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PREDACIOUS AND PARASITIC MITES ASSOCIATED DRY COTTON BOLLS AND THEIR EFFICIENCY FOR CONTRPLLING PINK BOLLWORM *PECTENOPHORA GOSSYPIELLA* (SAUNDERS)

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ABSTRACT: *Eight mite species (7 predators and 1 parasite), belonging to 2 Orders and 2 Suborders and six familles were found to be associated with the dry cotton bolls collected from Kalubyia Governorate during the period from Sept. 2002 to May 2003. The predacious mite species were, Blattisocius sp (Fam:Ascidae); Hypoaspis sp (Fam: Laelapidae); Amblyseius sp, Typhlodromus sp and Phytoseius sp (Fam: Phytoseiidae); Anystis sp (Fam; Anystidae) and Hemicheyletia sp (Fam: Cheyletidae). The parasitic mite Pyemotes herfsi Odemans (Family Pyemotidae) was the most common among all the collected mite species, represented by 75% of the total collect mites, followed by 14% of the mites belonging to Family Phytoseiidae. At the beginning of Jan., the population of Pyemotid mites was found in low levels (Jan. and Fab.), then increased at the beginning of Mar. and sharply increased during May. The population fluctuations were discussed in details. Laboratory tests were performed to asses the potential of the parasitic mite P. herfsi as biocontrol agent against the Pink bollworm (PBW) Pectinophora gossypiella (Saunders). The 1st larval instar died after 1day while the 4th larval instar died after 3.6± 0.4; 2.6±0.51 and 1.4±0.25 days when exposed to 2, 4 and 8 individuals of female parasitic mite. One day old pupal stage died after 5.2±0.58 days when exposed only to 8 individuals of parasitic mite. When the parasitic mites introduced to the 1st larvae, no egg-sacs were observed. Concerning the 4th instar, the percentage of egg-sacs ranged from 80-95% and the number of mite progeny ranged from 6.7 to 15.05 individual /1 female mite and the percentage of egg-sacs was 55% at the inoculum level of 8 parasitic mites /1pupa.*

Key Words: *Predacious and Parasitic mites, Pyemotes herfsi, Pink bollworm, Pectinophora gossypiella. Biological control*

INTRODUCTION

Profitable cotton production in Egypt depends on successful and efficient pest management programme which reduce the risk disastrous crop losses caused by pests. Pink bollworm, *Pectinophora gossypiella* (Saunders) is the most important insect pest attacking bolls. It feeds on squares, flowers and immature bolls. It also attacks the flower ovary causing flower's shedding (El-Feel, *et al.* 1991 and El-Sorady, *et al.* 1998). In the last few decades, the biological agents became one of the main elements within any integrated pest management programme. Predaceous and parasitic mites are among the major, and relatively unutilized, resources for biological control agents for practically all classes of pests (Gerson and smiley, 1990). Phytoseiids are the best – known predators among the Acari, and could be easily mass-reared and shipped (Overmeer, 1985). Several species have attained commercial status. The predacious mite *Phytoseiulus persimilis* Athias – Henriot, is currently being reared and sold for the biological control of spider mites (Especially *Tetranychus urticae* koch) infesting greenhouse crops in many parts of the world (McMurtry, 1982). Phytoseiids also prey on various other pests (McMurtry and Rodriguez, 1987). In Egypt, the Pyemotid mite *Pyemotes herfsi* (Oud.) induced mortality reached up to 85% in the first generation larvae of the Pink bollworm *P. gossypiella* (Tawfik and Awadallah 1970). During studies on adult emergence from larvae of the gelechiid *P. gossypiella* collected from seeds of cotton fields and ginning factories. Naresh and Balan (1985) mentioned that 48.56% of the larvae were parasitized by the mite *P. ventricosus*

One of the important factors which regulated the population of some stored product pests of groundnuts in storehouses was found to be the parasitic mite *P. tritici* (Matokoto *et al.* 1987). The parasitic mite *P. tritici* is of considerable interest not only as being associated with human dermatitis but also as a possible biological control agent of *Solenopsis invicta* of stored grain pests (Thorvilson *et al.* 1987). Pyemotid mites are common parasites of many species of Lepidoptera, Coleoptera, and Hymenoptera. They have been associated incidentally with virtually every insect order, paralyzing and ultimately killing their hosts (Bruce and Wrensch 1990).

