Journal of the Saudi Society of Agricultural Sciences (2013) **12**, 129–135

King Saud University

Journal of the Saudi Society of Agricultural Sciences

www.ksu.edu.sa
www.sciencedirect.com

FULL LENGTH ARTICLE

Evaluation of pollen collected by honey bee, *Apis mellifera* L. colonies at Fayoum Governorate, Egypt. Part 1: Botanical origin

Abdel-Halim M. Ismail [a], Ayman A. Owayss [a,*], Karem M. Mohanny [b], Rasha A. Salem [c]

[a] *Plant Protection Department, Faculty of Agriculture, Fayoum University, 63514 Fayoum, Egypt*
[b] *Plant Protection Department, Faculty of Agriculture, New Valley University, Qena, Egypt*
[c] *Bee Research Department, Institute of Plant Protection Research, Agricultural Research Center, Giza, Egypt*

Received 17 January 2012; accepted 18 September 2012
Available online 12 October 2012

KEYWORDS

Bee-collected pollen;
Floral sources;
Apis mellifera;
Activity;
Fayoum;
Egypt

Abstract The present work is the 1st part of 3-part study carried out at Fayoum Governorate, Egypt to evaluate the pollen species collected by honey bee, *Apis mellifera* L., colonies during two successive years, 2009 and 2010. Obtained results showed that, in 2009, total amount of trapped pollen (fresh weight) was 2354.89 g/colony/year (mean 588.72 g/colony/season), with peaks in summer and spring, while declined in autumn and winter. Correlation between mean maximum and minimum temperatures and weekly pollen weights was highly positive, while it was insignificant for relative humidity. In 2010, total amount of trapped pollen decreased to 1635.36 g/colony/year (mean 408.84 g/colony/season). The largest amounts were collected in summer followed by winter then spring, while least ones were in autumn. Correlation was highly positive between weekly mean of pollen weights and maximum temperature, while it was insignificant for minimum temperature or relative humidity. There were 24 plant species of 16 botanical families from which bees collected pollen. These sources were ranked according to their predominant quantities in the 1st and 2nd years by two numbers, respectively as the following: sesame 1 and 1, maize 2 and 2, clover 3 and 7, sunflower 4 and 8, wild mustard 5 and 3, casuarina 6 and 13, olive 7 and 11, eucalyptus 8 and 4, pumpkin 9 and 9, cocklebur 10 and 5, date palm 11 and 10, chamomile 12 and 12, field bindweed 13 and 6, pepper 14 and 20, coriander 15 and 16, acacia 16 and 24, citrus 17 and 0, marigold 18 and 0, common red 19 and 17, Christ's thorn 20 and 22, tooth pick 21 and 21, brood bean 22 and 15, belladonna 23 and 23, pea 0 and 14, marjoram 0 and 18 and fennel 0 and 19. The 1st five plants

* Corresponding author. Address: Department of Plant Protection, College of Food and Agriculture Sciences, King Saud University, Riyadh 11451, P.O. Box 2460, Saudi Arabia.Tel.: +966 4175282.
E-mail address: aabdelhakam@ksu.edu.sa (A.A. Owayss).

Peer review under responsibility of King Saud University.

ELSEVIER Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.jssas.2012.09.003

seem to be the main pollen sources for honey bee colonies and consequently pollen producing during the whole year in the tested region. These sources represented 75.61% and 66.95% of the total annual yield in the two surveyed years, respectively.

1. Introduction

Nowadays, the products of the honey bee, *Apis mellifera* L., are of great concern in many fields, e.g. nutritional and pharmaceutical industries. One of these products is bee-collected pollen. Pollen is the sole protein food of a honey bee colony harvested by bee foragers in their natural environment. Presence of pollen in the nest is a prerequisite for normal colony growth and development of the brood. Brood rearing is a major factor in apiary production and is affected mainly by feeding on pollen and nectar (Roman, 2006). Pollen loads are collected using pollen traps and the value of harvested pollen may be added also to a beekeeper's gross income (Nelson, 1987). A single pollen grain is about 5–200 μm in diameter and pollen pellets collected by bees come in a wide variety of colors (Wenning, 2003).

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). Many worldwide studies were carried out on bee plants to determine their flowering periods, pollen and/or nectar collection by honeybee colonies and how these activities are affected by prevailing weather factors, e.g. Petkova (1984) in Bulgaria; Payawal et al. (1989) in Philippines; Mahalefele (1991) and Addi et al. (2006) in South Africa; Hwa et al. (1993) in Taiwan; Ortiz (1994) and Faye et al. (2002) in Spain; Garg and Nair (1994) and Garg (1996) in India; Baydar and Gurel (1998) and Blsk et al. (2008) in Turkey; Zaitoun and Vorwohl (2003) in Jordan; Bastos et al. (2004) in Brazil; Abdrakhmanova et al. (2007) in Russia and Noor et al. (2009) in Pakistan. Also, Egyptian researchers studied pollen and nectar bee plants available in different regions of Egypt (e.g. Wafa, 1956; El-Shakaa, 1977; Hussein, 1982; El-Bassiouny, 1989; Elfeel, 2008; Hassan, 2009). Except the study of Ghoniemy (1984), no data about the recent status of bee pollen sources in Fayoum Governorate are available. So, the present work aims to fill this gap. It is the 1st part of 3-part study for evaluating pollen species as well as availability to bee colonies and pollen producers throughout the year.

