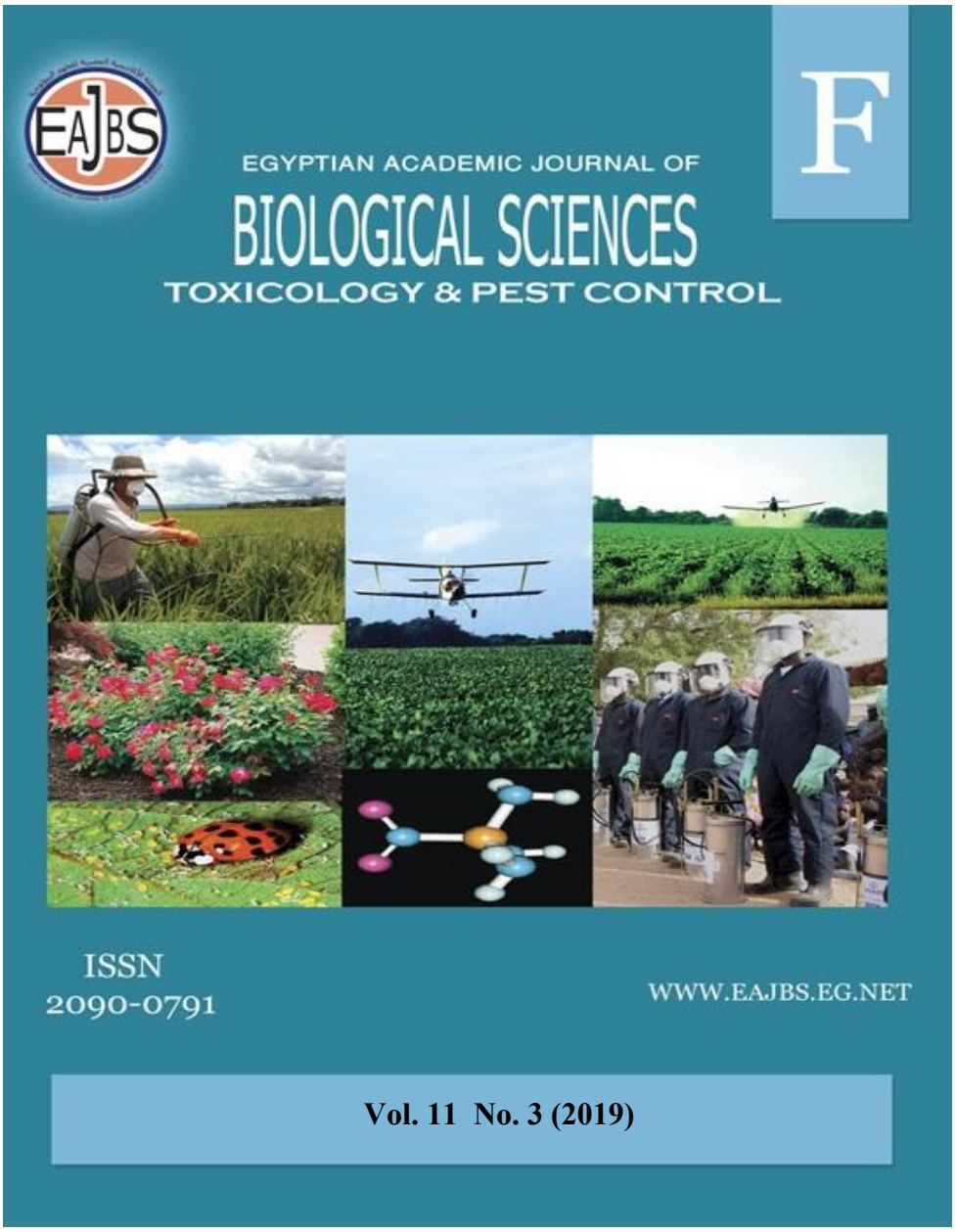

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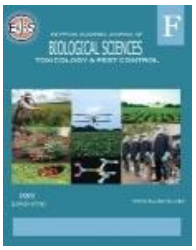