The present study covering the following points:

1- Survey and studying the population fluctuation of the predaceous and parasitic mites associated with dry cotton bolls to declare their role against the Pink bollworm.

2- Evaluate the efficiency of the most common biocontrol agent of the recorded mites against the Pink bollworm.

MATERIALS AND METHODS

1- Survey of predaceous and parasitic mites associated with cotton bolls:

To study the incidence of the predaceous and parasitic mites associated with cotton bolls, regular samples of one hundred bolls were collected randomly in cloth bags from stored cotton sticks at two weeks interval from Sept. 2002 to May 2003 at Kalubyia Governorate. Samples were transferred to the laboratory of Plant Protection Department, Faculty of Agriculture, Ain shames University for mite extractions.

Samples were placed on muslin in Tullgren (modified Berlese) funnels (10 bolls /funnel). The extracted mites were received in Petri- dishes filled with about 25 cm of tap water. Twenty four hours later, extraction contents of the Petri dishes were examined by using the dissecting microscope. The extracted mites were mounted on microscopic glass slides in modified berlese fluid (Schuster and Pritchard, 1963) for identification and counting using light microscope. The identification of mites was carried out to the families and species levels (The mature females were used to recognize the species), using keys erected by Baker&Wharton, (1952); Elbadry, (1970); Krantz, (1978) and Zaher (1986). The found taxa were described using the criteria of dominance as well as the symbols denoting degree of infestation used by Cusack *et al.* (1975). This was summarized in table (2) as following:

Dominancy

D = Dominant: species forming more than 11.1% of the total mite population.

I = Influent: species forming between 5.6 and 11.1% of the total mite population.

R = Recedent: species forming less than 5.6% of the total mite population.

2- Efficiency of the ectoparasitic mites *Pyemotes herfsi* (oud) in controlling of Pink bollworm (PBW) *pectinophora gossypiella* (saunders):

a- Source of mites:

Well-grown females of *P. herfsi* were obtained from cotton bolls as mentioned previously. The female mites were transferred to small Petri dish of 5 cm in diameter, supplied with the late instar of PBW larvae. The small Petri dish was placed in larger one filled with water to prevent mite escape (Hafez, 1977). Pink bollworm larvae were added from time to time to maintain the culture of mites.

b- Source of the larval and pupal stage of PBW.

The 1st, 4th larval instars and pupal stage of PBW were obtained from mass rearing culture at bollworms Research Dept., Plant Protection Research Institute at Doki Giza, Egypt.

c- Laboratory bioassay experiments.

To evaluate the effectiveness of *P. herfsi* on the larval instars and pupal stage of PBW, rearing circular plastic cells (2.5 cm diameter and 1.5 cm high), with a layer of mixture of plaster of Paris and charcoal (9:1) on its bottom to depth 3mm were used (El-Khateeb, 1998).

Insect first instar larvae of PBW were individually inoculated with 2, 4 and 8 female mites. Observations were done after each 24 hours and the number of dead larvae was recorded to determine the period before death. Treatments were replicated 5 times. The same procedure was done for the fourth instar larvae and one day old (1-d.old) pupal stage. Rearing cells were incubated at 25±1°C and 75±3 R.H. Check were used in parallel with each treatment.

To determine the effect of the host stages on the female mite progeny, percentages of egg sacs were calculated at 4th day from inoculation, while the number of progeny of mite females were counted from the beginning of emergence till 14 days from inoculation of the same experiment.

