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Population dynamics of *Varroa* mite infecting honeybees in Fayoum region, Egypt

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Abstract

A survey study was carried out for two successive years for monitoring population dynamics of the ectoparasitic *Varroa* mite infecting honeybees. Five chemically-untreated apiaries represented different provinces of Fayoum governorate, Egypt, were chosen. Naturally infested honeybee, *Apis mellifera carnica*, colonies situated in wooden Langstroth's hives were inspected regularly every 13 days. The obtained results under these circumstances showed that the infestation with *Varroa* mite was high in winter or autumn and was low in spring or summer on brood and on adult worker bees simultaneously, brood rearing activity and outdoor temperature are low leading to great danger to bee colonies in dearth period. So, the early mite control is very important. Although infestation in spring or in summer were obviously low, the damage is still expected, since female mites leave adult bees and reproduce in extended brood reared in these tow active seasons. Recording female mite categories in tested colonies indicated that one female mite/cell was the most frequent in the tested colonies in the tow years of study followed by two, three, four, five, six and finally ≥ seven female/cell.

Key Words: Honeybee - *Varroa* mite–Population dynamics-Fayoum-Egypt.

Introduction:

The ectoparasitic mite, *Varroa* destructor (=jacobsoni), is a serious parasite to honeybees worldwide. Besides feeding on haemolymph it causes colony disorder, weakness, decreasing brood and deforming bees. It also reduces colony ability to pollinate. Extensive colony mortality due to *Varroa* infestation all over the world were reported. Also, parasitizing by *Varroa* destroys the mechanical protective barriers of the integument and impairs the immune system of the bees (Glinski, 1991). So, different pathogens *i.e.* viruses and may fungi are probably transferred to bees by *Varroa*. Recently, six viruses could be transferred to *Varroa*-infested bees (Tentcheva *et al*. 2004). The present work aimed to record population dynamics of this important parasite during the year to observe the infestations and to contribute in mite controlling program.

Materials and methods

This work was conducted during two successive years; 1997/98-1998/99 to study seasonal fluctuations of the mite *Varroa* parasitizing honeybees. The locations, sampling and used techniques were as the following:

1.Locations of tested apiaries: 5 apiaries at 5 villages at the five districts of Fayoum governorate (1.Fayoum; Dar El-Ramad; apiary of Fayoum Fac. Agric., 2.Etsa; Herit, 3.Ibshawai; El-Gelani, 4.Tameia; El-Baharwa and 5.Sinnouris; Sanhour) were chosen. The distances away from Fayoum city are 3, 12, 18, 20& 10 km, respectively. Common cultivations were sweet clover, maize, cotton, sunfower, broad bean, eucalyptus, chamomile, marjoram, pot marigold and fruit orchards.

2.Tested colonies: 25 colonies (5 in each apiary) situated in Langstroth's hives, similarly of equal strength, bees covering 8 combs, headed with local Carniolan, Apis mellifera carnica, 1st hybrid queens were tested. No chemical treatments were applied to these colonies throughout the period of study.

3.Sampling: Samples were taken regularly at 13-day intervals. In the first year the sampling started at June 22, 23, 24, 25 & 26, 1997 and continued till June 8, 9, 10, 11 & 12,1998, and in the second year started at June 21, 22, 23, 24, & 25, 1998 till June 7, 8, 9, 10 & 11, 1999, in the previously mentioned apiaries respectively. *Varroa* infestations (%) were recorded as follows: About 100 adult worker bees were collected, if possible from combs with open brood, and dipped in water to which detergent (washing-up liquid) has been added. The bees were collected in a wire net, and removed after shaking several times. Mites would have fallen off them, and could be found at the bottom of the container (**Ritter, 1981)**. The bees and *Varroa* mites were counted and the infestation percentage (I.P.) was calculated using the equation:

I.P. = No. of *Varroa* mites / No. of bees X 100. On brood, an area of 5 x 5 cm of sealed worker brood in the middle of a sealed worker comb in every tested colony was used. Their cells were scratched and mature or immature *Varroa* females in each cell were recorded. Also the % infestation in cells was estimated.

4.Meteorology: Mean outdoor temperatures (°C) and relative humidity (RH%) in Fayoum governorate (from June 1997 till June 1999) were obtained from the Bulletin of Agricultural Meteorology, Ministry of Agriculture, Egypt.

5.Statistical analysis: Data collected were statistically analyzed and the treatment means were compared at 5% probability levels by LSD test, also correlation coefficients were calculated according to the methods given by **Snedecor and Cochran (1967)**.