Reproductive Potential Factors of *Pectinophora gossypiella* (Saund.) and *Coccinella undecimpunctata* (L.) Affected by Certain Compounds

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ABSTRACT

Experiments were conducted under laboratory conditions to study certain biological aspects of the pink bollworm, *Pectinophora gossypiella* (Saund.), and (predacious insect) eleven spotted ladybird, *Coccinella undecimpunctata* (L.), when adult stage treated by half recommended concentrations of Emamectin benzoate, Lufenuron, and Chlorpyrifos. The mean numbers of deposited eggs were 103.0, 142.7, and 70.0 eggs/female treated by three compounds, respectively compared with 234.0 eggs/females in control. All treatments caused increased in the time required for all developmental stages of *P. gossypiella* resulted from adults' treatment with the three insecticides; in addition, total immature stage, life cycle, and generation time were increased in all treatments than control. Also, data recorded that emamectin benzoate, lufenuron, and chlorpyrifos; reduced the predator eggs hatchability to 56.0, 61.0, and 48% compared with 98.0% in control. On the other hand, data recorded that effect of three compounds on *C. undecimpunctata* (predacious insect), mean numbers of deposited eggs (fecundity) were 126.0, 133.0 and 99.0 eggs/female when the predacious insect treated by the three compounds, respectively, compared with 190.0 eggs/female in control.

INTRODUCTION

The cotton plant is a major host of pink bollworm; *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae); it is currently found in almost all cotton plants growing in different countries of the world (Naranjo *et al*., 2001) and considered one of the most important economic pests attack the flower and cotton bolls in Egypt (Kandil, 2001). The adult is small, hiding during the day; also, adults were flying to the nearest cotton boll to mate, mating can occur on the first night after emergence and can occur more than once (Noble, 1969). The pre-oviposition is about two days (Matthews, 1989). After oviposition, the moths live from 1.5 to 2 weeks (Noble, 1969).

Different groups of Chemical insecticides are considered the most effective control against cotton bollworms. However, the continuous use of insecticides had developed resistance affected on the cotton production at the same time in predacious insects (Rizk *et al*., 2010) which caused toxicity to predators it leads to reducing the numbers of natural enemies after direct exposure to insecticides or indirect exposure when fed on different insect sprayed with any compound (Stark and Banks, 2003). It is necessary to minimize

dependence on the use of chemical control by replacement of such insecticides with biocides and the use of biocontrol agents such as releasing predatory (Abdel-Hafez and Mohamed, 2009).

The bio-insecticide emamectin benzoate is a novel foliar insecticide of Lepidoptera and another insect family. Emamectin benzoate is a derivative of the natural avermectin family produced by fermentation of soil microorganism *Streptomyces avermitilis* (Schallman, *et al.*, 1987).

The purpose of the present study is to explore the effects of different compounds on the biological and reproductive potential factors of the pink bollworm, *Pectinophora gossypiella* (Saund.), and the eleven-spotted ladybird, *Coccinella undecimpunctata* (L.) predator.

MATERIALS AND METHODS

Insects used:

1. Pink Bollworm, *Pectinophora gossypiella.*

Newly adult emergence (One day old) of the pink bollworm, *P. gossypiella*, used in this study was obtained from a laboratory colony of Bollworm Department, Plant Protection Research Institute; Agriculture Research Center (ARC), reared on an artificial diet that previously described by Rashad and Ammar (1985).

2. Eleven-spot Ladybird, *Coccinella undecimpunctata* (L.).

Eggs, pupal and adult stages of *C. undecimpunctata* predator were collected from the field of Qaliobia Governorate, by using the handpicking and then brought to the laboratory for rearing. The pupal stage was isolated singly in tubes (7x 2.5cm^2) until predator adult emergence which was used in the experiment as a field strain for treated with half recommended dose of emamectin benzoate, lufenuron or chlorpyrifos) and daily observed until adult death. Three compounds were used belong to three Insecticides groups as recorded in Table (1).