RESULTS AND DISCUSSION

1- Survey and population fluctuations of predaceous and parasitic mites associated with cotton bolls:

a- Survey

Eight mite species were recorded during the present study. These mite species were belonging to 2 orders; 2 Suborders and 6 families: Order Parasitiformes; Suborder Gamasida represented by 5 species belonging to 3 families: Family Ascidae (*Blattisocius sp.*); Family Laelapidae (*Hypoaspis sp.*); Family Phytoseiidae (*Amblyseius sp*; *Typhlodromus sp* and *Phytoseius sp.*). While Order Acariformes; Suborder Actinedida represented by 3 species belonging to 3 families: Family Anystidae (*Anystis* sp.); Family Cheyletidae (*Hemicheyletia sp.*) and Family Pyemotidae (*Pyemotes herfsi* Oud.). All the recorded mite species were predators except *P. herfsi*. (Table 1)

Table (1): Mite taxa associated with dry cotton bolls collected during the period from sept. 2002 to May 2003 at Kalubyia Governorate.

Mite taxa				
Order	Suborder	Family	Species	Feeding habits
Parasitiformes	Gamasida	Ascidae	*Blattisocius sp.*	Predator
		Laelapidae	*Hypoaspis sp.*	Predator
		Phytoseiidae	*Ambylyseius sp.*	Predator
			Typhlodromus sp.	Predator
			Phytoseius sp.	Predator
Acariformes	Actinedida	Anystidae	*Anystis sp.*	Predator
		Cheyletidae	*Hemicheyletia sp.*	Predator
		Pyemotidae	*Pyemotes herfsi* (Oud.)	Parasite
No. of mite taxa	2	6	8	

b- Population fluctuations and dominancy

Data given in (Table 2) revealed that, five predaceous mite families (Ascidae, Laelapidae, Phytoseiidae, Anystidae and Cheyletidae) and one parasitic mite family (Pyemotidae) were collected from dry cotton bolls during the period from Sept. 2002 – May 2003 at Kalubyia Governorate.

However the most common mite families were Pyemotidae (856.0 individuals) followed by Phytoseiidae (159.0 individuals), representing 75.1 % and 14% of the total mites respectively. A moderate numbers were recorded of the family Ascidae (33.0 individuals) and Cheyletidae (70.0 individuals), representing 2.9% and 6.1% of the total mites respectively. It could be concluded that family Pyemotidae and Phytoseiidae were "dominant" but family Cheyletidae was "influent" while the other families were "resident". However the obtained results supported by the finding of Youssef *et al.* 1976 and Naresh & Balan 1985 who mentioned that the phytoseiid *Amblyseius gossipi* Elbadry , *A. swirskii* (Athias-Henriot), *A. mumae* (Shehata & Zaher), *A. cydnodactylon* (Shehata & Zaher), *Phytoseius plumifer* mites were the most abundant predator mites collected from the field, while in the contrary, pyemotid mites *Pyemotes ventricosus* were the most abundant in the cotton seeds collected from the ginning factories than those collected from the fields.

Regarding to the normal distribution of the recorded mite families encountered cotton bolls during the period of this investigation, it could be observed that, families of Laelapidae and Anystidae were recorded only during Sept. and Mar. while family Ascidae recorded during April. and May. On the other hand family Phytoseiidae recorded during the period from Sep. to Mar. with a total number of mites ranged between 5 to 96 indiviuals/month. Family Cheyletidae found during the period from Dec. to Mar. with a total number ranged from 2 to 51 individuals/ month. Also family Pyemotidae found during the period from Jan. to May with a total number of mites ranged from 20 to 460 individuals/month. (Table 2).

Concerning family Pyemotidae (*P. herfsi*), the present data obviously revealed that, no mites was detected during the period from Sept. to Dec. However, at the beginning of Jan. the population was in low levels (Jan. and Feb.), then increased at the beginning of Mar. Moreover, sharply increase was observed during May (Table 2). However our finding strongly supported by the results obtained by (Tawfik and Awadallah 1970) who mentioned that the first record of resting Caterpillars of *Pectinophora gossypiella* parasitized by the swelling females of *P. herfsi* was obtained from samples examined on Jan., no earlier occurrence of the parasite was observed. Moreover some healthy larvae which left their bolls for pupation site, became subject for an "outside" attack by the mite. This may lead to increase the population of the parasitic mites.