2. Materials and methods

2.1. Location

The present study was carried out in an apiary situated in the experimental farm of Faculty of Agriculture, Fayoum University, at Demo region (coordinates: 30° 54′ 55″ E and 29° 17′ 06″) about 10 km east of the city of Fayoum (coordinates: 30° 50′ 0″ E and 29° 18′ 0″), Egypt.

2.2. Honeybee colonies

A set of equal strength honey bee colonies reared in wooden Langstroth hives and headed with 1st hybrid Carniolan, *Apis mellifera carnica*, queens of the same age were tested. Ordinarily beekeeping practices were carried out during the study period including needful winter feeding.

2.3. Pollen collecting activity

A pollen trap was fixed on the hive entrance of each colony in the experiment throughout the pollen collecting periods during two successive years (2009 and 2010).

2.4. Description of pollen trap used

The used pollen trap was a wooden box with a slope roof and two vertical metal strips each of 32 cm length × 17 cm width. Each strip has 4 holes /inch long. Pollen loads fallen through a horizontal wire gauze screen into a collecting tray were emptied as required. (Hassanein and Iskander, 1962; Ghoniemy, 1984). Collecting efficiency was determined by recording 100 worker bees in each hive entering with pollen loads through an empty trap. Number of pellets fallen in the tray was counted and the efficiency was calculated according to the equation reported by Khattab; 1976; El-Shakaa,1977; Ewies et al., 1980, as the following:

$$\text{Trap efficiency} = (\text{number of pollen pellets in the box } /200) \times 100.$$

Efficiency was found to be 28%.

2.5. Identification of pollen species

Fresh pollen pellets for every trap were collected daily and placed in 20 × 10 cm paper bags. They were cleaned and primarily classified by their colors, sizes, shapes and textures using a small drawing brush. Fresh weight of the pellets of each pollen type was recorded. For inspection, representative pollen samples were mounted in glycerin jelly medium placed on glass slides (White, 1999) and they were compared, using a microscope (40X–100X), with those of identified pollens obtained from nearly opened anthers of coincided flowers at the research region. The pollen bulks were kept in a freezer (ca.−10 °C).

2.6. Meteorology

Readings of minimum and maximum temperatures (°C) and relative humidity (RH%) recorded in Fayoum Governorate during the period of study were obtained from the Bulletin of Agricultural Meteorology, Ministry of Agriculture, Egypt.

2.7. Statistical analysis

Replicates of collected pollen were calculated as weekly means and their correlation with prevailing weather factors was statistically analyzed according to Snedecor and Cochran (1967).

Table 1 Plant sources and amounts of trapped pollen during seasons of 2009 at Fayoum Governorate.