Results

1. The *Varroa* infestation (%) on sealed worker brood:

For the 1st year, data in table (1) showed that all the tested apiaries were infested with the *Varroa* mite around the year with general mean 9.3%. The highest infestation (36.2%) was recorded in Fayoum district in winter (21/12/97) and lowest infestation (0.0%) was recorded three times in Tameia in summer (25/6, 21/7& 16/8/97) and in autumn (24/9/97). The infestation for the different districts throughout the whole year averaged 11.4, 9.5, 7.5, 8.4, and 9.8% for Fayoum (F), Etsa (E), Ibshawai (I), Tameia (T), and Sannouris (S), respectively with significant differences between F, E and I.

The average infestations for the four seasons were; 3.3, 11.2, 15.3 &7.4% for summer, autumn, winter and spring, respectively with significant differences between all values. In summer, the infestation averaged 3.6, 1.9, 1.7, 0.2, & 9.1% for F, E, I, T, and S, respectively. Statistical analysis showed that there was significant difference between the values of S and T while the other values did not differ significantly.

In autumn, infestation increased and averaged 11.7, 10.7, 10.8, 4.0, & 19.0% for the former districts, respectively. For the previous two seasons, values of T and S did not differ significantly. In winter, the infestation reached its maximum being 22.8, 13.2, 12.9, 18.9, & 8.5 % for the tested districts, respectively. Significant differences were found between all values except those of E and I. In spring, the infestation decreased to 7.4, 12.0, 4.6, 10.4 & 2.5% for F, E, I, T and S, respectively. There were insignificant difference between each of E&T, T&F, F&I and between I& S.

For the 2nd year, data in table (2) indicated that the general mean for infestation of *Varroa* mite was 9.7%. The highest infestation (25.0%) was recorded at F in autumn (16 /10 /98), while the lowest infestation (zero%) was recorded in spring (12/5& 7/6/99) for the same district. The average % infestation for tested districts were; 12.3, 9.5, 7.8, 8.3, &10.4% for F, E, I, T, & S, respectively with significant difference between F and each of E, I & S. For seasons, the infestation was low in summer (6.9%) and spring (3.1%) but was high in autumn (14.1%) and winter (14.5%) significant differences were found between autumn, summer and spring, while autumn and winter did not differ significantly.

For summer, % infestation averages were; 10.0, 9.3, 3.8, 3.4, & 7.7% for F, E, I, T& S, respectively, F, E &S values were insignificantly different. In autumn, high values; 19.1, 9.5, 9.1, 12.4 & 20.3% infestation were recorded for the same districts, respectively. Insignificant difference was found between E, I, T and also between F&S. In winter the % infestation was also high being 19.3, 10.5, 15.7, 15.1 & 12.2 % for the same districts, respectively I, T & S did not differ significantly, while F differed significantly with all values except for I. For spring, the % infestation values reduced, as in summer, representing 0.9, 8.6, 2.6, 2.1 & 1.3 % for the same districts, respectively. F, I , T & S did not differ significantly, while E differed significantly with all other values.

2. The *Varroa* infestation (%) on adult worker bees

For the 1st year, data presented in table (3) showed that the general mean % infestation of *Varroa* on adult worker bees was 7.8 % all over the whole year. The highest infestation (28.8%) was recorded in F in autumn (25/11/97), while it was zero% in T many times in summer (25/6, 16/8, 29/8/97), then in autumn (23/9/97) and also recorded 0.0 % one time in E in summer (23/6/97) .

The infestation throughout the whole year averaged 9.5, 8.7, 6.7, 4.9 & 9.3% for F, E, I, T& S, respectively with significant differences between I & T, while F, E & S did not differ significantly. In the four seasons % infestations were 2.9, 10.2, 13.2 & 5.1 % for summer, autumn, winter and spring, respectively with significant differences between all values. In summer, % infestations were low being 2.8, 2.6, 1.9, 0.2 & 6.7 % for F, E, I, T & S, respectively. Insignificant differences were found between the first for values, while the last one differed significantly with all these values. In autumn, these values increased to 13.0, 9.2, 8.8, 2.8 & 17.0 % for the same districts with significant differences between values except between E & I.

In winter, the infestation recorded its maximum increase, except for S, being 15.9, 15.4, 12.6, 10.3 & 11.6 %. The values of I, T & S were insignificantly different but each of these values differed significantly with that of F. In spring, the % infestation decreased in all the tested districts and averaged 6.3, 7.7, 3.3, 6.4 & 1.9 % for the same districts, respectively with insignificant differences between F, E & T or between I & S.

For the 2nd year, data presented in table (7) and illstrated in figure (6) indicated that the general mean of % infestation of *Varroa* on adult worker bees was 9.0 % throughout the whole year. The highest infestation (36.0 %) was recorded in F in winter (20/12/98) while it

recorded 0.0 % in summer (22/6 & 24/6/98) in E & T, respectively. The infestations averaged 12.5, 8.5, 8.4, 8.4 & 7.2 % for F, E, I, T & S districts, respectively all over the year with significant differences between F values and the rest ones which did not differ significantly in between. On the other hand, infestation averaged 3.3, 12.9, 16.1 & 3.3 % for summer, autumn, winter and spring, respectively with significant differences between summer, autumn and winter, while summer and spring did not differ significantly.