Table 1: Insecticides used.

Trade name	Common name	Chemical group	Rate of application
Pasha1.9%EC	Emamectin benzoate	Avermectin	300 cm^3/feddan
Match 5% EC	Lufenuron	Chitin synthesis inhibitor	160 ml/feddan
Dora 48% EC	Chlorpyrifos	Organophosphorus	1litter ml/feddan

Compound Preparations:

To study the activity of Emamectin benzoate, Lufenuron and Chlorpyrifos against *P. gossypiella* adults, one concentration in water were prepared for each compound concentration (860ppm) for Emamectin benzoate, (20 ppm) for Lufenuron and (120 ppm) for Chlorpyrifos was freshly prepared for the stock solution of each compound (1ml/1 liter).

Treatment of *P. gossypiella* Adults Stage:

Newly emerged moths resulted from laboratory strain were used; Three groups used, each one 30 pairs for each treatment were sexed. Each treatment was replicated three times (10 pairs /cage), every 10 females and 10 males were transferred to a chimney glass cage for treatment. Each group of moths was fed on the half recommended compound from emamectin benzoate or lufenuron or chlorpyrifos for 24 hr. at the same time, another group (30 pairs male with females) fed on water only as a control. After

24hr. all cages treatment or control fed on the original diet only as 20% sugar.
Cages were observed daily to estimate the pre-oviposition, oviposition, post-oviposition periods, and females' longevity for all treatments. In addition, the total number of eggs production per female and the eggs hatchability percentages were estimated as follows:
The Fecundity eggs and hatchability percentage was counted as follows:

$$\textbf{\% Egg hatchability} = \frac{\text{No. hatched eggs}}{\text{No. deposited eggs}} \times 100$$

-Reduction in hatchability percentage was calculated according to Zidan and Abdel-Megeed (1987) as follows:

$$\textbf{\% Reduction in hatchability} = \frac{\text{No. egg hatched in check} - \text{No. egg hatched in treatment}}{\text{No. egg hatched in check}} \times 100$$

-Fecundity was calculated according to Crystal and Lachance (1963) as follows:

$$\textbf{\% Fecundity} = \frac{\text{No. eggs/ treated female}}{\text{No. eggs/ untreated female}} \times 100$$

Latent Effect on the First Generation:

After adults treated by on half recommended dose with each compound, the eggs laid by adults females treatment with half recommended compounds, collected for used to studies some biological aspects; three replicates for a piece of paper containing eggs from each adults' treatment (each replicates approximately 150- 200 eggs on papers) were used and kept under laboratory condition 26±1°C and 75±5% R.H, until hatching, newly hatched larvae resulted from eggs deposited by each treated females were transferred individually to the diet tubes by camel hairbrush, three replicates of 50 tubes, each tube (2 X 7.5 cm) containing 3 gm diet were used. The same was used to the newly hatched larvae resulted from eggs collected from untreated (check) females. The tubes were capped with cotton and kept in a laboratory under 26±1°C and 75±5% R.H and inspected daily until pupation and adults' emergence. Some biological aspects such as incubation eggs, larval duration, pupal duration, percentage of adult emergence, sex ratio, and generation time (eggs+ larval + pupae+ pre- oviposition period required for development) were recorded for estimated the generation times.

Treatment of Predator Adults' Stage:

Four groups of predator adults used; each group replicates three times each replicate contains twenty adults of *C. undecimpunctata*.

-The 1st group of the predator adults fed on treated *P. gossypiella* eggs (dipping a piece of paper containing eggs) with the half-recommended concentration of emamectin benzoate.

-The 2nd group of the predator adults fed on treated *P. gossypiella* eggs (dipping a piece of paper containing eggs) with the half-recommended concentration of lufenuron.

-The 3rd group of the predator adults fed on treated *P. gossypiella* eggs (dipping a piece of paper containing eggs) with the half-recommended concentration of chlorpyrifos.

