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Comparative toxicity of some insecticides against *pectinophora gossypiella* (saunde and *chrysoperla carnea* (stephens)

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ABSTRACT

Comparative toxicity of four insecticides against the pink bollworm *Pectinophora gossypiella* (Saunders) as well as the predacious insect, *Chrysoperla carnea* (Stephens) were evaluated under laboratory conditions. Field recommended concentrations of the tested insecticides were used in this study. For *P. gossypiella*, the ovicidal action of the tested insecticides revealed that the three days old eggs were more effective than the one day eggs with the exception of Dimilin treatment where the one day old eggs showed slightly more susceptible than three days old eggs. Concerning one day old eggs, the highest ovicidal activity was noticed in case of Dimilin treatment where the eggs hatchability exhibited 82.61% with reduction of 9.67% compared with untreated eggs, whereas, Axon insecticide caused the highest ovicidal effect on three days old eggs where the corresponding eggs hatchability recorded 77.33% with reduction of 16.07% compared with the untreated eggs. On the other hand Spintor showed the least effect on one and three days old eggs. The corresponding eggs hatchability were 89.47 and 88.00% with reduction rate of 2.17 and 4.49%, while the eggs hatchability rates in untreated eggs one and three days old were 91.45 and 92.14%; respectively. The same trend of the ovicidal activity associated to the exposure of one and three days old eggs of the predatory insect to the tested insecticides. Whereas the ovicidal action was much remarkable higher in case of the predatory insect eggs than the pink bollworm eggs. According the effect of tested insecticides on the pupal stage of the pink bollworm and the predatory insect and their latent effect on the biotic potential of the two target organisms, Axon was the superior insecticide against one and three days old pupae of the two targets. Followed by Dimilin against one and three days old pupae *C. carnea*. Dimilin showed the highest latent effect on the pink bollworm male adult and lowest latent effect on the female adult resulted from the two aged pupae. Spintor and Pasha caused lowest latent effect on *C. carnea* adult emergence. Axon and Dimilin showed highest latent effect on both *P. gossypiella* and *C. carnea* egg hatchability.

Keywords: *Pectinophora gossypiella*, *Chrysoperla carnea*, toxicity, biology.

INTRODUCTION

The pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) is considered to be one of the most damaging cotton pests and a key pest and an economically important pest in Africa. The history of the pink bollworm in Egypt is tied to the production of cotton. Willcocks (1916) first detected pink bollworm in field plots during November-December 1910.

The green lacewing, *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae), is an important natural predator of insect herbivores in many different crop and non-crop habitats (Romeis *et al*., 2014). *C. carnea* is attacking pink bollworm and seems to prefer eggs and early instar larvae (Orphanides *et al*. 1971). *C. carnea* is the most frequently used control agent of pink bollworm.

Conventional insecticides have not provided a long-term solution to the pink bollworm problem (Henneberry, 1986). Spinosad is derived from a naturally occurring soil actinomycete bacterium, *Saccharopolyspora spinosa* (Thompson *et al*., 1997) and relatively safe on natural enemies and no significant difference was recorded for the hatchability between 1&3 day old eggs of pink bollworm (Temerak 2003). Application of chitin synthesis inhibitors have its effect on several insect species (Grosscurt, 1978 and Khebeb *et al*. 1997), diflubenzuron acts as a larvicide and also has an ovicidal on contact with eggs. These compounds interfere with cuticle secretion resulting in death at adult emergence by failure in ecdysis and acts by preventing the chitin biosynthesis (Soltani *et al*., 1996). Emamectin benzoate is a semisynthetic avermectin insecticide derived from the fermentation product avermectin B1 (abamectin). Few studies have evaluated the effect of insecticides on eggs and pupae of green lacewings, which considered more tolerant to insecticides (Giolo *et al*. 2009 and Rugno *et al*. 2015).

According to the importance of *C. Carnea* as a biological control agent of *P. gossypiella*, the purpose of this study was to evaluate the effect of insecticides using recommended concentrations from four different groups on *P. gossypiella* and *C. Carnea* eggs and pupae.

MATERIALS AND METHODS

Insect rearing:

The pink bollworm *Pectinophora gossypiella* (Lepidoptera: Gelechiidae) was reared in the Bollworms Research Department, Plant Protection Research Institute, Dokki, Giza, Egypt for several generations on modified artificial diet at 27±1°C and 75±5% R.H. as described by Rashad and Ammar (1985).