In summer, low infestation were recorded for the tested districts being 5.0, 2.7, 2.7, 1.8 & 4.4 % respectively without significant differences between the last four values, but the first value differed significantly with all ones except for the last one. In autumn, infestation increased to 18.7, 8.4, 12.3, 14.3 & 10.9 % for the same districts, respectively. Significant differences were found between F value and all other values.

In winter, high infestations were recorded being 23.2, 16.1, 15.8, 15.2 & 10.0 % for tested districts. F & S values differed significantly with all other values. In spring, low infestations (3.1, 6.7, 3.0, 2.2 & 3.7 %) were recorded for the same districts, respectively without significant differences between F, I, T & S values.

3. Intensity of infestation

Data in tables (5 & 6) showed the % of *Varroa* females of different categories; 1, 2, 3, 4, 5, 6 or ≥ 7 female mite (FM/cell) distributed in infested-brood cells. For the 1st year, data indicate that 1 FM is most frequent in all the colonies sampled throughout the year. The average percentage recorded was 47.84%, while the least frequent was for ≥ 7 FM/cell being 0.10% and the other values were; 24.05, 16.39, 7.85, 2.85& 0.92% for 2, 3, 4, 5& 6 FM/cell, respectively.

In summer, the distribution of female mites was; 60.17, 20.66, 11.19, 5.50, 1.78, 0.60& 0.09% for 1, 2, 3, 4, 5, 6& ≥7 FM/cell, respectively.

In autumn these values decreased for 1 FM/cell to 41.62% and to 0.07% for ≥7 FM/cell, and increased for other categories to 25.05, 18.39, 10.76, 3.19& 0.93% for 2, 3, 4, 5& 6 FM/cell, respectively. In winter, the average percentages were; 41.62, 25.05, 18.39, 10.76, 3.19, 0.93& 0.07% for the same categories, respectively.

In spring, the percentage increased for 1 FM/cell & 2 FM/cell to 50.78% & 25.31%, respectively, and decreased to 16.56, 4.94, 1.85, 0.55& 0.02%, for the other cases, respectively.

For the 2nd year, the same trend was observed. The average percentages were 41.57, 29.24, 17.02, 8.48, 2.82, 0.82% 0.05% for categories, respectively. In summer, the distribution of female mites was 40.51, 28.54, 19.05, 8.34, 2.38, 1.15& 0.03% for 1, 2, 3, 4, 5, 6& ≥7 FM, respectively. In autumn these values decreased for 1 FM to 39.20 % and increased to 29.56% for 2 FM, while in other categories they were 19.00, 8.84, 2.83, 0.48& 0.09 for 3, 4, 5, 6 & ≥7 FM, respectively. In winter, the average percentages were 37.71, 28.27, 18.03, 10.56, 4.60, 0.83 & 0.01% for the same categories, respectively. In spring, the percentages increased for 1FM& 2FM to 48.86% & 30.57%, respectively, while for the other categories they were 12.01, 6.19, 1.47, 0.83& 0.06%, respectively.

Discussion

The present findings are in disagree, partially, with those of Allam (1994), in Egypt, who found that infestations reached their highest levels during autumn and spring, followed by winter and recorded their lowest numbers during summer. She stated also that adult bees were less useful for determining infestation than samples from sealed brood. Shawer et al. (1999) found that July represented the month of lowest parasite infestation, while October

represented the highest one (37.0%). They added that solar radiation (direct sunlight) was found to decrease *Varroa* infestation (3.37%) while full shade was in contrary. Harbo and Zuhlke (1988) in USA, in early Feb., found that the number of mites per 100 adult bees ranged from 7 to 136 (average 19). Matthes et al. (1991) found in a 2-year study, that maximum infestation level with *Varroa* in worker brood in March 101.7 female mites/ 100 cells and 67.5 mites/100 bees in January. In the first year, mites were present in 10.9% of worker brood and in the second year in 31.5%. Higher *Varroa* infestations than those of the present study was recorded by El-Hady (2001), in Egypt, who found different levels of *Varroa* in honeybee colonies (from April-Sept.) at Kafr El-Sheikh (86.66 & 70.00 %), El-Qualubia (81.25 & 75.00 %), and El-Gharbia (62.50 & 83.33 %) governorates. in 1998 & 99, respectively. On contrary, Morsy (1998), in Alexandria, found that infestation levels of *Varroa* was very low during winter season, where the temperature is low and brood area is so limited. He attributed increased gradual rate of infestation during spring to rising temperature and wide brood rearing. He mentioned that the degree of infestation continued to increase during summer and autumn under the conditions of Alexandria. He added that strong or weak colonies do not affect the rate of infestation by the *Varroa* mite. Gergis (2002) claimed that insignificant differences were found among months, except Dec., in *Varroa* infestations on worker brood.

