Benbow, M.E. 2012. Honeybee Communication and

Pollination, New Perspectives in Plant Protection Tech.

Taha, E.A. 2005. Studies on honeybee (*Apismellifera* L.).Unpublished Ph.D. Thesis, Faculty of Agriculture, Tanta University, Egypt, 2005, 143.

Thompson, L. M. (1975): Weather variability, climatic change, and grain production. Science 188: 535 - 541.

Zaitoun, S. and Vorwohl, G. 2003. Major pollen plant species in relation to honey bees' activity in the Jordanian desert area. Inter J AgriBiol,, 5(4): 411-415.

Zerbo, A.C, Moraes, RLMS and Brochetto-Braga, M.R. (2001) Protein requirements in larvae and adults of *Scaptotrigonapostica* (Hymenoptera: *Apidia*, *Meliponinae*): midgut proteolytic activity and pollen digestion. Comp. Biochem. Physiol. 129: 139-147.