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POLLEN GATHERING ACTIVITY AND SPECIES COMPOSITION OF COLLECTED POLLEN LOADS BY HONEYBEE IN NEW VALLEY, EGYPT

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ABSTRACT

The present investigation was carried outin the apiary yard at El Kharga Oases, New Valley Governorate, Egypt, during the period extended from January to December 2011. The results of the study reveal that The highest percentages of pollen collectors (28.12 and 14.3%) were recorded during May and September, respectively. The lowest percentages, 3.12 and 2.85%, were noticed throughout February and June, respectively. Maximum number of pollen collectors was noticed during the period from 11 a.m. to 1 p.m. (0.23 bees/ 2 min. / colony). Minimum number of pollen collectors was noticed during the period 7 - 9 a.m. (0.13 bees/ 2 min. /colony). The highest amount of pollen (810 gm. / colony) was collected during May, followed by September (412 gm. / colony). The lowest amount of pollen (82 gm. / colony) was collected during June; followed by February and December (90 and 93 gm. / colony), respectively.Significant correlation were detected between temperature daily range and the average amounts of pollen collection, where, r= 0.310.Highly significant correlation were detected between relative humidity (R.H. %) and the average amounts of pollen collection (gm./colony/ 2h.), where, correlation coefficient (r) = - 0.405.Species composition of collected pollen loads by honeybee workers appeared that, there are 20 different floral sources in El Kharga Oases.Such information will be useful for improving honeybee colony status and development in New Vally especially during the pollen shortage periods.
Keywords: Honeybee,*Apismellifera*, pollen gathering, weather factors, species composition New Valley

INTRODUCTION

The importance of honeybees, *Apismellifera* to the global world economy far surpasses their contribution in terms of honey production, because bees are used for the pollination of many major crops. More than three-quarters of all flowering plants must be pollinated by an animal visitor. A number of agricultural crops are almost totally (90-100%) depend on honeybee pollination. The ability to easily move and manage honeybee makes them ideal for this purpose. One mouthful of three of the foods you eat directly or indirectly depends on pollination by honeybees (Delaplane and Mayer, 1999).

Sufficient nutrition in honeybee colony is an essential for growth and development. The development and the survival of honeybee colonies are therefore intimately associated with the availability of those environmental nutrients (Haydak, 1970; Keller *et al.*, 2005;Brodschneider and Crailisheim, 2010), which suggests that the alteration of bee foraging area due to the current intensification of agriculture and landscape changes might provide a deficient nutrition and therefore affect honeybee populations (Naug, 2009; Decourty*et al.*, 2010). This is further supported by beekeepers, which are ranking poor nutrition or starvation as one of the main reasons for colony losses (Abdel-Rahman and Moustafa, 2012). Therefore, studying the connexion between nutrient availability and honeybee colony health might help to better understand the current bee losses observed throughout the world (Nneumann and Carreck, 2010; Van-Engelsdarp and Meixner, 2010). Colonies with limited protein intake decline from the combination of reduced brood rearing and a shorter lifespan for adult water.

Honeybee repose on pollen as their source of protein, lipids, sterols, amino acids, starch, vitamins and minerals (Stanly and Linskens, 1974; Roulston and Buchmann, 2000), is a major factor influencing the longevity of individuals (Haydak, 1970). Also, pollen is important at the colony level, since it enables the production of royal jellyby workers that is fed to larvae of all castes and to the queen (Crailsheim, 1994).

In addition to need for pollen in brood rearing and to optimize worker longevity, nutrition (particularly protein availability) is a key factor in resistance to pathogens (Ford *et al.*, 2001; Kaminogawa and Nanno, 2004; Riz and Gardner, 2006; Rowley and Powell, 2007). Acually, pollen intake is known for influencing the physiological metabolism (Alaux*et al.*, 2011), immunity (Alaux*et al.*, 2010), the tolerance to pathogens like bacteria (Rinderer*et al.*, 1974), virus (Degrandi-Hoffman, *et al.*, 2010) and microsporidia (Rinderer and Elliotl, 1977) reducing the sensitivity to pesticides (Wahl and Ulm , 1983).