No.	Common name	Family	Scientific name	Presence in traps	Quantity of pollen (g/colony)					%
					Spring	Summer	Autumn	Winter	Total	
1	Sesame	Pedaliaceae	*Sesamum indicum*	Jun 29 to Aug 31	0.00	702.33	0.00	0.00	702.33	29.82
2	Maize	Poaceae	*Zea mays*	May 31 to Dec 12	70.23	315.98	70.66	0.00	456.87	19.40
3	Clover	Fabaceae	*Trifolium alexandrinum*	Apr 12 to Jun 22	371.72	18.40	0.00	0.00	390.12	16.57
4	Sunflower	Compositae	*Hilianthus annuus*	May 31 to Oct 12	6.40	124.93	2.23	0.00	133.56	5.67
5	Wild mustard	Cruciferae	*Brassica kabar*	Dec 14 to Apr 19	52.07	0.00	1.08	44.49	97.64	4.15
6	Casuarina	Casuarinaceae	*Casuarina glauca*	* Two periods	0.00	72.52	8.14	0.00	80.66	3.43
7	Olive	Oleaceae	*Olea europea*	Mar 29 to May 10	65.70	0.00	0.00	0.00	65.70	2.79
8	Eucalyptus	Myrtaceae	*Eucalyptus* sp.	** Two periods	10.08	0.00	33.66	20.62	64.36	2.73
9	Pumpkin	Cucurbitcaeae	*Cucurbita maxima*	Aug 24 to Oct 26	0.00	24.19	29.89	0.00	54.08	2.30
10	Cock lebur	Asteraceae	*Xanthium brasilicum*	Sep 7 to Oct 26	0.00	33.86	19.87	0.00	53.73	2.28
11	Date palms	Palmaceae	*Phoenix dactylifera*	Feb 15 to May 10	27.14	0.00	0.00	12.06	39.20	1.66
12	Chamomile	Compositae	*Matricaria chamomilla*	Nov 30 to May 24	22.20	0.00	1.64	9.25	33.09	1.41
13	Field bindweed	Convolvulaceae	*Convolvulus arvensis*	*** Three periods	10.09	5.25	10.07	3.63	29.04	1.23
14	Pepper	Solanaceae	*Capsicum frutesens*	May 10 to Jun 14	24.60	0.00	0.00	0.00	24.60	1.04
15	Coriander	Umbelliferae	*Coriandrum sativum*	Mar 8 to Apr 19	14.64	0.00	0.00	1.17	15.81	0.67
16	Acacia	Fabaceae	*Acacia* sp.	**** Two periods	5.29	0.00	2.19	3.71	11.19	0.48
17	Citrus	Rutaceae	*Citrus* spp.	Mar 1 to Apr 5	3.57	0.00	0.00	6.13	9.70	0.41
18	Marigold	Compositae	*Calendula officinalis*	Mar 1 to Apr 5	2.64	0.00	0.00	4.70	7.34	0.31
19	Common red	Poaceae	*Phragmites anstralis*	***** Two periods	0.00	0.00	2.8	4.01	6.81	0.29
20	Christ's thorn	Rhamnaceae	*Zizyphus spina-christi*	Apr 26 to May 3	6.15	0.00	0.00	0.00	6.15	0.26
21	Tooth pick	Umbelliferae	*Ammi* spp.	Apr 5 to Apr 19	4.83	0.00	0.00	0.00	4.83	0.21
22	Broad bean	Fabaceae	*Vicia faba*	Dec 21 to Jan 25	0.00	0.00	0.73	3.63	4.36	0.19
23	Belladona	Convolvulaceae	*Ipomoea tricolor*	Sep 28 to Oct 5	0.00	0.00	0.81	0.00	0.81	0.03
24	Unidentified 1			May 31 to Jun 22	44.71	2.51	0.00	0.00	47.22	2.01
25	Unidentified 2			Apr 12 to May 3	15.69	0.00	0.00	0.00	15.69	0.66
		Total (g/colony/season)			757.75	1299.97	183.77	113.40	2354.89	100%
		Mean (g/colony/week)			54.15	92.86	14.15	9.45	588.72	

* = Sep 7 to Oct 5 and from Nov 2 to Dec 14.** = Sep 28 to Mar 29 and May 17 to Nov 16.
*** = Feb 15 to May 10, Sep 7 to Oct 26 and Nov 23 to Dec 21.
**** = Nov 9 to Dec 14 and Feb 1 to Apr 5.
***** = Jan 11 to Jan 25 and Oct 12 to Nov 16.

Table 2 Plant sources and amounts of trapped pollen during seasons of 2010 at Fayoum Governorate.