-The 4th group fed on untreated *P. gossypiella* eggs as a control.

Treatment of Predator Eggs Stage:

Three groups of predator eggs used; each group replicates three times each replicate contains 20 eggs of *C. undecimpunctata*; the treatment was done by dipping eggs in half recommended concentration for each tested compound of the emamectin benzoate or lufenuron or chlorpyrifos to one min. after that, the treated eggs kept in a laboratory under 26±1°C and 75±5% R.H and inspected daily until hatching; the percent of hatchability and incubation period of eggs were recorded.

The recorded data values for the biological characteristic were statistically analyzed by one – way analysis of variance (ANOVA) ($P < 0.05$ %) (Snedecor, 1952) and Duncan's multiple range test of means (Duncan, 1955).

RESULTS AND DISCUSSION

Ovipositional Periods of Treated Females*:*

The times require**,** pre-oviposition, oviposition, post-oviposition and longevity periods for females treated by the three tested half recommended compounds in comparison to the control were recorded in Table (2).

Data in Table (2) clear that the pre-oviposition period was a highly significant increase when the females treated by three tested compounds. These periods were 2.9, 3.3, and 3.9 days, respectively, resulted from emamectin benzoate, lufenuron, and chlorpyrifos, respectively, and compared with 2.6 days in control. From this data can be concluded that the three compounds caused increased in the pre-oviposition period from 0.3 to 1.3 days.

Table 2: Effect of three compounds on *P. gossypiella* adults stage**.**

Compound used	Duration times in days (longevity ± SE)					
	Ovipositional periods				Longevity	
	Conc. (ppm)	Pre oviposition	Oviposition	Post-oviposition	Female	Male
Emamectin benzoate	860	2.9^{ab}±0.3	7.3^{b}±0.9	4.3^{b}±0.9	14.5^{c} ±1.5	9.6^{c}±0.7
Lufenuron	20	3.3^{ab}±0.4	11.3^{a}±1.1	5.3^{a}±0.3	18.9^{a}±1.4	16.3^{a}±0.9
Chlorpyrifos	120	3.9^{a}±0.2	5.3^{c}±1.3	1.3^{d}±0.5	10.5^{d}±1.8	13.6^{b}±1.2
Control	0	2.6^{b}±0.3	11.2^{a}±0.6	2.7^{c}±0.9	16.5^{b}±0±1.6	13.6^{b}±0.9
LSD	-	1.03	0.54	0.84	1.17	1.30
F valus	-	3.12^{ns}	1.35^{***}	$5/30^{***}$	9.25^{***}	4.86***

Values are mean ± SE of three replicates. Values within the same column having the same letters are not significant different (ANOVA, Duncan's multiple range tests, $P < 0.05$)**.**

Analysis of variance the results were arranged in Table (2) that recorded; emamectin benzoate and chlorpyrifos, caused high significant decreasing of the oviposition periods (7.3 and 5.3 days), on contrast no different recorded between lufenuron and control 11.3 & 11.2 days/ the oviposition period/females treated and control, respectively. Also, the results arranged in Table (2) proved that the post-oviposition period per female after treated by emamectin benzoate and lufenuron increased to 4.3 and 5.3 days (approximately 1.5 to 2 times) compared with 2.7 days in control. The respective, female and male longevity increased after lufenuron treatment to 18.9 and 16.3 days compared with 16.5 and 13.6 days/ female and male, respectively, in control.

Fecundity and Sterility:

Results in Table (3) showed a highly significant reduction in the number of deposited eggs per each treated female by emamectin benzoate, lufenuron, and chlorpyrifos (the reduction approximately, half time with emamectin benzoate or lufenuron and increased to 3 times with chlorpyrifos). The respective, mean numbers of deposited eggs (fecundity) estimated by 103.0, 142.7, and 70.0 eggs/female fed on three compounds, compared with 234.0 eggs/females in control.