Table (2): Total number, percent of total mites and dominancy of predacious and parasitic mite families collected monthly from 200 cotton bolls during the period from Sept. 2002 to May 2003 at Kalubyia Governorate.

Months	Total no. of mites /200 cotton bolls/month						Total
	Ascidae	Laelapidae	Phytoeiidae	Anystidae	Cheyletidae	Pyemotidae	
Sept.2002	0	9	8	0	0	0	17. 0
Oct.	0	0	5	0	0	0	5. 0
Nov.	0	0	28	0	0	0	28. 0
Dec.	0	0	22	0	2	0	24. 0
Jan.2003	0	0	0	0	6	20	26. 0
Feb.	0	0	0	0	11	51	62. 0
Mar.	0	0	96	13	51	107	267. 0
Apr.	11	0	0	0	0	218	229. 0
May.2003	22	0	0	0	0	460	482. 0
Total	33. 0	9. 0	159. 0	13. 0	70. 0	856. 0	1140. 0
Average	3.7	1. 0	17.7	1.4	7. 8	95.1	126.7
%	2. 9	0. 8	14. 0	1.1	6.1	75.1	100
Dominance	R	R	D	R	I	D	

D = dominance: species forming more than 11.1% of the total mite population

I = infeluent: species forming between 5.6 and 11.1% of the total mite population

R = resedent: species forming less than 5.6% of the total mite population

2-Efficiency of the ectoparasitic mite *P. herfsi* in controlling PBW

The present results (Table 3, Fig.1 and 2) show the effects of the parasitic mites *P. herfsi* on the different stages of PBW. However it could be observed that the 1st larval instar died after 1day while the 4th larval instar died after 3.6± 0.4; 2.6±0.51 and 1.4±0.25 days when exposed to 2, 4 and 8 individuals of female parasitic mite.

On the other hand the one day old pupal stage died after 5.2±0.58 days when exposed only to 8 individuals of parasitic mite. The obtained results in agreement with the finding of Ram *et al.* (1984) and Abdel-Rahman *et al* 1999 who found that, time elapsed for *P. gossypiella* larvae to die after exposed to *P. hesfsi* varied according to the number of parasitic mite individuals and PBW larval instars. The venom of a single attacking female of *Pyemots tritici* is sufficient to paralyze a host (Tomalski *et al.* 1988). However the pyemotid mites are common parasites of many species of Lepidoptera, Coleoptera,

and Hymenoptera. They have been associated incidentally with virtually every insect order, paralyzing and ultimately killing their hosts (Bruce and Wrensch 1990). Female mites of *P. tritici* inject an extremely potent venom into their insect prey that causes muscle contraction and paralysis. These mites are able to paralyze insect 150.000 times their size and their venom is effective in a broad range of insect species. A toxin (TxP-I) associated with the mite venom apparatus causes immediate muscle – contractive paralysis when injected into insect (Michael and Miller 1991).

Table (3): Mean duration of mortality of different larval instars (1^{st} and 4^{th}) and pupal stage (one day old) of Pink bollworm (PBW) exposed to different numbers of the parasitic mite *P. herfsi*.

No. of female mite inoculated to 1 larva or pupa of PBW	Mean duration of mortalities (in days)		
	Larval instars		pupal stage
	1^{st}	4^{th}	(one day old)
2	1.0 ± 0.0	3.6 ± 0.4	0.0
4	1.0 ± 0.0	2.6 ± 0.51	0.0
8	1.0 ± 0.0	1.4 ± 0.25	5.2 ± 0.58
Control (insect stags without parasitic mites)	2 - 2.5	3 - 4	5 - 7