No.	Common name	Family	Scientific name	Presence in traps	Quantity of pollen (g/colony)					%
					Spring	Summer	Autumn	Winter	Total	
1	Sesame	Pedaliaceae	*Sesamum indicum*	Jun 13 to Sep 6	6.47	488.71	0.00	0.00	495.18	30.28
2	Maize	Poaceae	*Zea mays*	May 30 to Dec 12	5.97	279.31	50.73	0.00	336.01	20.55
3	Wild mustard	Cruciferae	*Brassica kabar*	Nov 15 to Apr 18	11.37	0.00	8.32	96.19	115.88	7.08
4	Eucalyptus	Myrtaceae	*Eucayptus* sp.	Oct 18 to Mar 21	0.00	0.00	17.82	72.95	90.77	5.55
5	Cock lebur	Asteraceae	*Xanthium brasilicum*	Aug 23 to Oct 25	0.00	59.47	23.9	0.00	83.37	5.10
6	Field bindweed	Convolvulaceae	*Convolvulus arvensis*	* three periods	5.78	56.7	3.96	7.20	73.64	4.50
7	Clover	Fabaceae	*Trifolium alexandrinum*	Mar 28 to Jun 28	73.35	8.77	0.00	0.00	82.12	5.02
8	Sunflower	Compositae	*Hilianthus annuus*	Jun 6 to Aug 16	5.84	59.86	0.00	0.00	65.70	4.02
9	Pumpkin	Cucurbitcaeae	*Cucurbita maxima*	Jul 26 to Oct 25	0.00	44.55	5.27	0.00	49.82	3.05
10	Date palms	Palmaceae	*Phoenux datylifera*	Feb 4 to May 2	13.63	0.00	0.00	34.27	47.90	2.93
11	Olive	Oleaceae	*Olea europea*	Mar 7 to May 2	41.87	0.00	0.00	3.46	45.33	2.77
12	Chamomile	Compositae	*Matricaria chamomilla*	Nov 29 to may 16	10.98	0.00	2.65	29.57	43.20	2.64
13	Casuarina	Casuarinaceae	*Casuarina glauca*	** two periods	0.00	12.76	2.17	0.00	14.93	0.91
14	Peas	Fabaceae	*Pisum sativum*	Dec 27 to Jan 24	0.00	0.00	0.00	14.54	14.54	0.89
15	Broad bean	Fabaceae	*Vicia faba*	Dec 6 to Feb 7	0.00	0.00	3.33	8.74	12.07	0.74
16	Coriander	Umbelliferae	*Coriandrum sativum*	*** two periods	7.04	0.00	0.00	5.19	12.23	0.75
17	Common red	Poaceae	*Phragmites anstralis*	**** two periods	0.00	0.00	2.82	8.15	10.97	0.67
18	Marjoram	Lamiaceae	*Majorana hortensis*	Feb 28 to Mar 28	2.69	0.00	0.00	5.22	7.91	0.48
19	Fennel	Umbelliferae	*Foeniculum vulgare*	Mar 7 to Apr 4	0.57	0.00	0.00	5.67	6.24	0.38
20	Pepper	Solanaceae	*Capsicum frutesens*	May 9 to may 30	5.16	0.00	0.00	0.00	5.16	0.32
21	Tooth pick	Umbelliferae	*Ammi* spp.	Apr 4 to May 2	5.60	0.00	0.00	0.00	5.60	0.34
22	Christ's thorn	Rhamnaceae	*Zizyphus spina-christi*	Apr 25 to May 2	4.09	0.00	0.00	0.00	4.09	0.25
23	Belladona	Convolvulaceae	*Ipomoea tricolor*	Sep 27 to Oct 4	0.00	0.00	1.57	0.00	1.57	0.10
24	Acacia	Fabaceae	*Acacias* sp.	Nov 8 to Nov 29	0.00	0.00	0.54	0.00	0.54	0.03
25	Unidentified			***** two periods	1.66	0.00	0.00	8.93	10.59	0.65
		Total (g/colony/season)			202.07	1010.13	123.08	300.08	1635.36	100
		Mean (g/colony/week)			15.54	77.70	9.47	23.08	408.84	

* = Mar 7 to May 23, Jun 28 to Jul 26 and Sep 13 to Dec 6.
** = Aug 30 to Oct 11 and Dec 6 to Dec 13.
*** = Jan 10 to Feb 7 and Mar 7 to Apr 25.
**** = Jan 10 to Feb 7 and Oct 11 to Nov 8 and Dec 27 to Feb 21 and May 30 to Jun 6.

3. Results and discussion

3.1. Pollen collecting activity

Data in Tables 1 and 2 indicate the amounts (fresh weight) and sources of bee-collected pollen in Fayoum Governorate during two tested years. In 1st year (Table 1), total weight of trapped pollens was 2354.89 g/colony/year (mean 588.72 g/colony/season). For different seasons quantities were descendingly ordered as; summer, spring, autumn and winter. In summer, total weight of trapped pollen was 1299.97 g (mean 92.86 g/colony/week) with a peak in July. In autumn, total weight decreased to 183.77 g (mean 14.15 g/colony/week) with a peak in Oct. In winter, total weight decreased to 113.04 g (mean 9.45 g/colony/week) with a peak in March. In spring, this weight increased to 757.75 g (mean 54.15 g/colony/week) with a peak (141.56 g) in June (Fig. 1).

In the 2nd year (Table 2), total weight of trapped pollen was 1635.36 g/colony/year (mean 408.84 g/colony/season). For different seasons, quantities were descendingly ordered as; summer, winter, spring and autumn. These results indicate that quantity of trapped pollen throughout winter had the 2nd rank instead of the 4th one in the 1st year of study. This may due to noticeable wide areas of different plants, e.g. peas, broad bean, coriander, marjoram and fennel which were cultivated close to the apiary. In summer, total weight of trapped pollen was 1010.13 (g mean 77.70 g/colony/week) with a peak in July. In autumn, this quantity was sharply declined to 123.08 g (mean 9.47 g/colony/week) with a peak in Oct. In winter, total weight increased to 300.08 g (mean 23.08 g/colony/week) with a peak in March. In spring, total weight of trapped pollen was 202.07 g (mean 15.54 g/colony/week) with a peak in April (Fig. 1). The present pollen quantities are greater than those reported by Ghoniemy (1984), in Fayoum, who averaged 1505.5 g/colony/year and 574.3 g/colony/year. He recorded the highest amounts in Aug (332.1 g/colony and 156.1 g/colony), while the lowest ones were in Nov (15.7 g/colony and 3.7 g/colony) for two successive years, respectively. Also, in the same region, lower amounts of trapped pollen were found by Elsayh (2012). She recorded 1061.77 g/colony and 826.36 g/colony as a total pollen yield in 2009 and 2010 years, respectively, when traps were applied in spring (April, May and June) and in summer (July, Aug and Sep). In another study, Ghoniemy and Abo-Lila (1998) reported an average of 781.8 g/colony collected from 22 plant sources in Dokki, Giza. They reported that trees were the main sources of pollen (more than 80%). Also, El-Bassiouny (1989), at Moshtohor, recorded 4736.4 g (average 789.4 g/colony) and 3766.1 g (average 627.6/g/colony) for two successive years, respectively. Taha (2006), in Mansoura, found 1697.0 g/colony/year, where the largest amount was collected from maize, while the smallest one was from peas. Fathy (2008), in Dakahlia, found spring as the best season for collecting pollen with an average of 316.68 g/colony representing 38.18%. Contrarily, he added that winter was inferior season with 88.97 g/colony (10.73%). Elfeel (2008), in Siwa oasis, recorded the highest pollen collection in summer (31.26%) followed by spring (29.0%) and autumn (21.89%) then winter (17.85%) of the total. The variations in amounts of trapped pollens mentioned by those authors, compared to the present ones, are due to many factors, e.g. locations, available flowering areas, trap efficiency, colony strength, as well as local environmental conditions of the tested areas. etc.