Table 3: Effect of compounds on fecundity and sterility of *P. gossypiella* adults' stage**.**

Compound used	Different stages resulted in adults treated (Duration times in days)				
	Fecundity		Fertility		% Observed sterility
	Total eggs/♀	Reduction in total eggs	% hatchability	Reduction in hatchability	
Emamectin benzoate	103.0^{c}±5.113	-55.90	53.00^{c}	43.0	59.00
Lufenuron	142.7^{b}±3.5	-39.00	67.00^{b}	29.4	70.60
Chlorpyrifos	70.0^{d}± 3.7	-70.00	54.00^{c}	43.1	56.90
Control	234.0^{a}± 3.9	0.00	95.00^{a}	0.00	0.00
LSD	5.37	0.62	4.35	4.53	6.23
F values	.0000***	.	0026**		

Values are mean ± SE of three replicates. Values within the same column having the same letters are not significantly different (ANOVA, Duncan's multiple range tests, P < 0.05).

Also, the percentage of hatchability was highly significant affected by all treatments, it decreased highly to 53.00 and 54.00% for eggs deposited by females treated with emamectin benzoate, and chlorpyrifos, respectively. However, in lufenuron, the hatchability percentages increased to 67.00% compared with control (95.00%) as mentioned in Table (3). From these data in the same table can be shown that the reduction in the reproductive adult of *P. gossypiella* reached to -39.00 with lufenuron and reached -55.90 & -70.00) after treatment with emamectin and chlorpyrifos,

Data presented in Table (4) showed different developmental stages of *P. gossypiella* resulted from adults' treatment with the three insecticides; the incubation period eggs were 5.1, 6.1 and 5.7 days in case of emamectin benzoate, lufenuron and chlorpyrifos treatments, respectively, compared with 3.3 days in control. While, larval duration elongated to 21.3 and 16.3 days in lufenuron and chlorpyrifos treatments, respectively, compared with 14.6 days in control, but was 13.6 days in case of emamectin benzoate treatment which was decreased than control. In addition, the pupal duration increased to 9.2, 10.3 &9.3 days/ pupae, compared with 7.3 days in control. On the other hand, the total immature stage, life cycle, and generation times were increased in all treatments than control.

Table 4: Effect of three compounds on total immature stages and generation time of *P. gossypiella.*

Compound used	Different stages resulted from adults treated with three compounds (Duration times in days) (days ± SE)						
	eggs Incubation	larva stage	Pupal stage	Total immature stage	Life cycle	Pre- ovi	Generation time
Emamectin benzoate	5.1^{c}±0.1	13.6^{b}±0.5	9.2^{a}±1.1	22.8^{b}±1.3	27.9^{bc}±1.8	3.6^{a}±0.35	32.3^{b}±2.4
Lufenuron	6.1^{a}±0.3	21.3^{a}±1.2	10.3^{a}±0.4	31.6^{a}±1.2	37.7^{a}±2.4	4.3^{a}±3.6	40.2^{a}±3.1
Chlorpyrifos	5.7^{b}±0.8	16.3^{b}±1.3	9.3^{a}±0.6	25.6^{b}±1.7	31.3^{b}±2.3	2.4^{a}±2.1	33.7^{b}±2.9
Control	3.3^{d}±0.1	14.6^{b}±0.7	7.3^{a}±0.3	21.9^{b}±0.8	25.4^{c}±1.3	2.6^{a}±1.6	28.0^{c}±1.9
LSD	0.63	2.96	4.32	4.39	3.83	2.87	3.58
F values	.0000***	.0013**	.4835^{ns}	.0033**	.0004***	.8420^{ns}	.0003***

Values are mean ± SE of three replicates. Values within the same column having the same letters are not significantly different (ANOVA, Duncan's multiple range tests, P < 0.05).