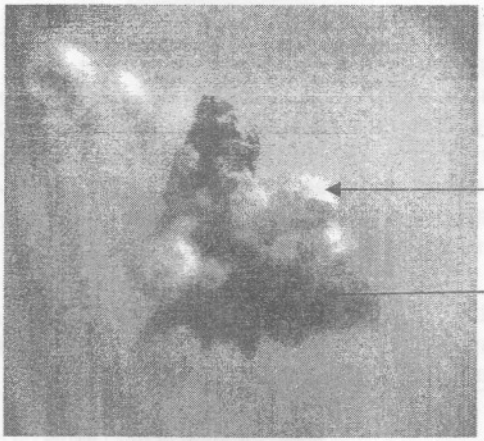

Fig. (1): 4th instar larva of PBW infested with parasitic mites *P. herfsi*

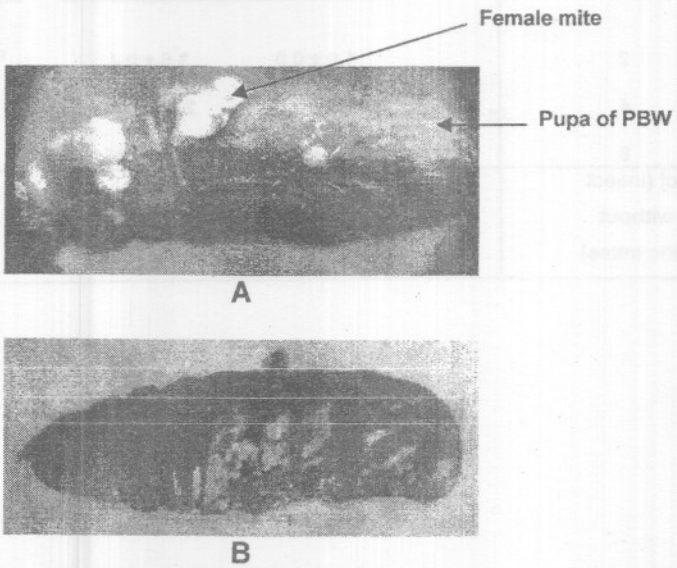

Fig. (2): One day old pupa of PBW infested with the parasitic mites *P. herfsi*

A: Infestation at the beginning B: Infestation at the end

Regarding the egg-sacs formation and the female mite progeny of *P. herfsi,* data given in (Table 4) indicated that, when mites introduced to the 1st instar larvae, the percentage of egg-sacs and number of mite progeny were zero. While, in the 4th larval instar the percentage of egg-sacs ranged from 80 to 95% and the number of mite progeny ranged between 6.7 to15.5 average number /1 female mite.

One day old pupa produced an average number 11.8 /1 female mite and the percentage of egg-sacs was 55% at the inoculum level of 8 parasitic mite/1 pupa. Also, it could be observed that the high inoculum level (8 female mite /1 larvae) produced a lower number of progeny, while an opposite trend was observed with the low inoculums levels (2 and 4 female mite/1 larva). However there was a considerable variation in the percent of emergence and produced progeny related to the host larval instar and the number of parasitoids attacked the larvae. The most efficient larval instar of PBW to produce progeny of *P. herfsi* was th 3rd instar followed by 4th one (Abdbel-Rahman *et al.* 1999). Moreover Tawfik *et al.* (1984) mentioned that *Pyemotes tritici*, which normally parasitizes grain insects, has been found in stored cotton seeds and is highly toxic to man, was reared in the laboratory in Egypt at 27.5 °C and 56% RH on the larvae of 4 host species, *P. gossypiella, Anagasta kuehniella* [*Ephestia kuehniella*], *Tribolium confusum and Corcyra cephalonica.* The parturition period of the viviparous mite lasted 7.6 days, resulting in 540 progeny /25 females, on *P. gossypiella* and 11.4 days, resulting in 1891 progeny/25 females on *C. cephalonica*; the parturition periods on the other hosts were intermediate in duration and in number of progeny produced. In all broods, females outnumbered males and the number of offspring was correlated with the size of the opisthomal globe of the female parent.