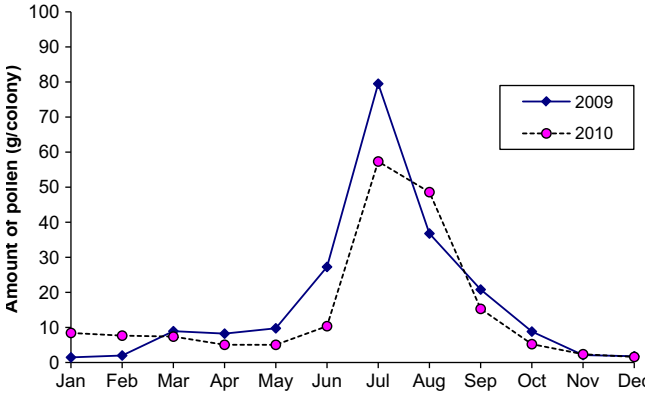

Figure 1 Mean monthly collected pollen by honey bee colonies at Fayoum Governorate.

In the 1st year, statistical analysis showed that correlation between mean max. or min. temps. and weekly mean of pollen weights was positively high significant ($r = 0.644$ and 0.653, respectively), while it was negatively insignificant for relative humidity ($r = -0.158$). In the 2nd year, correlation between weekly pollen weight and max. temp. was positively high significant ($r = 0.543$), while it was insignificant for min. temp. ($r = 0.164$) or negatively insignificant for relative humidity ($r = -0.180$).

In this regard, Wafa (1956), in Giza, recorded the highest pollen amounts from Feb to Aug with peaks during blooming of broad bean, clover, and cotton. He mentioned that least daily collection (13 g/colony) was in Oct, while the highest one (80 g/colony) was in Aug, with a large amount being 15807 g/colony/year. Noticeably, honey bees cannot collect pollen pellets from cotton flowers, because of specific dislodging of cotton pollen grains (Owayss, 1996) and the observable activity of colonies during cotton blooming is due to collecting cotton nectar and gathering pollen from other coincided plants, e.g. maize, sunflower...etc. El-Shakaa (1977) reported a positive correlation between daily mean temp. and daily weight of collected pollens from clover, maize, wild mustard and broad bean. He added that increased temperature by 10 °C resulted in an increase of 0.49 g, 0.21 g, 0.74 g and 1.49 g in the yields of pollens of these sources, respectively. Hussein (1981), in Assiut, recorded two peaks of pollen collecting activity during March and Sep, while the lowest amounts were collected in June, Nov and Dec. In the same region, the highest levels of pollen collection were in summer and autumn at 8:00 am, while they were between 12.00 and 1.00 pm during winter and spring (Hussein, 1982). In Fayoum, Ghoniemy (1984) found a positive insignificant correlation between max. or min. temp. and monthly collected pollen, while this relation was negatively insignificant for RH% during two experimental years.