Some parameters of *C. undecimpunctata* eggs when treated by three compounds (direct effect) and adult stages when *P. gossypiella* eggs treated with three compounds (indirect effect). Data illustrated in Table (5) showed that the hatchability percentage of the predator eggs after direct exposure to the half-recommended concentration of emamectin benzoate, lufenuron, and chlorpyrifos; it was 56.0, 61.0 and 48% compared with 98.0% in control. Whereas, the eggs incubation period of predacious insect *C. undecimpunctata* increased to 4.6, 5.9, and 4.4 days compared with 3.6 days in control. In addition, mortality percentages of the adult stage after feeding on *P. gossypiella* eggs treated with three insecticides (indirect effect) used were shown in Table (5), it was 37.0, 51.0 and 41.0% with emamectin benzoate, lufenuron, and chlorpyrifos, respectively, compared with 4% in control. The adults' longevity of *C. undecimpunctata* decreased when predator fed on all treatments than control by; 25.3, 38.3, and 19.0 days in emamectin benzoate, lufenuron and chlorpyrifos treatments, respectively, compared with 41.0 days in control.

Table (5) recorded a significant reduction in average numbers of deposited eggs per predacious insect female feed on *P. gossypiella* eggs dipping on each compound; emamectin benzoate, lufenuron, and chlorpyrifos. The respective, mean numbers of deposited eggs (fecundity) were 126.0, 133.0, and 99.0 eggs/female fed on the three compounds, respectively, compared with 190.0 eggs/female in control**.** From this data can be concluded that the average numbers of deposited eggs per predacious insect female feed on *P. gossypiella* eggs dipping on each compound; decreased approximately from 30 to 50% than control.

Table 5: Effect of three compounds on *C. undecimpunctata* eggs and adult stages

Compound used	*C. undecimpunctata* eggs (1-2 days)			*C. undecimpunctata* adult (1-5 days)		
	% Of non-hatchability	% Hatchability	Eggs Incubation period (days ± SE)	% Mortality	Longevity (days ± SE)	Total eggs laid
Emamectin benzoate	44.0^{b}	56.0^{c}	$4.6^{b}\pm0.3$	37.0^{c}	$25.3^{b}\pm1.9$	126.0^{b}
Lufenuron	38.0^{c}	61.0^{b}	$5.9^{a}\pm0.5$	51.0^{a}	$38.3^{a}\pm3.1$	133.0^{b}
Chlorpyrifos	52.0^{a}	48.0^{d}	$4.4^{b}\pm0.5$	41.0^{b}	$19.0^{c}\pm1.5$	99.0^{c}
Control	1.0^{d}	98.0^{a}	$3.6^{c}\pm0.2$	4^{d}	$41.0^{a}\pm2.5$	190^{a}
LSD	1.88	1.88	0.078	4.03	4.11	10.62
P values	.0000***	.0000***	.0001***	.0000***	.0000***	.0000***

Values are mean ± SE of three replicates. Values within the same column having the same letters are not significant different (ANOVA, Duncan's multiple range tests, $P < 0.05$).

The presented results showed some changes in different parameters on the adult stage after feeding on different compounds; this appeared in a highly significant reduction in fecundity and hatchability in comparison with control. Also, there were highly significant differences in the longevity of females ($P<0.05$) when feeding or exposed to the three compounds and significantly influenced with a high reduction in daily eggs deposited and fecundity of adults. These results also were somewhat similar to that obtained by Kandil *et al.*, (2012 and 2013) who found that different IGRs treatment of *P. gossypiella* decreased the total laid eggs, on the other hand, the obtained results are partially in agreement with Said *et al* (2017) who recorded that teflubenzuron (IGR's) caused high reduction percent of laid eggs and hatchability for *P. gossypiella* than control. Some authors studied the effect of insecticides on lepidopteran insects like Moustafa (2016) and Sholla *et al* (2017) found that emamectin benzoate caused a high

reduction in eggs hatchability of *P. gossypiella*.

In general, emamectin benzoate, lufenuron, and chlorpyrifos cause an increase in the sterilization of insect adults (devastating effect on fecundity and fertility) as well as mortality and increased in the duration of larvae or pupae, life cycle which leads to elongate the resulted 1st generation.