Whilst, honeybee rarely face a total lack of pollen in their environment, but are rather challenged with variability in time and space of pollen resource nultitude, type and diversity. In addition, pollen can differ between floral species regarding their nutritional contents (Herbert and Shimanuki, 1978; Roulston and Cane, 2000; Odoux*et al.*, 2012) insufflate that some are of better quality for bees than others. It is a well-known fact that flowering plants found in the same region compete among themselves in terms of their ability to attract pollinators through more visits. This is one of the characteristics of successful plants (Al- Ghamdi, 2003).

Foraging activity of honeybee to gather pollen depends directly on a set of weather factors (temperature, humidity and wind speed). The effect of weather factors on the foraging activity of honeybee colonies and the importance of temperature as a major factor affecting bee foraging activity was studied by many researcher (Johansen, 1968; Nunez, 1977;Burgett*et al.*, 1985 and Johansen and Mayer, 1987).Atallah*et al.* (1989) found in Minia region,the most pollen trapped was from Egyptian clover, followed by maize, bean, coriander and least from Borage. In terms of pollen production (kg/ feddan /day), maize gave the highest yield, followed by bean, Egyptian clover, Borage, coriander, cotton, fennel and dill.

In Egypt, the pollen collection, pollen flora and species composition of pollen loads were studied by many researcher (Wafa and Ibrahim, 1957; Ibrahim and Selim, 1967; El-Shakaa, 1977; Attalah*et al.*, 1989 and Hussein *et al.*, 1992).

Thus, the objective of the current study aimed to study the cycles of pollen collection and their relation to some weather factors. And to study the species composition of collected pollen loads by honeybee, *Apismellifera* L., colonies.

MATERIALS AND METHODS

The present study was carried out in a private apiary located at Al kharga Oasis New valley, Egypt. The different s trials were conducted and extended for one year, from the beginning of January to the end of December, 2011.

The experimented bees:

Ten bee colonies of the local race of Carniolan honeybee (*Apismelliferacarnica* Pollmann) nearly in equal strength, contained stored pollen and honey and headed with sister queens were initiated.The colonies were located in one area beside the Agricultural secondary school in Al kharga Oasis.

Determination the monthly numbers of pollen collectors:

Total numbers of bee worker pollen collectors of the tested colonies were counted separately. Six counts were made weekly, over one day, at 2-hours intervals, starting from 7 a.m. to 5 p.m. throughout the period of the work. The periods classified as P1 (7-9 a.m.); P2 (9-11 a.m.); P3 (11-1 p.m.); P4 (1-3 p.m.); P5 (3-5 p.m.) and P6 (5-7 p.m.). Three readings, two minutes for each, were made at each count using a stopwatch and counter. Average number of pollen collectors (bees/ 2 min. / colony) was calculated as monthly mean.

Determination the quantity of collectedpollen:

Total amount of pollen collection from the tested colonies were weighted separately using pollen traps. Six counts were made weekly, over one day, at 2-hours intervals, starting from 7 a.m. to 5 p.m. (as described previously) throughout the period of the work. Average amount of pollen collection (gm. / colony / 2 hr.) was calculated as monthly mean.Also, the percentages of botanical origin of the collected pollen were calculated as monthly mean and in comparison with the total amount all over the year.

Species compositionof cc llectedpollen:

For identification of the botanical origin of the collected pollen, one pollen load of each group was crushed in little of boiling water then in a series of alcohol solution, 50, 70,90 and 100 %. A drop of alcohol suspension was put on a glass slide for 2 minutes and then drop of xylene was added and left for one minute. The prepared slides were mounting with glycerol and its content of pollen grains were examined microscopically at magnification of 400x (Moore and Webb,1978). Determination of the botanical origin of the collected pollen, was done through the comparison between the feature of pollen grain on the prepared slides and the library reference of pollen of the plant origin according to method of (Sawyer,1981). Representation % of the different floral source was estimated.