Concerning female mite categories, the high occurrence of 1 and 2 female mites/cell categories in summer and spring means that a high percentage either in *Varroa* infestation or in female fertility in the subsequent period could be expected.

In this respect, Kulincevic *et al.* (1988) and Otten (1990) showed that infertility in mite females increases when mites are produced out of the peak brood-rearing season (May to Aug.). Marcangeli *et al.* (1992) recorded a greater reproduction of the parasite in spring time and a large proportions of non-reproductive females. Such variation in reproduction levels could produce differential growth in mite populations during different seasons. As the number of mites per cell increased, a clear decrease in the reproductive rates observed from about three offspring per mite at 1/ cell to one offspring per mite at 6 mites/cell and decrease in the number of females reaching the adult stage. Parasitic intensity was high (up to 6 mites/cell) in winter and low (up to 2 mites/cell) in summer. At the 1 mite/cell, there were 38.7% males in the offspring, but at 6 mites/cell the proportion of males was 51.3%. During winter, a low number of brood cells were available resulting in a high proportion of highly infested cells and a reduced reproductive rate (Eguaras *et al.*, 1994).

Conclusion

The ectoparasitic *Varroa* mite, *Varroa destructor* Anderson and Trueman (formerly *V. jacobsoni* Oud.) is still one of the most important honeybee pests worldwide. Damages caused by this mite is not only impairing bees by direct haemolymph-feeding, but destroying defensive barriers in infested bees. Also, collapsing of colonies is much expected since, bee pathogens transferred by the mite (subsequent infections) are emphasized and magnituded by the mite performance. Under studied circumstances, the infestation with *Varroa* was recorded in all tested apiaries allover the year. High infestations were recorded in autumn or in winter, while low ones were recorded in summer or spring *vice versa* brood rearing activity. Reproducing of female mites in spring or in summer is a major factor in reinfestation. It was found from obtained results that one female mite per brood cell was the most frequent category followed by two females and then subsequent categories. Beekeeping precautions and control treatments must be carried out early at the end of honey flow (Aug.) otherwise weakness or maybe death of infested colonies will be expected in autumn or winter.

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الملخص العربي

ديناميكية تعداد أكاروس الفاروا المتطفل على نحل العسل فى منطقة الفيوم – مصر

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فى هذا البحث اختيرت خمسة مناحل تمثل مراكز محافظة الفيوم لدراسة تعداد أكاروس الفاروا على نحل العسل وذلك فى طوائف هجين أول كرينولي متقاربة فى قوتها ومصابة طبيعياً بالفاروا ولم تعامل بأية مادة كيماوية طوال فترة الدراسة التى استمرت عامين متتاليين. و قد دلت النتائج المتحصل عليها ظهور الإصابة على مدار العام فى كل مناحل الدراسة وسجلت أعلى إصابة فى الشتاء والخريف وكانت أقل إصابة فى الصيف والربيع وذلك فى عكس اتجاه تربية الحضنة. وبدراسة فئات إناث الطفيل فى عيون حضنة الشغالات وجد أن أكثرها شيوعاً وجود أنثى واحدة / عين سداسية تلاها اثنتان ثم ثلاثة وكان أقلها شيوعاً وجود سبعة إناث أو أكثر من الطفيل / عين سداسية. وفى ضوء هذه النتائج يجب التبكير فى مكافحة هذا الطفيل بعد انتهاء موسم الفيض (أغسطس) حيث أن الإهمال يؤدى إلى ضعف الطوائف وربما هلاكها فى الخريف والشتاء.

الكلمات الدالة: نحل العسل – طفيل الفاروا – ديناميكية التعداد – الفيوم – مصر.

Table (1). Infestation (%) of *Varroa* on sealed worker brood in different districts of Fayoum during 1997 / 1998.

