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EFFECT OF ENVIRONMENTAL FACTORS ON THE INVENTORY AND POPULATION OF VARROA MITE, *VARROA DESTRUCTOR* IN HONEY BEE *APIS MELLIFERA* COLONIES IN DOKKI, Giza, EGYPT

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ABSTRACT: Population dynamics of Varroa destructor , Anderson and Trueman were studied along the autumn season of 2018 to the summer season of 2019 in 20 Apis mellifera , shaded or unshaded colonies, located in Dokki (Giza). The number of bees, the amount of open and capped brood , daily natural mortality, level of infestation of adult bees, and level of infestation of the brood, was monitored. The obtained results showed that the infestation with Varroa mite was high in winter and autumn and was low in spring and summer on brood and on adult worker bees. Relative humidity and outdoor temperature leading to great danger to bee colonies in dearth period. So, early mite control is very important. Successive brood cycles allow the population growth of Varroa, while the absence of brood during the summer months has the opposite effect of reducing populations of Varroa.

Key words: *Varroa destructor*, *Apis mellifera* ,temperature, relative humidity, shading.

INTRODUCTION

The pathogenic action induced by the parasite related to honey bee colony population dynamics. Africanized bees have a degree of tolerance to the mite (De Jong *et al.,* 1984; Camazine, 1986; Moritz and Mautz, 1990; Message and Goncalves, 1995, Vandame 1996; Medina and Martin, 1999; Anderson, 2000). Different growth of the mite population were also observed between European races, sub-races, ecotypes intra-racial and colonies and between different geographical areas (Ruttner and Hanel, 1992; . Branco *et al.*, 1999). 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).

Honey bees, *Apis mellifera,* colonies infected with many pathogens, parasites and pests which endangering their health and life (Rosenkranz *et al*., 2010) , This mite which feeds on haemolymph of brood and adult bees causes colony disorder, weakness, decreasing brood and deforming immature and mature bees (Kotwal and Abrol, 2013).

The majority of pathogens and parasites affecting honey bees have an almost worldwide distribution (Ellis *et al*., 2005) Also, parasitizing by Varroa destroys the mechanical protective barriers of the integument and impairs the immune system of the bees (Glinski, 1991) Honey bee colonies commonly die from *V. destructor* infestation within a few years if we're not treated (Fries *et al*. 2006), The temperature relations within honey bee colonies are complex, as honey bees thermo regulate their colonies according to the season and the presence or absence of brood (Seeley and Heinrich, 1981). *Varroa destructor* preferentially reproduces on at 32·5-33·4ºC temperature as it is the temperature on which drone brood maintained (Le Conte *et al.,* 1990). Various workers have tried to investigate

the relationship of *Varroa destructor* population with abiotic factors in *Apis mellifera* colonies (Martin *el al*., 2012).

It is also known that the dynamics of mite populations respond to the climatic conditions and the dynamics of bee populations (Presnce the brood and the number of male brood cells (Garcia Fernandez *et al.,* 1995).

The present work aimed to record the population dynamics of this important parasite during the year to observe the infestations and to contribute the mite control program.

The parasite population was monitored on adult bees, brood, and the naturally falling parasite for a comprehensive evaluation of the building-up trends during the year.

To study the population dynamics of *Varroa destructor* in *A. mellifera* intermission colonies, the development of the infestation levels of adult bees and brood of workers sealed, and the number of mites on the bottom board of the hive was studied in relation to population dynamics bee for a one year period. In addition, calculations of the number of the mite population were determined. The research was carried out in a fixed apiary under typical conditions of the Egypt beekeeping

MATERIALS AND METHODS

This study was conducted during the period from October 2018 to September 2019 in the experimental apiary of Bee Research Department, Plant Protection Research Institute in Dokki, Giza, Egypt. Ten colonies equal in strength from Italian and others from Carniolan were chosen for the experiments.

This work was conducted to study seasonal fluctuations of the parasitic mite, *Varroa destructor* infecting honeybees colonies .

1- Seasonal fluctuations of *Varroa destructor* infesting Carniolan and Italian honeybee colonies :

Percentages of varroa infestation, at the four seasons under study , for each colony in the examined races was determined as older brood (pupae with pigment eyes), in 50 drone and worker cells. While, the infestation percentages of adult workers was determined in 100 living workers, which was directly taken directly from the combs. The previous methods were based according to the technique of (De Jong *et al.,* 1982). Examination was done for Carniolan and Italian races at 14 days intervals.