Meteorological data:

Record of tested weather factors at the inspected dates were obtained from the Meteorological station located of Kharga oasis, New Valley Governorate.

The following meteorological factors were used: daily average temperature C°; daily average relative humidity(R.H.) %; and wind speed, W.S., (Knot, Kn= 1.852 km. hr.-1).

Statistical analysis of date:

Data were analyzed using analysis of variance (ANOVA) that was carried out using MSTAT-C software program (MSTAT-C, Michigan University, Version. 2010) and presented as mean ± S.E. (slandered error).Means numbers were compared according to the method of Waller and Duncan' s Multiple Range Test (Waller and Duncan, 1969) and the least significant difference (L.S.D.) values at 0.05 probabilities were calculated. Simple correlation between the previous weather factors and the amount of pollen gathering as well as simple regression was analysis.

RESULTS AND DISCUSSION

In Egypt, various seasons of the year carrying much difference in their weather factors, flora availability and presence or absence of honey bee enemies. These variations may effect on quantity of pollen collected by the honey bee colonies over the year. In Kharga Oasis, New Valley, activity and productivity of honey bee colonies were subjected under observation for one year to study the following parameters.

Determination the monthly numbers of pollen collectors:

Table (1) shows the calculated monthly means number of pollen collectors at different period and monthly percentages were illustrated in Figure (1). The highest percentages of pollen collectors (28.12 and 14.3%) were recorded during May and September, respectively. The lowest percentages, 3.12 and 2.85%, were noticed throughout February and June, respectively. Maximum number of pollen collectors was noticed during the period from 11 a.m. to 1 p.m. (0.23 bees/ 2 min. / colony). Minimum number of pollen collectors was noticed during the period 7 - 9 a.m. (0.13bees/ 2 min. /colony).

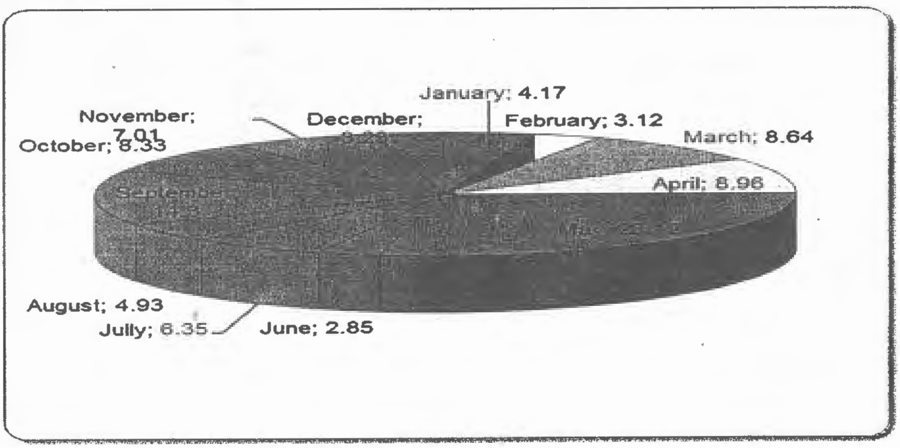

Fig. (1): Monthly mean percentage (%) of honeybee worker pollen gatheringduring different periods by honeybee colonies at Kharga Oasis during 2011.

Table (1): Monthly mean numberof honeybee worker pollen gathering during different period by at Kharga Oasis during 2011.

Month	Different periods						Total	Mean
	P1	P2	P3	P4	P5	P6		
January	3	16	18	22	27	34	120	0.04
February	2	11	20	9	14	34	90	0.03
March	36	37	36	47	48	45	249	0.09
April	41	39	62	62	28	26	258	0.09
May	81	87	178	208	162	94	810	0.28
June	18	23	15	25	6	5	82	0.06
July	16	11	52	33	15	56	183	0.28
August	26	36	18	32	12	18	142	0.06
September	57	58	120	84	55	38	412	0.14
October	31	51	49	43	43	23	240	0.03
November	61	51	60	20	10	2	202	0.07
December	11	25	23	19	12	3	93	0.03
Total	386	445	651	600	408	432	2881	
Mean	0.13	0.15	0.23	0.21	0.15	0.13		
Percent %	13.40	15.45	22.60	20.83	14.99	13.16	100%	