Seasons	Inter-vals	Date	Districts					Mean
			Fayoum	Etsa	Ibshawai	Tameia	Sanouris	
Summer	1	22-26/6/97	3.4	0.2	2.0	0.0	3.8	1.9
	2	5-9/7	3.4	0.2	0.4	0.2	4.6	1.8
	3	18-22/7	3.6	1.6	1.0	0.0	3.4	1.9
	4	31/7-4/8	3.2	1.6	1.8	0.2	7.0	2.8
	5	13-17/8	2.2	1.6	0.6	0.0	9.2	2.7
	6	26-30/8	4.4	2.4	2.8	0.2	12.2	4.4
	7	8/9-12/9	4.8	6.0	3.0	0.6	23.8	7.6
	Mean		**3.6**	**1.9**	**1.7**	**0.2**	**9.1**	**3.3**
Autumn	8	21-29/9	6.0	14.0	4.4	0.0	24.0	9.7
	9	4/10-8/10	8.6	9.0	7.8	0.6	17.6	8.7
	10	17-21/10	13.4	7.6	8.8	2.4	17.2	9.9
	11	30/10-3/11	9.4	8.4	10.0	4.2	17.4	9.9
	12	12-16/11	10.6	6.0	14.2	6.2	18.6	11.1
	13	25-29/11	15.0	9.0	13.2	6.6	21.2	13.0
	14	8/12-12/12	18.6	21.0	17.0	8.0	17.0	16.3
	Mean		**11.7**	**10.7**	**10.8**	**4.0**	**19.0**	**11.2**
Winter	15	21-25/12	36.2	17.2	16.4	9.2	20.8	20.0
	16	3-7/1/98	28.4	10.0	15.2	19.4	14.6	17.5
	17	16-20/1	22.8	6.2	15.2	22.8	8.0	15.0
	18	29/1-2/2	22.8	10.8	10.8	21.6	2.8	13.8
	19	11-15/2	17.2	16.6	14.0	16.8	4.0	13.7
	20	24-28/2	18.2	17.0	11.8	21.2	6.8	15.0
	21	9-13/3	14.2	14.8	6.8	21.6	2.8	12.0
	Mean		**22.8**	**13.2**	**12.9**	**18.9**	**8.5**	**15.3**
Spring	22	22-26/3	11.8	16.8	7.8	21.2	2.8	12.1
	23	4-8/4	14.0	13.0	5.6	19.2	5.4	11.4
	24	17-21/4	7.4	14.6	4.2	14.8	2.4	8.7
	25	30/4-4/5	6.4	14.8	4.6	6.2	2.6	6.9
	26	13-17/5	5.0	9.8	3.6	5.0	2.4	5.2
	27	26-30/5	3.0	4.6	3.4	3.8	0.8	3.1
	28	8-12/6/98	4.0	10.6	2.8	2.6	1.2	4.2
	Mean		**7.4**	**12.0**	**4.6**	**10.4**	**2.5**	**7.4**
General mean			**11.4**	**9.5**	**7.5**	**8.4**	**9.8**	**9.3**

$LSD_{5\%}$	
Districts	1.74
Seasons	1.55
Districts X Seasons	3.48
Seasons X Intervals	4.11
Districts X Seasons X Intervals	9.20

Table (2). Infestation (%) of *Varroa* on sealed worker brood in different districts of Fayoum during 1998 / 1999.

Seasons	Inter-vals	Date	Districts					Mean
			Fayoum	Etsa	Ibshawai	Tameia	Sanouris	
Summer	1	21-25/6/98	10.4	4.6	2.0	2.8	2.6	4.5
	2	4/7-8/7	11.4	14.8	3.0	5.4	4.2	7.8
	3	17-21/7	8.2	10.6	2.4	3.4	5.6	6.0
	4	30/7-3/8	7.4	11.0	4.0	2.8	4.6	6.0
	5	12-16/8	6.8	7.2	4.4	2.8	10.8	6.4
	6	25-29/8	9.8	9.8	5.4	2.6	13.0	8.1
	7	7/9-11/9	16.2	7.2	5.6	4.0	13.4	9.3
	Mean		**10.0**	**9.3**	**3.8**	**3.4**	**7.7**	**6.9**
Autumn	8	20-24/9	14.8	9.0	5.2	5.8	17.6	10.5
	9	3/10-7/10	20.0	8.6	5.2	7.2	15.2	11.2
	10	16-20/10	25.0	10.4	6.8	9.4	19.8	14.3
	11	29/10-2/11	15.8	11.4	8.8	12.8	22.2	14.0
	12	11-15/11	15.4	9.0	8.4	14.0	23.6	14.1
	13	24-28/11	19.4	9.2	14.8	20.0	22.4	17.2
	14	7/12-11/12	23.0	9.2	14.2	17.8	21.6	17.2
	Mean		**19.1**	**9.5**	**9.1**	**12.4**	**20.3**	**14.1**
Winter	15	20-24/12	19.6	14.2	15.2	16.8	20.4	17.2
	16	2/1-6/1/99	20.8	14.4	12.4	17.8	18.0	16.7
	17	15-19/1	17.8	9.4	22.0	20.0	16.2	17.1
	18	28/1-1/2	19.4	5.2	19.8	24.2	14.4	16.6
	19	10-14/2	18.4	6.0	17.8	18.0	8.6	13.8
	20	23-27/2	21.8	11.6	13.2	5.2	4.2	11.2
	21	8/3-12/3	17.6	12.4	9.2	3.8	3.4	9.3
	Mean		**19.3**	**10.5**	**15.7**	**15.1**	**12.2**	**14.5**
Spring	22	21-25/3	1.6	14.4	5.0	3.8	1.8	5.3
	23	3-7/4	2.0	13.4	4.2	1.6	3.2	4.9
	24	16-20/4	1.6	13.6	3.2	3.6	1.2	4.6
	25	29/4-3/5	0.8	10.2	2.4	3.0	0.8	3.4
	26	12-16/5	0.0	3.4	1.4	1.6	1.0	1.5
	27	25/29/5	0.2	2.6	1.0	0.4	0.2	0.9
	28	7-11/6	0.0	2.4	0.8	0.4	0.6	0.8
	Mean		**0.9**	**8.6**	**2.6**	**2.1**	**1.3**	**3.1**
General mean			**12.3**	**9.5**	**7.8**	**8.3**	**10.4**	**9.7**