To determine the rate of infestation with varroa mite on the adult worker of an experimental colony, sample of about 100 workers was taken in a glass bottle filled with a soapy water mixture, the bottle was closed with its cover, shacked well and the bottle content was sieved, from the detergent solution using a wire screen (12 mesh/inch). These mites were counted and the percentage of infestation of adult bees were calculated, using the following formula:

$$\text{Infestation (\%)} = \frac{\text{Total no. of recorded mites}}{\text{Total no . of examined workers}} \times 100$$

Mean outdoor temperatures (°C) and relative humidity (RH%) in Cairo (from October 2018 to September 2019) were obtained from :
https://www.wunderground.com

2- Natural mortality of mites fallen on the hive bottom board:

A white paper card covered with vaseline was put on the bottom board under the brood chambers of each colony and observed at two days intervals for the presence of naturally dead mites which were counted and recorded. The data were calculated as a mean /14 days according to Ritter *et al*., 1989, and Milani, 1990.

3- Varroa mite numbers in the infested sealed brood cells:

The mite numbers (adult &immature stages) found naturally inside the infested sealed brood cells for each examined colony were counted and recorded, the older brood (pupae with pigment eyes) in drone and worker cells (50 individuals for each and three colonies for each treatment). The examination was done for all groups of bee races every 14 days intervals as mentioned by the techniques of (Marcangeli *et al.,* 1992). (Each application represent by three colonies to obtain the total number of 12 experimental colonies).

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 examined. Their cells were scratched and mature or immature Varroa females in each cell were recorded. Also the infestation in cells was estimated.

In each tested colony, 25 of sealed worker brood cells were opened using a sharp needle and the number of infested cells with varroa mite was counted and recorded. The percentage of infestation was calculated according to the following formula:

$$\text{Infestation (\%)} = \frac{\text{No. of infested cells}}{\text{Total no. of examined cells}} \times 100$$

4- Varroa extraction and enumeration:

One hundred 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.

The Varroa mites were counted and the infestation percentages (I.P.) were calculated using the equation:

$$\text{Infestation (\%)} = \frac{\text{No. of Varroa mites}}{\text{Total no . of examined bees}} \times 100$$

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 AND DISCUSSION

1- Effect of shading process in Italian and Carniolan hybrids of honey bee colonies on *Varroa destructor* numbers along four seasons:

1-1 Natural mortality of mites:

As for shaded colonies, the obtained results in Table (1) and illustrated in Figs. (1 , 3, 4, 5) indicated that the natural mortality of mites at Carniolan colonies was higher than those of Italian ones. Moreover, the highest numbers of natural mortality of the mites were recorded at Autumn season (42,52 , 33.23 mite per colony) for Carniolan and Italian colonies , while the least numbers were recorded at Spring season (12.85 , 22.59 mite per colony) for Carniolan and Italian colonies.

Regarding to that unshaded colonies results in Table (2) and illustrated in Fig. (2, 3, 4, 5) indicated that the highest numbers of natural mortality of the mites were recorded at Autumn season (42,52 , 33.23 mite per colony) for Carniolan and Italian colonies , while the least numbers were recorded at Spring season (12.85 , 22.59 mite per colony) for Carniolan and Italian colonies.