These data are in general agreement with the previously finding of Mannaa*et al.*, (1992), that activity of honeybee increased slightly by raising air temperature which proved to be the most important factor of the weather conditions. These results go in line with the findings of El-Dakhakhni, (1980) who found that, the highest rate of pollen collection in Kafer El-Sheik region was observed during May and the lowest was during November. Hussein (1981) recorded that, in Assiut, the maximum weight of trapped pollen loads by honeybee colonies were obtained during September, March, August and Febraury, while the minimum collected loads were during November, December and June.

Determination the quantity of collectedpollen:

As shown in Table (2) there were non-significant differences between the mean amounts of pollen collection. The maximum amount of pollen collection, 10.49+ 2.766 gm./colony/ 2h., was noticed at P3. While, the minimum average (7.525 ± 1.625) was recorded at P1.The maximum amount of pollen collection (47.6 ± 5.391 gm./colony/ 2h) were recorded at P4 during May. Meanwhile, the minimum amount of pollen collection (0.4 ± 0.245) was noticed at P1 during January.

Table (2): Monthlyaverage amount (± S.E.) of pollen gathering (gm. / colony / 2h.) during some differentdaily times in New Valley during 2011.

DailyTime / Month	P1	P2	P3	P4	P5	P6
Jan.	0.4 B + 0.245	3.2 AB + 1.393	3.6 AB + 1.4	4.4 AB + 1.536	5.4 A + 2.839	6.8 A + 1.594
Feb.	0.5 B + 0.224	2.76 B + 0.662	2.5 B + 0.387	2.28 B + 0.371	3.5 B + 1.162	8.5 A + 2.5
March	9.0 A + 4.074	9.26 A + 4.116	9.0 A + 2.51	11.76 A + 3.498	12.0 A + 3.564	11.2 A + 2.332
April	11.8 A + 0.374	4.0 C + 0.548	7.2 BC + 1.281	6.2 BC + 0.8	8.8 AB + 1.625	8.8 AB + 1.855
May	16.2 C + 3.262	17.6 C + 2.337	35.6 AB + 5.183	47.6 A + 5.391	32.4 B +6.75	18.8 C +2.267
June	4.8 AB + 0.97	3.2 AB + 0.86	3.8 AB + 1.393	6.2 A + 3.308	1.6 AB + 0.245	1.2 B + 0.2
July	4.0 B + 2.324	2.8 B +1.114	5.6 B + 1.806	3.2 B + 0.49	3.8 B + 0.86	14.0 A + 3.987
August	5.2 A + 0.583	7.2 A + 2.498	3.6 A + 1.4	6.4 A + 2.227	3.4 A + 1.503	3.6 A + 1.122
Sept.	14.2 AB + 2.709	12.6 AB + 2.804	20.0 A + 8.081	16.0 AB + 7.675	8.8 AB + 2.289	3.8 B + 1.02
Oct.	6.2 A + 2.596	10.2 A + 2.782	9.8 A + 3.455	8.6 A + 6.169	7.2 A + 4.79	6.0 A + 2.302
Nov.	15.2A + 2.154	12.8 AB + 3.693	17.0 A + 4.93	6.6 BC + 0.678	2.6 C + 0.748	1.0 C + 0.00
Dec.	2.8 B + 0.86	6.2 AB + 1.262	8.2 A + 3.569	3.8 AB + 1.114	2.6 B + 1.03	1.0 B + 0.316
Mean	7.525A + 1.625	7.652 A + 1.408	10.49A + 2.766	10.25 A + 3.571	7.675 A + 2.426	7.007A ±1.571

Means followed by the same letter in the same row are not significantly different (P < 0.05).