$LSD_{5\%}$	
Districts	1.97
Seasons	1.76
Districts X Seasons	3.94
Seasons X Intervals	4.66
Districts X Seasons X Intervals	10.42

Table (3). Infestation (%) of *Varroa* on adult worker bees in different districts of Fayoum during 1997 / 1998.

Seasons	Inter-vals	Date	Districts					Mean
			Fayoum	Etsa	Ibshawai	Tameia	Sanouris	
Summer	1	22-26/6/97	4.5	0.0	1.4	0.0	1.4	1.5
	2	5-9/7	0.8	1.9	1.6	0.2	1.8	1.3
	3	18-22/7	1.9	2.7	2.3	0.6	6.8	2.9
	4	31/7-4/8	3.2	2.1	1.4	0.2	8.0	3.0
	5	13-17/8	5.3	4.7	4.3	0.0	6.9	4.2
	6	26-30/8	3.3	3.0	1.3	0.0	13.0	4.1
	7	8/9-12/9	0.8	4.0	1.2	0.4	9.1	3.8
	Mean		**2.8**	**2.6**	**1.9**	**0.2**	**6.7**	**2.9**
Autumn	8	21-29/9	5.4	6.7	3.0	0.0	14.2	5.9
	9	4/10-8/10	7.5	5.4	4.1	1.3	15.5	6.8
	10	17-21/10	7.4	6.5	6.8	0.4	13.8	7.0
	11	30/10-3/11	9.4	7.4	8.4	2.8	15.6	8.7
	12	12-16/11	7.3	9.5	11.6	3.0	17.4	10.0
	13	25-29/11	28.8	11.7	13.8	4.8	21.6	16.1
	14	8/12-12/12	25.4	16.9	14.2	7.2	21.1	16.9
	Mean		**13.0**	**9.2**	**8.8**	**2.8**	**17.0**	**10.2**
Winter	15	21-25/12	14.6	14.7	17.6	9.7	24.0	16.2
	16	3-7/1/98	15.2	14.4	16.9	11.7	17.6	15.2
	17	16-20/1	17.9	15.9	16.0	14.7	12.7	15.4
	18	29/1-2/2	20.1	13.9	18.1	11.1	7.2	14.1
	19	11-15/2	14.5	14.7	9.5	6.7	6.9	10.5
	20	24-28/2	14.5	19.8	4.2	7.9	7.2	10.7
	21	9-13/3	14.5	14.2	6.0	10.4	5.2	10.1
	Mean		**15.9**	**15.4**	**12.6**	**10.3**	**11.6**	**13.2**
Spring	22	22-26/3	8.7	11.4	4.4	13.0	3.9	8.3
	23	4-8/4	15.3	13.5	3.3	13.0	1.7	9.4
	24	17-21/4	7.2	7.5	2.8	7.2	1.6	5.3
	25	30/4-4/5	4.4	7.1	1.6	4.8	2.8	4.1
	26	13-17/5	2.7	5.4	1.9	2.2	1.9	2.8
	27	26-30/5	3.7	4.9	3.9	2.7	0.9	3.2
	28	8-12/6/98	2.4	4.1	5.3	1.8	0.4	2.8
	Mean		**6.3**	**7.7**	**3.3**	**6.4**	**1.9**	**5.1**
General mean			**9.5**	**8.7**	**6.7**	**4.9**	**9.3**	**7.8**

$LSD_{5\%}$	
Districts	1.44
Seasons	1.29
Districts X Seasons	2.89
Seasons X Intervals	3.42
Districts X Seasons X Intervals	7.64

Table (4). Infestation (%) of *Varroa* on adult worker bees in different districts of Fayoum during 1998 / 1999.