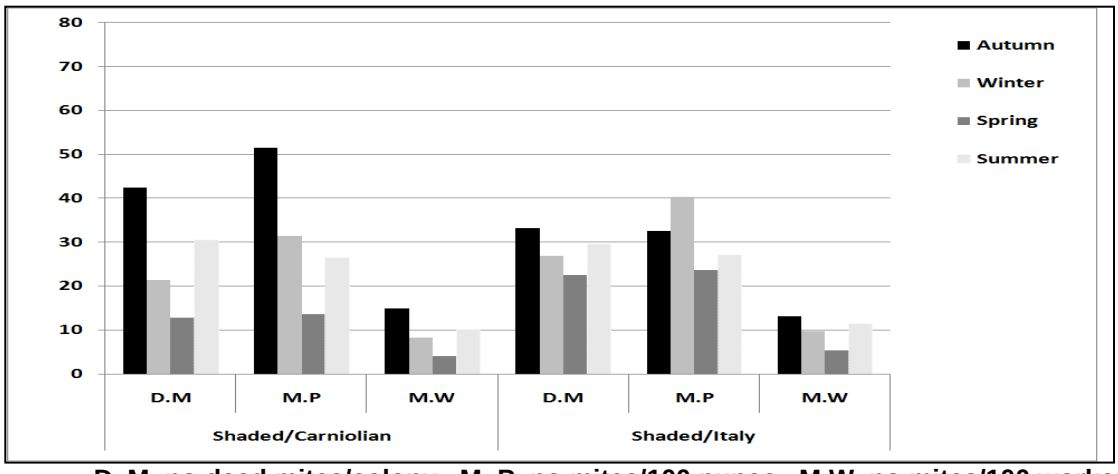
As for numbers of varroa mites per 100 pupa , results in Tables (1 , 2) indicated that the highest numbers of mites were recorded at Autumn season on Carniolan bee under shaded or unshaded conditions giving 51.45 mites, while the least numbers were recorded at

Spring season under unshaded Italian colonies at Spring season giving only 4.1 mite per 100 pupa, Also, the least numbers of varroa mites were found under shaded or unshaded conditions on Carniolan bees giving 12.61 and 13.55 mites per 100 pupa.

As for numbers of varroa mites per 100 bee worker, results in Tables (1 , 2) indicated that the highest numbers of mites were recorded at Autumn season on Carniolan bee under shaded or unshaded conditions giving 15.3 and 22.44 mites ,while the least numbers were recorded at Spring season under unshaded Italian colonies at Spring season giving only 3.17 mite per 100 worker , Also, the least numbers of varroa mites were found under shaded or unshaded conditions on Carniolan bees giving 4.11 and 5.61 mites per 100 worker.

Table (1): Effect of shading process in Italian and Carniolan hybrids of honey bee colonies on *Varroa destructor* population along four seasons.

Season	Italian colonies			RH %	Temp
	No. dead mites/colony	No. mites/100 pupae	No. mites/100 worker		
Autumn 2018	33.23±13.87	32.61± 3.18	13.22 ± 4.96	57.033	21.167
Winter 2019	26.85 ± 6.08	40.33± 8.09	9.77± 3.09	51.567	15.833
Spring 2019	22.59±5.86	23.61±7.74	5.44 ±1.08	45.3	25.933
Summer 2019	29.56±11.29	27.17±13.27	11.45±6.14	54.9	29.533
Season	Carniolan colonies			RH %	Temp
	No. dead mites/colony	No. mites/100 pupae	No. mites/100 worker		
Autumn 2018	42.52± 3.40	51.45±12.23	15±3.04	57.033	21.167
Winter 2019	21.48±10.18	31.39±14.73	8.22±5.20	51.567	15.833
Spring 2019	12.85±3.94	13.55±3.04	4.11±1.27	45.3	25.933
Summer 2019	30.59±11.84	26.50±15.62	10.11± 4.51	54.9	29.533