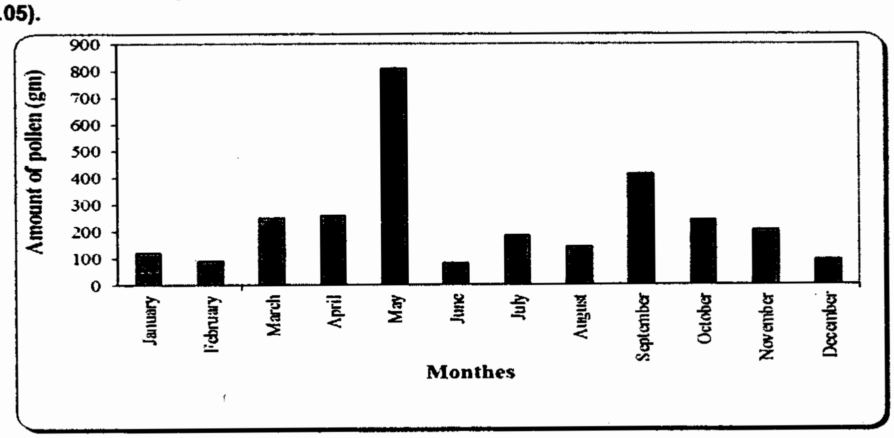

Fig. (2): Monthly average amount (gm.) of pollen collection in New Valley during 2011.

Data in Fig. (3) illustrated the averages of total monthly averages amount of collected pollen in year 2011. The highest amount of pollen (810 gm. / colony / month) was collected during May, followed by September (412 gm. / colony / month).The lowest amount of pollen (82 gm. / colony) was collected during June, followed by February and December (90 and 93 gm. / colony / month), respectively.

These results go in line with the findings of El-Dakhakhni, (1980) who found that, the highest rate of pollen collection in Kafer El-Sheik region was observed during May and the lowest was during November. Hussein (1981) recorded that, in Assiut, the maximum weight of trapped pollen loads by honeybee colonies were obtained during September, March, August and Febraury, while the minimum collected loads were during November, December and June.

Significant positive correlation were detected between temperature daily range and the average amounts of pollen collection, where, r= 0.310. Moustafa (1991) and Garcia *et al.*, (1999) found a positive with highly significant between temperature (max., min., mean) and honeybee foraging.

Highly significant negative correlation were detected between relative humidity (R.H. %) and the average amounts of pollen collection (gm./colony/ 2h.), where, correlation coefficient (r) = - 0.405 Table (3). This result support the finding of Hussein (1987), he stated that, significant and negative correlation was detected between relative humidity and foraging and pollen gathering activity.

Table (3): Simple correlation coefficient (r) and regression equations between some weather factors and pollen gathering in New Valley during 2011

Weather factor	Correlation coefficient (r)	Regression equation	Multiple correlation (R)
Temp. daily average (X1)	0.310 *	Y =1.97 + 1.908 X1	
R.H. % (x2)	- 0.405 **	Y = 115.01 – 1.709 X2	0.437
W.S. (x3)	- 0.071	Y = 61.49 – 1.444 X3	

Insignificant negative correlation was detected between wind speed and the average amounts of pollen collection, r= - 0.071. Reddy (1978) observed that foraging fluctuations in pollen collection significantly correlated with relative humidity and rainfall, and was not significantly affected by wind speed and temperature.

The regression equations between studied weather factors and the amounts of pollen collection were calculated and presented in Table (3). Multiple correlation (R) between the studied weather factors and the average amounts of pollen collection was 0.437. This means that those weather factors affect the activity of collecting pollen by about 44% and that in the New Valley. While there are factors other than deliberate, whether air or related plant and soil contributing around 66%.

Wafa and Ibrahim (1957) found a positive correlation between temperature and number of honey bee workers visiting broad bean, Citrus, Clover and Cotton. Eshbah (1981) noted that daily Maximum and daily mean temperature and daily mean relative humidity had significant effects on foraging activity. Also, Szabo (1980) found highly significant correlation between flight activity and temperature. In contrast, Lee et al, (1987), in

Korea, found that the flight activity was not correlated significantly with temperature, humidity or wind velocity (speed), but was highly significantly and positively correlated with intensity of solar radiation.