3.2. Pollen plant sources

In the 1st year, data in Table 1 indicate that there were 23 plant species that belong to 16 botanical families from which bees collected pollen throughout the year. These species were classed according to their relative predominance into 4 main groups: the 1st one includes 4 sources; sesame (*Sesamum*

indicum), maize (*Zea mays*), clover (*Trifolium alexandrinum)*, and sunflower (*Hilianthus annuus*). These sources were found to be the main pollen sources all over the year representing 29.82%, 19.40%, 16.57% and 5.67%, respectively, of the total annual amount. The 2nd group contains 6 sources; wild mustard (*Brassica kabar*), casuarina (*Casuarina glauca*), olive (*Olea europea*), eucalyptus (*Eucalyptus* sp.), pumpkin (*Cucurbita maxima*) and cock lebur (*Xanthium brasilicum*) representing 4.15%, 3.43%, 2.79%, 2.73%, 2.30% and 2.28%, respectively, of the total annual amount. The 3rd one has 7 sources; date palm (*Phoenux datylifera*), chamomile (*Matricaria chamomilla*), field bindweed (*Convolvulus arvensis*), pepper (*Capsicum frutesens*), coriander (*Coriandrum sativum*), acacia (*Acacia* sp.) and citrus (*Citrus* spp.) representing 1.66%, 1.41%, 1.23%, 1.04%, 0.67%, 0.48% and 0.41%, respectively, of the total annual amount. The 4th group contains 6 sources: marigold (*Calendula officinalis*), common red (*Phragmites anstralis*), Christ's thorn (*Zizyphus spina-christi*), tooth pick (*Ammi* spp.), brood bean (*Vicia faba*) and belladona (*Ipomoea tricolor*) as well as 3 unidentified pollen sources with low representative amounts.

In the 2nd year, data in Table 2 revealed that there were 24 plant species of 16 botanical families which were recorded as sources of bee-collected pollen throughout the year. These species were classed descendingly into 4 main groups: the 1st group contains 8 sources; sesame, maize, wild mustard, eucalyptus, cock lebur, field bindweed, clover and sunflower. These plants were found to be the common pollen sources, representing 30.28%, 20.55%, 7.08%, 5.55%, 5.10%, 4.50%, 5.02% and 4.02%, respectively, of the total annual amount. The 2nd group had small pollen amounts from 4 sources, pumpkin, date palm, olive and chamomile, representing 3.05%, 2.93%, 2.77% and 2.64%, respectively, of the total annual amount. The 3rd group includes 5 sources; casuarina, peas (*Pisum sativum*), broad bean, coriander, and common red, representing 3.96% of the total annual amount. The 4th group were 7 sources; marjoram (*Majorana hortensis*), fennel (*Foeniculum vulgare*), pepper, tooth pick, Christ's thorn, belladona and acacia as well as 2 unidentified species representing the least pollen amounts collected all over the year.

Formerly, different major and minor bee-pollen sources were recorded in Egypt, e.g. Ibrahim (1967), at Giza, who reported more than 50 pollen sources. El-Shakaa (1977), at the same region, found that main earlier pollen source was broad bean followed by wild mustard then clover. Conversely with the present findings, he found maize as the least major source in the active season, while minor sources were citrus, stone fruits and ornamental plants. Khattab (1976) recorded 40 species during the year; *Z. mays*, *T. alexandrinum*, *Citrus* spp., *V. faba*, *Eucalyptus* spp., *Bombax malabricum* and *B. kaber* were the main sources. El-Dakhakhni (1980), at Kafer El-Sheikh, noticed honeybees collecting pollens from citrus, clove, rose, eucalyptus, sunflower, maize and wild mustard, during spring, but during summer pollen sources were: clover, eucalyptus, rose, maize, sunflower and wild mustard. In autumn, sources were: eucalyptus, rose, sunflower, maize, casuarinas and lambsqurater. In winter they were: broad bean, eucalyptus, casuarinas and lambsqurater. In Assiut, 23 plants were recorded as pollen sources, mainly broad bean, clover, wild mustard, maize, sunflower, date palm, citrus, coriander, and casuarina. Most of pollens (65%) were collected from Fabaceae then Cruciferae (Hussein, 1982). Ghoniemy (1984), at Fayoum, classed pollen sources into four groups: the 1st one contained four major sources: *Z. mays*, *V. faba*, *T. alexandrinum*, and *Citrus* spp.; the 2nd one had *P. dactylifera*, *Eucalyputus* spp., *Salix aegyptica* and *B. kaber*; the 3rd had *X. spinosum*, *Cichorium pumilum*, *H. annuus*, and *Chysenthemum carinatum*, while the 4th, the least predominant group, included wild weeds, medicinal and aromatic plants. Contrarily with the present findings, date palm and broad bean were not main pollen sources and that recently may due to small areas cultivated with broad bean and to low numbers of male trees available to bee colonies. Formerly, El-Bassiouny (1989), in Moshtohor, found that main sources of pollen were: *Z. mays*, *T. alexandrinum*, *Citrus* spp., *V. faba*, *Eucalyptus* spp., and *B. kaber*. Also, Fathy (2008), in Dakahlia, recorded 26 pollen species in 15 families mainly *Z. mays*, *T. alexandrinum*, *V. faba*, *Eucalyptus rostrata*, *C. sinensis* and *P. dactylifera*. Major pollen sources were found by Haggag (2002), in New Valley (Siwa oasis), which were descendingly: alfalfa (*Medicago saliva*), *P. dactylifera*, tamarisk (*Tamarix articulate*), *C. sativtim*, prickly broom (*Parkensonia aculeate*), *Eucalyptus* spp., medicinal plants, and citrus. In Siwa oasis, also, different pollen sources were found (Elfeel, 2008). He descendingly classified pollen sources according to their representative amounts as the following: *H. annus*, *P. dactylifera*, *Eucalyptus* sp., *Acacia* sp., *M. sativa*, *C. pepo*, *Casuarina* sp., *Portulaca oleraceae*, *T. articulate*, *Citrus* spp., stone fruits, *S. indicum*, dandelion, *O. europea*, *Hibiscus* sp., *Prunus domesticus*, and *Datura* sp.