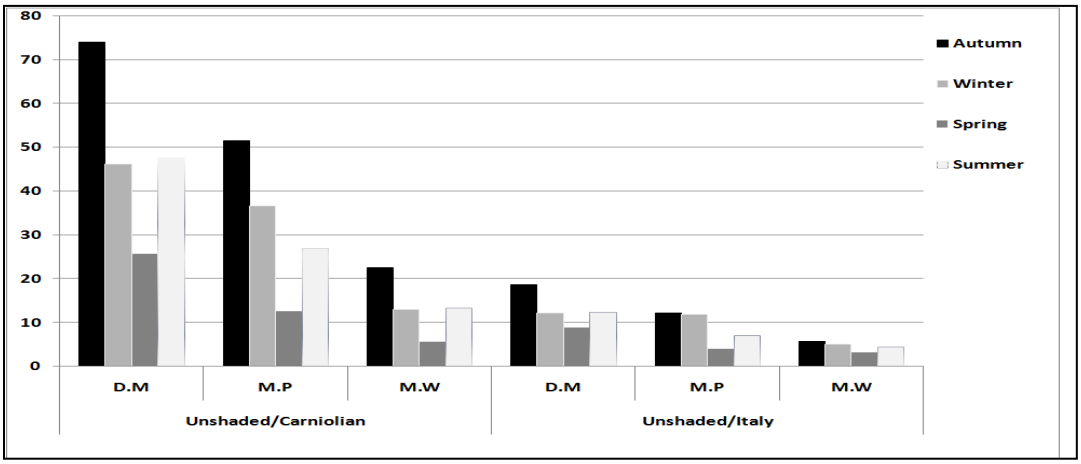


D. M. no dead mites/colony, M. P. no mites/100 pupae, M.W. no mites/100 worker

Fig (1): Effect of shading process in Italian and Carniolan hybrids of honey bee colonies on *Varroa destructor* population along four seasons.

Table (2): Effect of unshaded Italian and Carniolan hybrids of honey bee colonies on *Varroa destructor* population along four seasons.

Season	Italian colonies			RH %	Temp
	No. dead mites/colony	No. mites/100 pupae	No. mites/100 worker		
Autumn 2018	18.56±3.17	12.11±3.26	5.72±2.34	57.033	21.167
Winter 2019	12.22±3.04	11.88±4.39	5±0.44	51.567	15.833
Spring 2019	8.85±1.87	4±1.73	3.17± 0.73	45.3	25.933
Summer 2019	12.33±4.37	6.89±3.59	4.39±0.98	54.9	29.533
Season	Carniolan colonies			RH %	Temp
	No. dead mites/colony	No. mites/100 pupae	No. mites/100 worker		
Autumn 2018	74.04±3.38	51.45±12.19	22.44±1.92	57.033	21.167
Winter 2019	46.18±23.63	36.61±17.85	12.89±4.56	51.567	15.833
Spring 2019	25.74±4.50	12.61±4.85	5.61±1.46	45.3	25.933
Summer2019	47.67±22.17	26.89±16.46	13.33±7.59	54.9	29.533



D. M. no dead mites/colony, M. P. no mites/100 pupae, M.W. no mites/100 worker

Fig (2): Effect of unshaded Italian and Carniolan hybrids of honey bee colonies on *Varroa destructor* numbers along four seasons.

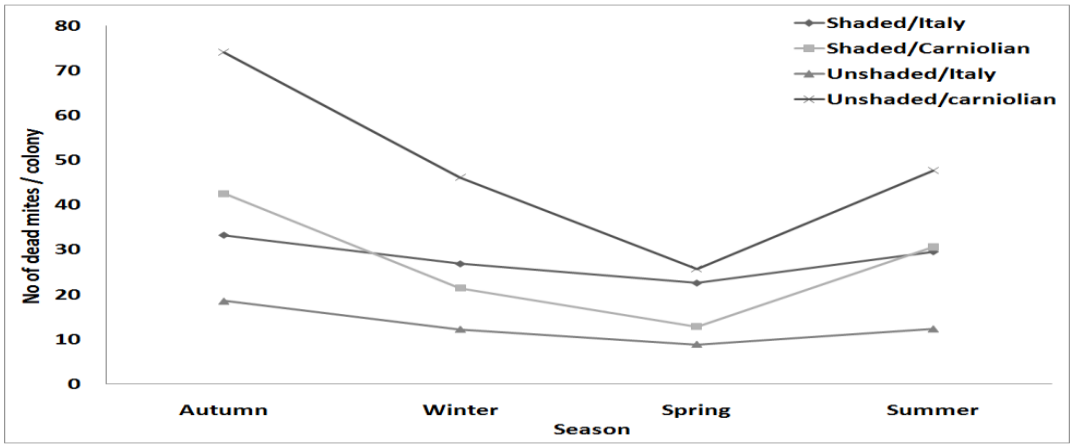


Fig (3): Seasonal mean numbers of dead mites /colony in the tested hybrids.