Our results showed that *C. undecimpunctata* adult's longevity becomes shorter to half times and the oviposition period decreased which caused a high effect on fecundity (total eggs laid) after feeding on *P. gossypiella* treated eggs with emamectin benzoate and chlorpyrifos. While in contrary to lufenuron which considerably nearly safe on *C. undecimpunctata* predator. These results agreed with Kandil *et al*. (2012 and Said *et al*. (2017). Moustafa and Salem (2019) found that profenofos, alpha-cypermethrin & flufenoxuron prolonged larval, pupal duration and adults' longevity of treated *P. gossypiella* larvae and affected the total laid eggs/female.

On the contrary, Barrania *et al*., (2016) found that lufenuron and spinetoram achieved the highest efficacy against *P. gossypiella* and has the harmful effects against lady beetle and aphid lion. Also, some studied measurement of toxicological effects on some predators currently advocated by Stark and Banks (2003) and would determine more accurately the sub-lethal effects of some IGR on reduced the fecundity, viability of eggs and prolonged deferent immature stages, Also, Bozsik (2006) recorded that the pyriproxifen, imidacloprid, and *B. thuringiensis* seem to be safe for *C. septempunctata* adults. Also, Liu *et al*., (2019) tested the toxicity and sub-lethal effects of different insecticides classes on *C. septempunctata*. Results found that spirotetramat did not affect survival, longevity, fecundity, and egg hatching of *C. septempunctata*. Clothianidin and bifenthrin prolonged the duration of larval development stages of *C. septempunctata* obviously.

Conclusion

The effect of three insecticides on the lepidopteran insect adult stage after treated or feeding on all compounds the effect appeared in a high reduction in fecundity (total eggs laid/ females) and fertility (hatchability percent) and in a direct effect on elongated the first-generation times of *P. gossypiella*. It can be concluded that the use of emamectin benzoate or lufenuron in the field have a low effect on the predator.

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ARABIC SUMMARY

عوامل التكاثر المحتملة لدودة اللوز القرنفلية وأبو العيد ذو الإحدى عشر نقطة المتأثرة بمركبات معينة

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أجريت التجارب تحت الظروف المعملية لدراسة بعض الظواهر البيولوجية لدودة اللوز القرنفلية *Pectinophora gossypiella* (Saund.) والمفترس الحشرى أبو العيد ذو الإحدى عشر نقطة *Coccinella undecimpunctata* (L.) بمعاملة الطور البالغ بنصف التركيز الموصى به لثلاثة مركبات (الإيمامكتين بنزوات- لو فينيرون- كلوربيريفوس). وجد عدد البيض ١٠٣ و ١٤٢,٧ و ٧٠ بيضة/ أنثى عند معاملة دودة اللوز القرنفلية بالثلاثة مركبات السابقة على التوالى مقارنة بـ ٢٣٤ بيضة/أنثى فى التجربة الغير معاملة .

اظهرت كل المعاملات زيادة فى الوقت اللازم لنمو الأطوار المختلفة لدودة اللوز القرنفلية المعاملة فى الطور البالغ. كما حدثت زيادة فى نمو الأطوار غير الكاملة ودورة الحياة وفترة الجيل مقارنة بالكونترول. أظهرت النتائج أيضا أن الإيمامكتين بنزوات واللوفنيرون والكلوربيريفوس أدت إلى خفض فقس البيض لمفترس أبو العيد إلى ٥٦ و ٦١ و ٤٨% مقارنة بالكونترول (٩٨%). كما أظهرت النتائج انخفاض أعداد البيض (الخصوبة) لمفترس أبو العيد إلى ١٢٦ و ١٣٣ و ٩٩ بيضة/أنثى عند المعاملة بالثلاثة مركبات السابقة وذلك مقارنة بالتجربة غير المعاملة (١٩٠ بيضة/أنثى).