Table (4) : Effect of the 1st and 4th larval instars and the pupal stage of Pink bollworm (PBW) on the production of egg sacs and the number of progeny produced by the female mite of *P. herfsi.*

No. of female mite inoculated to 1 larva or pupa of PBW	Larval instars								pupal stage (one day old)			
	1st				4th							
	%of egg sacs	No. of progeny /1 female mite			%of egg sacs	No. of progeny /1 female mite			%of egg sacs	No. of progeny /1 female mite		
		Min.	Max.	General mean		Min.	Max.	General mean		Min.	Max.	General mean
2	0	0	0	0	80	12.5	17	14.9	0	0	0	0
4	0	0	0	0	95	11	18.8	15.05	0	0	0	0
8	0	0	0	0	82.5	4	10	6.7	55	9.7	15.5	11.8

Finally, from the obtained results it could be concluded that the pyemotid mites *P. herfsi* has a great potential as biological control agent to suppress the population of the resting stage of Pink bollworm *P. gossypiella* in the dry cotton bolls especially from the period from Jan. to May. The obtained results confirmed by the finding of Tawfik and Awadallah (1970) that, *P. herfsi* (Oud.) parasitized overwintering caterpillars of the Pink bollworm *P. gossypiella* (Saunders). In Egypt, mite induced mortality reached up to 85% in the first generation larvae of this important cotton pest. Ram *et al.* (1984) during observations in February-March at the diapausing larvae of *P. gossypiella*, were found shrunken in size from less of haemolymph and infested by up to 100 individuals of *P. herfsi* (Oud.) each. During studies on adult emergence from larvae of the gelechiid *P. gossypiella* collected from seeds of cotton fields and ginning factories, Naresh and Balan (1985) mentioned that 48.56% of larvae were parasitized by the mite *Pyemotes ventricosus*. Johinder *et al.* (1986) evaluated the extent of carryover of the gelechiid *P. gossypiella* through different sources from unsprayed cotton. Suicidal moth emergence reduced the carryover of population by 4.5 and 14.2% in seed cotton and leftover bolls, respectively. Seed cotton, which carried 38.5% of the total overwintering larval population, was not an important source of carryover to the subsequent crop due to adult trapping in stores and larval mortality during seed treatment and parasitism by *P. ventricosus*. Open but unpickable bolls and picked bolls with leftover seed cotton were the major sources of carryover. Furthermore, Rizk *et al.* (1979) reported that the progeny of a single mite female *P. herfsi* parasitized all larvae produced by a single beetle female of the stored food pest beetle *Tribolium confusum* Duv within ten days. The impact of various densities of *P. tritici* on *Ephestia kuehniella* indicated that complete destruction of cohorts of 400 larvae of *E . kuehniella* was achieved by adding about 80 females of *P. tritici* 10 days after the eggs were laid, or 6 days after the larvae hatched. Half the above density of pyemotid mites gave inconsistent, but at times complete control (Hoschele and Tanigoshi, 1993)

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الأكاروسات المفترسة والمتطفلة المصاحبة للوز القطن الجاف وكفاءتها فى مكافحة دودة اللوز القرنفلية

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الملخص العربى:

الحصر:

تم عمل حصر الأعداء الحيوية الاكاروسيه المصاحبه للوز القطن الجاف فى الفترة من سبتمبر ٢٠٠٢ إلى مايو ٢٠٠٣ فى محافظة القليوبيه وذلك بهدف التعرف على اهم الاعداء الحيويه التى قد تلعب دور فى المكافحه الحيوية لدودة اللوز القرنفليه وقد اظهرت النتائج ما يلى:

١- يوجد ٨ انواع من الاعداء الحيوية الاكاروسيه تنتمى الى رتبتين و تحت رتبتين وستة فصائل. سبعة منها مفترسه لمفصليات الارجل الصغيره التى تكون مصاحبه لافات المواد المخزونه او الموجودة فى التربة او على النبات احيانا وهى كالآتى:

Blattisocius sp **(Fam:Ascidae);** ***Hypoaspis*** **sp (Fam: Laelapidae);** ***Amblyseius sp*****;** ***Typhlodromus sp*** **and** ***Phytoseius sp*** **(Fam: Phytoseiidae);** ***Anystis*** **sp (Fam; Anystidae) and** ***Hemicheyletia sp.*****(Fam: Cheyletidae)**

أما النوع الثامن فهو متطفل على يرقات حرشفية الاجنحة وهو Pyemotes *hefsi* Oud. والذى ينتمى الى Family Pyemotidae.

٢- سجل اعلى تعداد للا كاروس المتطفل التابع لفصيلة Fam: Pyemotidae (٧٥% من المجموع الكلى للأكاروسات) وكان الاكثر شيوعا وسياده عن جميع الانواع الاكاروسية الاخرى ثم تبعه أكاروسات فصيلة Fam: Phytoseiidae بنسبة ١٤% من المجموع الكلى للأكاروسات.

٣- اظهرت الدراسة ان الاكاروس المتطفل ***Pyemotes herfsi*** يبدا ظهوره فى شهر يناير ثم يزداد تدريجيا فى الاشهر التالية بينما حدث زيادة حادة فى شهر مايو وذلك بتزامن مع بداية

خروج يرقات العمر الرابع لدودة اللوز القرنفلية للتعذر خارج اللوز الجاف. وعموما زيادة هذا الطفيل مع بداية خروج اليرقات يؤدى إلى خفض تعدادها وبالتالى ينعكس ذلك على خفض نسبة الإصابة بدودة اللوز القرنفلية فى بداية الموسم، وهذا يظهر الدور الهام الذى يقوم بة هذا الطفيل فى المكافحة الحيوية تحت الظروف الطبيعية.

الاختبارات المعملية :

بناءا على الحصر السابق تم اختيار الاكاروس المتطفل *P. herfsi* لاجراء بعض التجارب العمليه عليه وذلك لايضاح دوره فى امكانيه استخدامه فى مكافحه دوده اللوز القرنفليه *Pectenophora gossypiella* (Saundres) وقد اظهرت النتائج المتحصل عليها ما يلى :

١- تموت يرقات العمر اليرقى الاول بعد يوم واحد من تعريضها الى عدد ٢ او ٤ او ٨ اكاروس لكل يرقه.

٢- تموت يرقات العمر الرابع بعد ٠,٠٤ ± ٣,٦ يوم عند تعريضها لعدد ٢ أكاروس لليرقه بينما تموت بعد ٠,٢٥ ± ١,٤ يوم عند تعريضها لعدد ٨ اكاروس لليرقه كما اوضحت ان العذارى عمر يوم واحد تموت بعد ٠,٥٨± ٥,٢ يوم عند تعريضها الى ٨ اكاروس / عذراء.

٣- لم يحدث تكوين لاكياس البيض وكذلك لم تنتج افراد من الا كاروس عند تطفله على يرقات العمر الاول بينما تم تكوين اكياس البيض وانتاج الافراد عند تطفلها على يرقات العمر الرابع (تراوحت نسبة أكياس البيض من ٨٠-٩٥% بينما عدد الأفراد الناتجة تراوح من ٦,٧ – ١٥,٥ فرد/ لكل أنثى أكاروس متطفلة) والعذراء عمر اليوم الواحد (نسبة أكياس البيض المتكونة كانت ٥٥% بينما متوسط عدد الأفراد الناتجة ١١,٨ فرد/ لكل أنثى أكاروس متطفل).

٤- كانت نسبة تكوين اكياس البيض وانتاج الافراد للاكاروسات المتطفله على يرقات العمر الرابع اعلى عن مثيلاتها على العذارى.

٥- تشير النتائج المتحصل عليها الى ان هذا الاكاروس المتطفل قد يلعب دورا هاما فى المكافحه الحيويه لدوده اللوز القرنفليه .