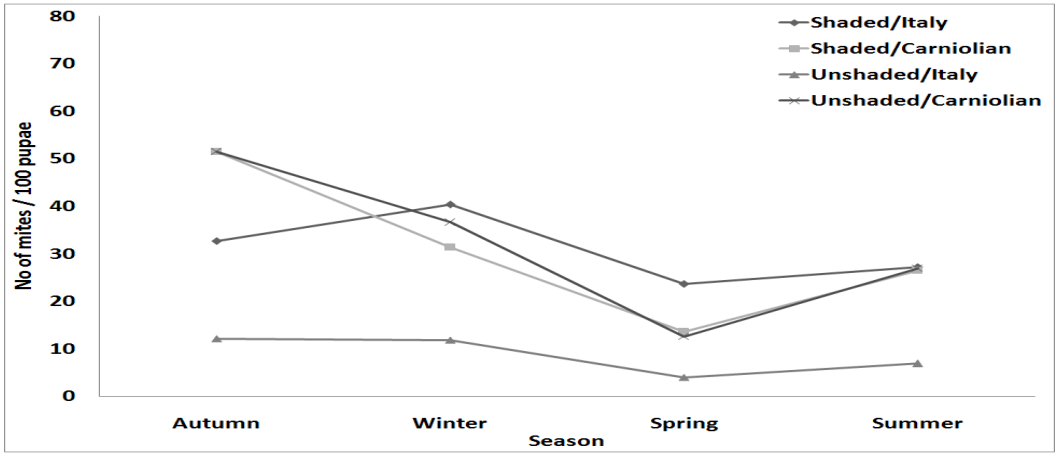


Fig (4): Seasonal mean number of mites /100 pupa in the tested hybrids.

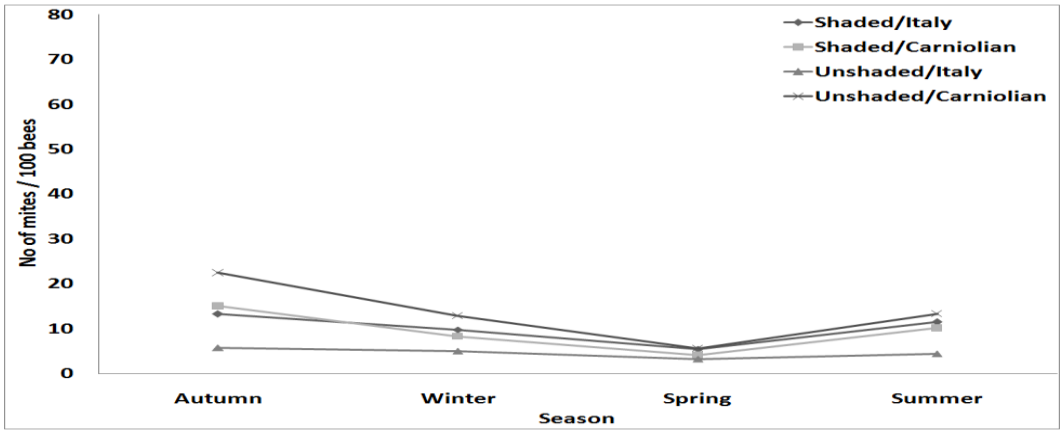


Fig (5): Seasonal means number of mites /100 worker bees in the tested hybrids.

2- Effect of air temperature and humidity on *Varroa* numbers infesting honey bee stages along 4 seasons under shading or unshaded process in Italian and Carniolan hybrids.

The statistical analysis of the obtained results in Tables (1 & 2) revealed that there were positive significant correlation between temperature degrees and varroa population as well as between relative humidity and varroa population as follow:

1- Temp. and No of mites / 100 worker for Italian hybrids in shaded colonies (r =0.008372)

2-Temp. and No of mites / 100 worker for Carniolan hybrids in shaded colonies (r=0.010263)

3- Temp. and No of mites / 100 pupae for Italian hybrids in unshaded colonies (r =0.006872)

4- Temp. and No of dead mites / colony for Carniolan hybrids in unshaded colonies (r=0.0500)

5- RH% and No of mites / 100 pupae for Italian hybrids in shaded colonies (r =0.003061)

6- RH% and No of mites / 100 pupae for Carniolan hybrids in shaded colonies (r =0.040889)

These data are in agreement with those of Helmy *et al.* (2005) who found that there was a highly positive correlation between dropped Varroa and each of mean temps. or % R.H., since r values were 0.714 & 0.777, respectively.