Species composition of collectedpollen:

Species composition and representation percentage of collected pollen loads by honeybee workers in Kharga Oasis during 2011 are recorded in Table (4).Data showed that,there were 19 different floral sources over the year 2011 as mentioned followed.

Capparis (*Capparisaphylla*), parslane (*Partulocaalercea*), broad bean (*Viciafaba*), plantain (*Plantago major*), date palm (*Phoenix dactylifera*), sedge (*Cyperus sp.*), Egyptian clover (*Trifoliumalexandrium*),parsly (*Petroselonumsativum*), maize (*Zeamays*), chicory (*Chicoriumintypus*),Arabic gum (*Acacia arabica),* alfaalfa *(Medicago sativa),* bermuda grass *(Cynodonduydylon),* sun flower *(Helianthus annus), Sesban (Seasbaniasp),* eucalyptus (*Eucalyptus* sp.), rocket (*Eruco sativa*), carium (*Cariumcarvi*) and pimpinella (*Pimpinellaanisum*).

Percent pollen collection from major and minor pollen sources was calculated in weekly counts and then the monthly amount and percent were calculated.

Table (4) Month activity of pollen collection (gm / colony) by honey bee clolonies of Kharga Oasis New Valley, over 2011, year

Month	Vegetable source of collected pollen	Monthly total amount of collected pollen (gm . / colony)	Representation % of different floral source.	
			Monthly	Annually
Jan.	*Capparisaphylla*	50	41.67	1.74
	Viciafafa	33	27.05	1.15
	Coriandrumsativum	20	16.67	0.69
	Plantago major	15	12.05	0.52
	Cyperussp	2	1.67	0.07
Feb.	*Phoenix dactylifera*	45	50.0	1.56
	Coriandrumsativum	30	33.33	1.04
	Cyperussp	15	16.67	0.52
March	*Trifoliumalexandrium*	100	40.16	3.47
	Capparisaphylla	77	30.25	2.67
	Phoenix dactylifera	33	13.25	1.15
	Heliathusannus	29	11.65	0.01
	Partulacaaleracea	10	4.02	0.35
April	*Trifaliumalexandrium*	77	32.72	2.67
	Cariumcarvi	61	25.96	2.12
	Nighella sativa	51	21.71	1.77
	Pimpinellaanisum	46	19.57	1.60
	Phaenixdactylifera	23	8.91	0.80
May	*Trifaliumalexandrium*	256	31.60	8.89
	Acacia arabica	228	28.15	7.91
	Petroselonumsativum	164	20.25	5.69
	Medicago sativa	162	20.00	5.62
June	*Trifaliumalexandrium*	48	58.54	1.67
	Acacia arabica	22	26.82	0.76
	Zea mays L.	9	10.97	0.31
	Medicago sativa	3	3.66	0.10

cont. 4 Month	Vegetable source of collected pollen	Monthly total amount of collected pollen (gm . / colony)	Representation % of different floral source.	
			Monthly	Annually
July	*Acacia arabica*	55	30.05	1.91
	Zea mays L.	41	22.40	1.42
	Medicago sativa	34	18.58	1.18
	Chicoriumintypus	30	16.39	1.04
	Helianthus annus	23	12.59	0.80
August	*Acacia arabica*	57	40.14	1.95
	Medicago sativa	33	23.24	1.15
	Cynodonduydylon	30	21.13	0.10
	Helianthus annus	22	15.49	0.76
Sept.	*Zea mays L.*	137	33.25	4.76
	Acacia arabica	100	24.27	3.47
	Medicago sativa	87	21.12	3.02
	Cynodonduyctylon	39	9.47	1.35
	Helianthus annus	29	7.04	1.01
	Cyperussp	20	04.84	6.69
Oct.	*Zea mays L.*	126	52.5	4.37
	Cyperussp	48	20.0	1.67
	Eruca sativa	26	10.8	0.90
	Acaiaarabica	16	6.7	0.56
	Seasbania	24	10.0	0.83
Nov.	*Eucolyptusspp*	65	32.18	2.26
	Eruco sativa	63	17.82	2.19
	Partulocaalercea	47	23.27	1.63
	Cyperussp	17	8.42	0.59
	Plantogo major	10	4.95	0.35
Dec.	*Copparisaphylla*	25	26.86	0.80
	Eucolyptusspp	23	24.73	0.80
	Viciafaba	17	18.28	0.59
	Plantago major	12	12.90	0.42
	Seasbania sp.	12	12.90	0.42
	Partulacaalercea	4	4.30	0.14
Total				100