4. Conclusion

Twenty-four plants that belong to 16 families were recorded as pollen sources for honey bee, *A. mellifera* L., colonies at Fayoum Governorate, Egypt during two successive years (2009 and 2010). Five species, i.e. sesame, maize, clover, sunflower and wild mustard were found to be the main sources. Summer and spring were the best seasons for massive pollen collection, while autumn and winter were the least ones in the tested region. Relative variations noticed in pollen amounts for the same source in the two studied years may due to fluctuation in cultivated areas. Current observations indicate that cropping composition in the tested area may be relatively changed during the past three decades.

References

Abdrakhmanova, S., Markova, E., Mandrygin, A., 2007. Pollen collecting activity of different breeds of bees. Mezhdunarodnyi Sel' skokhozyaistvennyi Zhurnal 6, 64.

Addi, A., Phillipson, P., Hepburn, H.R., 2006. Floral resources of *Apis mellifera capensis* in the fynbos biome in the Eastern Cape Province, South Africa.. African Entomology 14 (1), 153–159.

Andrada, A.C., Tellería, M.C., 2005. Pollen collected by honey bees (*Apis mellifera* L.) from south of Caldén district (Argentina): botanical origin and protein content. Grana 44, 1–8.

Bastos, D.H.M., Barth, O.M., Rocha, C.I., Cunha, I.B.daS., Carvalho, P.deO., Torres, E.A.S., Michelan, M., 2004. Fatty acid composition and palynological analysis of bee (Apis) pollen loads in the states of Sao Paulo and Minas Gerais, Brazil. Journal of Apicultural Research 43 (2), 35–39.

Baydar, H., Gurel, F., 1998. The pollen collection activity and preference of honey bees (*Apis mellifera*) in the natural habitat of antalya and some morphological and quality properties of different pollen types. Turkish Journal of Agriculture and Forestry 22 (5), 475–482.

Blsk, A., Cakmak, I., Bcakc, A., Malyer, H., 2008. Seasonal variation of collected pollen loads of honeybees (*Apis mellifera anatoliaca*). Grana 47 (1), 70–77.

El-Bassiouny, M.N., 1989. Studies on spread and distribution of pollen grains collected by honey bees with reference to the their chemical composition. Ph.D. Thesis, Faculty of Agriculture, Al-Azhar University, Egypt.

El-Dakhakhni, N.M., 1980. Studies on the honey bees (*Apis mellifera* L.). Ph.D. Thesis, Faculty of Agriculture, Alexandria University, Egypt.

Elfeel, M.A.M., 2008. Studies on the Egyptian honeybee race *Apis mellifera* lamarckii Cockerell in Siwa Oasis as a new isolated region. M.Sc. Thesis, Department of Economic Entomology and Pesticides, Faculty of Agriculture, Cairo University, Egypt.

Elsayh, Hebat Allah, S. (2012). Management of honeybee apiaries for maximizing the economic return. M.Sc. Thesis. Faculty of Agriculture, Fayoum University, Egypt, p. 106

El-Shakaa, S.M., 1977. Studies on pollen grains collected by the honey bees in Giza region. M.Sc. Thesis, Faculty of Agriculture, Cairo University, Egypt.

Ewies, M.A., Salem, M.S., Ali, M., 1980. Brood rearing activity of the honey bee in relation to pollen gathering and some weather factors in Mostorod region. Zagazig University, Faculty of Agriculture Research Bulletin 139 (5), 1–10.

Fathy, D.M., 2008. Types and quantities of pollen grains collected by honey bee *Apis mellifera* L. with reference to brood rearing activity. M.Sc. Thesis, Faculty of Agriculture, Mansoura University, Egypt.

Faye, P.F., Planchuelo, A.M., Molinelli, M.L., 2002. Apicultural flora survey and identification of pollen load for Southeastern Cordoba Argentina. Source Agriscientia 19, 19–30.

Garg, A., 1996. Palyno contents of bee-collected pollen loads of autumn season in Bhimal, India. Taiwania 41 (3), 197–207.

Garg, A., Nair, P.K.K., 1994. Honey Bee Pollen Load as a Bioindicator of Bee Pasturage in Bhimtal Area of Western Himalayas, India. National Botanical Research Institute, Lucknow, India.