Our investigation inspected the effect of *V. destructor* on slipping off and settlement size boundaries of *Apis mellifera scutellata* under common invasion levels. African bumble bees for the most part slip away because of trouble some natural conditions, human unsettling influence and parasitism (Hepburn and Radlof , 1998, Strauss *et al*., 2015). The stealing away pace of the analyzed *Apis mellifera scutellata* honey bees (7 out of 20 provinces, addressing 35%) is like those revealed already in Ugandan honey bees (38–45%) (Chemurot *et al.,* 2016) and Ethiopian honey bees (41.1%) (Gebremedhn *et al.,* 2019). In this investigation, stealing away happened during July because of low measure of covered brood and diminished rummaging, particularly for dust, which had all the remarks of being influenced essentially by settlement size as opposed to levels of parasitism.

Comparable outcomes were accounted by Mcmenamin *et al.* (2017). States scrounged in a similar environmental territory, accordingly approached a comparable sort and measure of assets, so varieties in the measure of dust among provinces may be brought about by differences in searching effort by the grown-up honey bees and at last by their number. Brood infections, for example, American foulbrood, European foulbrood, Nosema and *V. destructor* can likewise prompt departing suddenly of bumble bee provinces (Kurze *et al.,* 2016). As knowledgeable about different pieces of the world, bumble bee populaces in Africa have additionally been effected by the presentation of these microorganisms, parasites, and bugs just as territory misfortune (Hussein, 2001a, 2001b; Dietemann *et al.,* 2009). In any case, the pace of stealing away estimated during the checking time frame in this investigation was not identified with *V. destructor* pervasion, yet to diminished quantities of covered brood. This is steady with past investigations which detailed that slipping away in Africanized bumble bees states happened following diminished brood, put away dust, nectar, and nectar (Winston *et al.,* 1979).

Fries *et al.* (1994) revealed that before a province turns out to be seriously swarmed, *V. destructor* antagonistically meddles with brood creation. Along these lines, there is a requirement for close checking of *V. destructor* pervasion levels inside *Apis mellifera scutellata* states to decide the fine-scale elements of invasion, province size, and scrounging. Dust stockpiling levels have a direct effect on the province size as they are identified with quick state development rates through brood creation which thus may prompt expanded

One cause of this fall would be the drastic reduction of capped brood during the summer period. Robaux and Nolet (1985) point out that, in heavily infested colonies, capped brood decreased comparatively much faster than the open brood. They explain this drop that bees abandon the old and heavily infested brood firstly, and secondly the brood perished due to cooling caused by a reduction in the strength of the colony.

Moretto *et al.* (1991) found significant differences of infestation in three different climatic regions in Brazil, when they used the same races of bees. In addition, Otten (1991) recorded that the number of mites in brood cells were significantly different between colonies; the highest reproduction rate of mite in spring was in *Apis mellifera carnica* and in summer for *Apis mellifera.*

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تاثير العوامل البيئية على حصر وتعداد اكاروس الفاروا فى طوائف نحل العسل فى منطقه الدقى

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[2] قسم الحشرات الاقتصادية والحيوان الزراعى كلية الزراعة جامعة المنوفية شبين الكوم مصر.

الملخص العربى

تمت دراسة ديناميكيه تعداد طفيل الفاروا لمدة عامين (خريف 2018–صيف 2019) في 12 طائفه لنحل العسل الموجودة في الدقي (الجيزة). تم رصد عدد النحل ، وكمية الحضنة المفتوحة والمقفوله ، و الطبيعي اليومي ، ومستوى إصابة النحل البالغ ، ومستوى إصابة الحضنة. وأظهرت النتائج التي تم الحصول عليها في ظل هذه الظروف أن الإصابة باكاروس فاروا كانت عالية في الشتاء و الخريف وكانت منخفضة في الربيع و الصيف على الحضنة وعلى النحل البالغ في وقت واحد، نشاط تربية الحضنة ودرجة الحرارة في الهواء الطلق منخفضة مما يؤدي إلى خطر كبير على طوائف النحل. لذا ، فإن التحكم المبكر في الاصابه مهم جدا. تسمح دورات الحضنة المتتالية بزياده تعداد طفيل الفاروا ، في حين أن غياب الحضنة خلال أشهر الصيف له تأثير معاكس على تقليل طفيل الفاروا.

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