These results are in agreement with Nasr Allah (2009), he studied on pollen types collected by honey bee in Dakhla Oasis, and found 18 different pollen grains belonging to the different floral sources.Chaubal (1980), found occurrence in the samples of pollen grains of 45 species or genera and a flowering calendar of 59 species. Villanueva (1989), Arita and Fujii (1992) found the monthly pollen samples were usually a composition of many pollen types, including 1-4 dominant types.

Kirk (1994), identified pollen of 268 plants species in UK. He found that 3 colors for each species to show the range of variation (over 500 colors in total). Also, Freitas, (1994); Garcia et al (1999);Steffan – Dewenter and Kuhn (2002) and Webby (2004). They found that local vegetation play a significant role as to which pollens are collected by bees.

This study identify fewer and more productive months of pollen to identify periods of scarcity or lack of pollen to compensate with directive substitution or pollen supplements. Such information will be useful for improving honeybee colony status and development in New Vally especially during the pollen shortage periods.

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نشاط جمع حبوب اللقاح والتركيب النوعي لكتل حبوب اللقاح المجموعة بواسطة نحل العسل في الوادي الجديد – مصر

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تمت هذه الدراسة في منحل يقع في واحة الخارجة بمحافظة الوادي الجديد بمصر. وكانت مدة الدراسة عام ميلادي من يناير حتى ديسمبر ٢٠١١ في بعض مناحل واحات الخارجة – الوادي الجديد – مصر. ولقد عكست النتائج أن أعلى نسب مئوية للشغالات الجامعة لحبوب اللقاح (٢٨.١٢ و ١٤.٣ %) قد سجلا خلال مايو وسبتمبر على الترتيب. وكانت أقل نسب ٣.١٢ و ٢.٨٥ % قد لوحظا خلال فبراير ويونيو على التوالي.لوحظ أقصى عدد لجامعات حبوب اللقاح خلال الفترة من الساعة ١١ صباحاالى ١ ظهرا (٠.٢٣ نحلة / دقيقتين / طائفة). ولوحظ أقل عدد لجامعات حبوب اللقاح خلال الفترة من ٧ إلى ٩ صباحا (٠.١٣ نحلة / دقيقتين / طائفة). كانت أكبر كمية لحبوب اللقاح (٨١٠ جم / طائفة) قد جمعت خلال مايو تلاه سبتمبر (٤١٢ جم / طائفة). وكانت أقل كمية (٨٢ جم / طائفة) قد جمعت خلال يونيو وتبعه شهري فبرايروديسمبر (٩٠ و ٩٣ جم / طائفة) على التوالي. كان هناك إرتباط معنوي وموجب بين المعدل اليومي لدرجات احرارة وبين كمية حبوب اللقاح المجموعة حيث كان معامل الإرتباط = ٠.٣١٠. وجد أن هناك إرتباط معنوي جدا وسالب بين الرطوبة النسبية وكمية حبوب اللقاح المجموعة وكان معامل الإرتباط = -٠.٤٠٥. وقد أظهر التركيب النوعي لكتل حبوب اللقاح المجموعة أنه يوجد ٢٠ نوع نباتي مختلف في واحة الخارجة.إن مثل هذه المعلومات ستكون مفيدة لتحسين حالة طائفة نحل العسل وتطورها في الوادي الجديد خاصة في فترات نقص حبوب اللقاح.