Seasons	Inter-vals	Date	Districts					Mean
			Fayoum	Etsa	Ibshawai	Tameia	Sanouris	
Summer	1	21-25/6/98	2.8	0.0	1.6	0.0	1.0	1.1
	2	4/7-8/7	4.5	3.1	2.6	0.2	1.6	2.4
	3	17-21/7	6.2	3.8	2.5	1.2	3.0	3.3
	4	30/7-3/8	4.9	1.9	5.2	1.9	3.8	3.5
	5	12-16/8	4.6	4.2	2.3	2.3	4.3	3.6
	6	25-29/8	4.8	2.5	2.1	3.1	6.2	3.7
	7	7/9-11/9	7.4	3.3	2.4	3.6	10.6	5.5
	Mean		**5.0**	**2.7**	**2.7**	**1.8**	**4.4**	**3.3**
Autumn	8	20-24/9	8.3	4.3	3.2	7.2	10.0	6.6
	9	3/10-7/10	11.2	6.2	4.3	7.0	11.7	8.1
	10	16-20/10	7.9	6.6	6.8	11.2	10.8	8.7
	11	29/10-2/11	22.2	8.0	10.5	15.3	10.6	13.3
	12	11-15/11	22.8	9.3	16.5	17.6	10.6	15.4
	13	24-28/11	25.4	10.0	19.6	23.5	11.1	17.9
	14	7/12-11/12	33.3	14.5	25.0	18.6	11.2	20.5
	Mean		**18.7**	**8.4**	**12.3**	**14.3**	**10.9**	**12.9**
Winter	15	20-24/12	36.0	17.9	25.0	19.0	12.3	22.0
	16	2/1-6/1/99	24.4	18.4	21.1	20.1	11.0	19.0
	17	15-19/1	22.2	18.8	16.8	20.4	12.4	18.1
	18	28/1-1/2	23.6	16.5	14.2	22.1	8.8	17.1
	19	10-14/2	21.3	15.5	12.8	14.9	8.8	14.7
	20	23-27/2	19.7	13.6	12.1	5.4	8.5	11.9
	21	8/3-12/3	15.2	12.2	8.6	4.7	7.8	9.7
	Mean		**23.2**	**16.1**	**15.8**	**15.2**	**10.0**	**16.1**
Spring	22	21-25/3	11.3	11.7	6.4	4.0	8.7	8.4
	23	3-7/4	6.6	9.8	5.0	2.0	12.2	7.1
	24	16-20/4	2.4	8.9	4.4	3.3	2.3	4.3
	25	29/4-3/5	0.3	8.6	2.7	3.5	0.6	3.1
	26	12-16/5	0.4	3.3	1.1	1.8	0.8	1.5
	27	25/29/5	0.6	2.6	1.1	0.4	0.8	1.1
	28	7-11/6	0.2	1.8	0.6	0.2	0.6	0.7
	Mean		**3.1**	**6.7**	**3.0**	**2.2**	**3.7**	**3.7**
General mean			**12.5**	**8.5**	**8.4**	**8.4**	**7.2**	**9.0**

LSD $_{5\%}$

Districts	1.49
Seasons	1.33
Districts X Seasons	2.98
Seasons X Intervals	3.53
Districts X Seasons X Intervals	7.89

Table (5). Percentages (%) of *Varroa* female categories in different districts of Fayoum during 97/1998.