Ghoniemy, A.H., 1984. Studies of some activities of the honey bee colonies under the environmental conditions of Fayoum region. M.Sc. Thesis, Faculty of Agriculture, Cairo University, Egypt.

Ghoniemy, H.A., Abo-Lila, S.M., 1998. Evaluation of role of borage plant, Borago officinalis, L as a source of pollen under Dokky conditions with observations on honey bees as pollinators. Journal of Agricultural Sciences 23 (7), 3401–3409, Mansoura University.

Haggag, E.I., 2002. Flowering plants visited by Egyptian honey bees *Apis mellifera lamarckii* Cockerell in Siwa Oasis. Egyptian Journal of Applied Sciences 17, 11.

Hassan, M.A., 2009. Studies on pollen types collected by honey bee in Dakhla Oasis, New Valley. M.Sc. Thesis, Faculty of Agriculture, Minia University, Egypt.

Hassanein, M.H., Iskander, R.L., 1962. Studies on the effect of pollen on the brood rearing activity of the honey bee colony. Bulletin of the Entomological Society of Egypt 46, 343–357.

Hussein, M.H., 1981. Pollen gathering activity of honeybee workers in Assiut Governorate. Proceedings of the fourth Arab Pesticides Conference, Tanta University, Egypt, (special vol. 377–385). Apicultural Abstracts, 36(2) (1985) 497/85.

Hussein, M.H., 1982. The pollen flora of Assiut Governorate, Egypt. Assiut Journal of Agricultural Sciences 13 (6), 173–184. Apicultural Abstracts 1985, 36, 2, 526/85.

Hwa, L.S., Young, C.H., Hwa, C.H., 1993. The study of bee-collected pollen loads in Nantou, Taiwan. Taiwania 38 (3/4), 117–133.

Ibrahim, S.H., 1967. Pollinators and factors affecting their activity with special reference to the honey bee on the chief sources of nectar and pollen grain plants in Egypt. M.Sc. Thesis Faculty of Agriculture, Cairo University, Egypt.

Khattab, M.M., 1976. Effect of ecological factors on honey bee activities. M.Sc. Thesis, Faculty of Agriculture, Cairo University, Egypt.

Mahalefele, L., 1991. Comparison between Lesotho and South African bee-botany, 189.

Nelson, D., 1987. The effect of continuous pollen trapping on sealed brood, honey production and gross income in Northern Alberta. American bee Journal 126, 648–650.

Noor, M.J., Khan, M.A., Camphor, E.S., 2009. Palynological analysis of pollen loads from pollen sources of honeybees in Islamabad, Pakistan. Pakistan Journal of Botany 41 (2), 495–501.

Ortiz, P.L., 1994. The pollen collected by *Apis mellifera* L. in Hinojos (Huelva) during the spring. Acta Botanica Malacitana 19, 115–122.

Owayss, A.A., 1996. The effect of supplementary feeding of honeybees, *Apis mellifera* L. on brood, honey and royal jelly. M.Sc. Thesis, Plant Protection Department, Faculty of Agriculture, Cairo University, Egypt.

Payawal, P.C., Tilde, A.C., Manimtim, A.L., 1989. Year round pollen sources for the honey bee, *Apis mellifera* L. in the Philippines. II Metro Manila. Philippine. Entomologist 7 (6), 593–604.

Petkova, O.P., 1984. Origin of pollen collected by honeybees during different seasons in Smoljan and Beden regions Bulgaria Godishnik na Sofiiskiya Universitet Kliment Okhridski. Biologicheski Fakultet 74 (2), 105–112.

Roman, A., 2006. Effect of pollen load size on the weight of pollen harvested from honey bee colonies (*Apis mellifera* L). Journal of Apicultural Science 50 (2), 47–57.

Snedecor, G.W., Cochran, W.G., 1967. Statistical Methods, sixth ed. The Iowa State University Press, Ames, Iowa, USA.

Taha, A.A., 2006. Comparative studies on some secondary products in different races of honey bees. Ph.D. Thesis, Faculty of Agriculture, Mansoura University, Egypt.

Wafa, A.K., 1956. Contribution to the study of factors affecting the amount of pollen grains gathered by honeybees, *Apis mellifera* L. Bulletin of Faculty of Agriculture, Cairo University 99, p.24, (Apicultural Abstracts, 209/59).

Wenning, C.J., 2003. Pollen and the honey bee. American Bee Journal 134, 394–397.

White, J.H., 1999. Pollen its collection and preparation for the microscope, second ed. Northern Biological Supplies Ltd., Martlesham Heath, Ipswich, Antony Rowe Ltd., Eastbourne, 28pp.

Zaitoun, S.T., Vorwohl, G., 2003. Major pollen plant species in relation to honeybee's activity in the Jordanian desert area. International Journal of Agriculture and Biology 5 (4), 411–415.