Seas-sons	Interv-vals	Categories of female mite (FM)						
		1 FM	**2 FM**	**3 FM**	**4 FM**	**5 FM**	**6 FM**	**≥ 7 FM**
Summer	1	74.47	17.02	0.00	4.26	2.13	2.13	0.00
	2	84.00	10.00	4.00	0.00	2.00	0.00	0.00
	3	57.08	29.60	10.57	2.11	0.00	0.00	0.63
	4	69.57	18.84	7.25	4.35	0.00	0.00	0.00
	5	60.29	13.24	17.65	7.35	1.47	0.00	0.00
	6	44.55	30.91	15.45	6.36	2.73	0.00	0.00
	7	31.25	25.00	23.44	14.06	4.17	2.08	0.00
	Mean	**60.17**	**20.66**	**11.19**	**5.50**	**1.78**	**0.60**	**0.09**
Autumn	8	41.32	26.86	23.14	7.44	0.83	0.41	0.00
	9	38.66	20.25	18.41	13.35	6.90	2.30	0.14
	10	42.28	28.46	17.07	9.76	2.03	0.41	0.00
	11	44.13	27.13	16.19	11.34	1.21	0.00	0.00
	12	42.91	21.64	21.28	11.18	2.16	0.72	0.11
	13	41.32	26.21	15.73	11.72	4.01	0.93	0.09
	14	40.74	24.79	16.93	10.55	5.15	1.72	0.12
	Mean	**41.62**	**25.05**	**18.39**	**10.76**	**3.19**	**0.93**	**0.07**
Winter	15	30.73	25.87	21.02	15.77	4.04	2.22	0.34
	16	33.56	28.00	18.51	10.65	6.94	1.85	0.49
	17	41.06	22.81	18.79	11.00	4.83	1.34	0.16
	18	45.93	20.06	20.93	7.85	4.36	0.87	0.00
	19	44.11	25.42	17.53	7.60	3.51	1.75	0.09
	20	37.55	27.63	19.05	9.39	3.76	2.41	0.21
	21	38.62	26.53	20.15	9.07	4.70	0.67	0.27
	Mean	**38.79**	**25.19**	**19.43**	**10.19**	**4.59**	**1.59**	**0.22**
Spring	22	45.57	24.26	15.41	9.18	3.93	1.64	0.00
	23	42.41	28.74	18.23	6.66	2.80	1.05	0.11
	24	61.29	21.66	13.36	3.23	0.46	0.00	0.00
	25	44.51	24.28	22.54	5.78	1.73	1.16	0.00
	26	50.39	27.13	19.38	1.55	1.55	0.00	0.00
	27	57.50	27.50	10.00	2.50	2.50	0.00	0.00
	28	53.77	23.58	16.98	5.66	0.00	0.00	0.00
	Mean	**50.78**	**25.31**	**16.56**	**4.94**	**1.85**	**0.55**	**0.02**
General mean		**47.84**	**24.05**	**16.39**	**7.85**	**2.85**	**0.92**	**0.10**

Table (6). Percentages (%) of *Varroa* female categories in different districts of Fayoum during 98/1999.

Seas-sons	Interv-als	Categories of female mite (FM)						
		1 FM	2 FM	3 FM	4 FM	5 FM	6 FM	≥ 7 FM
Summer	1	46.15	35.04	15.38	2.56	0.00	0.85	0.00
	2	36.60	30.93	19.59	10.31	2.06	0.52	0.00
	3	36.17	28.13	18.08	10.05	6.70	0.67	0.20
	4	35.57	28.86	22.15	10.07	2.68	0.67	0.00
	5	48.13	25.63	18.13	6.25	1.88	0.00	0.00
	6	37.93	27.59	20.20	9.85	2.46	1.97	0.00
	7	43.04	23.63	19.83	9.28	0.84	3.38	0.00
	Mean	**40.51**	**28.54**	**19.05**	**8.34**	**2.38**	**1.15**	**0.03**
Autumn	8	36.47	28.79	21.11	11.52	1.92	0.00	0.19
	9	34.71	31.02	22.53	8.12	2.58	0.74	0.30
	10	48.60	27.93	12.57	8.10	2.51	0.28	0.00
	11	34.08	31.55	20.56	9.30	3.66	0.85	0.00
	12	41.79	30.45	16.88	7.47	2.77	0.55	0.08
	13	39.58	29.98	19.44	7.03	3.51	0.47	0.00
	14	39.17	27.21	19.94	10.32	2.81	0.47	0.07
	Mean	**39.20**	**29.56**	**19.00**	**8.84**	**2.83**	**0.48**	**0.09**
Winter	15	37.36	28.72	17.28	10.74	4.67	1.17	0.07
	16	36.12	26.79	19.62	11.24	4.78	1.44	0.00
	17	44.05	25.24	15.95	9.29	4.76	0.71	0.00
	18	37.62	32.52	18.93	8.25	2.67	0.00	0.00
	19	34.78	30.43	18.26	10.43	5.80	0.29	0.00
	20	38.08	28.47	18.15	10.68	3.91	0.71	0.00
	21	35.97	25.70	17.99	13.28	5.57	1.50	0.00
	Mean	**37.71**	**28.27**	**18.03**	**10.56**	**4.60**	**0.83**	**0.01**
Spring	22	46.62	30.83	13.53	6.77	2.26	0.00	0.00
	23	48.00	27.20	12.80	7.20	2.40	2.40	0.00
	24	36.44	27.56	18.67	11.56	4.44	0.89	0.44
	25	45.88	27.06	15.29	10.59	1.18	0.00	0.00
	26	59.46	32.43	5.41	2.70	0.00	0.00	0.00
	27	54.55	31.82	9.09	4.55	0.00	0.00	0.00
	28	51.04	37.12	9.28	0.00	0.00	2.55	0.00
	Mean	**48.86**	**30.57**	**12.01**	**6.19**	**1.47**	**0.83**	**0.06**
General mean		**41.57**	**29.24**	**17.02**	**8.48**	**2.82**	**0.82**	**0.05**