Bioassay of different insecticides on eggs and pupae of *P. gossypiella* and *C. carnea*

For the bioassays, the pupae and eggs of each *P. gossypiella* and *C. carnea* were used in this study. Two different ages of eggs; one and three days old were sprayed directly with the field recommended concentrations of the insecticides used through the laboratory bioassays then placed into glass jars and observed daily for the number of hatched larvae in each treatment.

Insecticides used:

One and three days old of *P. gossypiella* and *C. carnea* pupae were sprayed directly with the field recommended concentrations of the tested insecticides through laboratory bioassays. Each concentration included three replicates. Control replicates were treated with water. After direct spray of pupae one and three days old of either *P. gossypiella* and *C. carnea* were transferred to glass tubes then incubated at 26 ± 1°C and 70 ±5% RH and observed daily until emergence of the

adult. The adults obtained in each treatment were separated by sex, and 10 couples per treatment were separated, and placed in cages to determine pre-oviposition, oviposition and post-oviposition periods and longevity of the females. Moths of *P. gossypiella* were fed on 10% sugar solution and adults of *C. carnea* were fed with a mixture of brewer's yeast and honey.

Table (1): Insecticides data used in this study as follow:

Trade names	Active ingredient	Chemical Groups	Recommended concentrations
Axon 5%EC	Lambda cyhalothrin	Pyrethroid	375ml/Fed.
Spintor 24%SC	Spinosad	actinomycete *Saccharopolyspora spinosa*	50cm/Fed.
Dimilin 48%SC	Diflubenzuron	Chitin synthesis inhibitor	125cm/Fed
Pasha 1.5%EC	Emamectin Benzoate	Avermectin	300cm/Fed

Four commercial insecticides were evaluated on both eggs and pupae of *P. gossypiella* and *Chrysoperla carnea*. All compounds were tested using the field recommended concentrations.

Percentages of mortality were calculated and corrected by Abbott's formula (1925).

RESULTS AND DISSCUSION

Results of the effect of the tested insecticides using field recommended concentrations against one and three days old of *P. gossypiella* eggs are presented in Table (2). The reduction percentage in the hatchability of one day old eggs was 2.17% when treated with Spintor while it was 9.67% in case of Dimilin treatment compared with control. On the other hand, the egg hatchability percentage was 82.61% in case of Dimilin treatment whereas, Spintor showed the highest hatchability percentage with 89.47% compared with control, in which was 91.45%.

Table (2): Ovicidal activity of four insecticides applied against *P. gossypiella* eggs.

Insecticides	Rec. Conc. ml/L.	Eggs one day old		Eggs three days old	
		% Egg Hatchability	% Reduction	% Egg Hatchability	% Reduction
Axon 5%EC	0.94	85.14	6.90	77.33	16.07
Spintor 24%SC	1.25	89.47	2.17	88.00	4.49
Dimilin 48%SC	0.3125	82.61	9.67	82.93	10.00
Pasha 1.5%EC	0.625	86.54	5.37	82.19	10.80
Control	-	91.45	0.00	92.14	0.00

Concerning the effect of these insecticides used against the three days old of *P. gossypiella* eggs was as follows; the reduction percentages in the eggs hatchability were 16.07% for Axon treatment while, it was 4.49% in case of Spintor treatment compared with control. Based on the eggs hatchability percentages, of hatchability the ovicidal action of the tested insecticides could be descending as follows; 88.00, 82.93, 82.19 and 77.33% respectively in Spintor, Dimilin, Pasha and Axon as compared with 92.14% in control. In this respect, El-Barkey *et al*., (2009) stated that hexaflumuron had ovicidal effects on *P. gossypiella*, an important lepidopteran pest of cotton. In contrast with, Boiteau and Noronha (2007) they found high toxicity on eggs of treated, *Ostrinia nubilalis* with spinosad. In this field of study, Mohamed *et al*., (2011) indicated that hexaflumuron and spinosad with low active ingredients and high mortality could be the best choices for controlling the *P. xylostella* in the egg stage.

Results of treating the recommended concentrations of the tested insecticides against one and three days old of *C. carnea* eggs are illustrated in Table (3). The reduction percentage in one day old egg hatchability was 29.31% after treatment with Pasha, while this value attained 88.37 % in case of Dimilin treatment. According to egg hatchability percentage, it was the lowest for Dimilin treatment, which being 11.63 % while, it was 70.69% for Pasha treatment compared with 100 % in control.

Regarding to the ovicidal action of the four tested toxicants against three days old eggs of *C. carnea* reduction percentages in egg hatchability were 63.46% for Axon treatment, whereas, it was 9.1 % in case Pasha treatment. As shown in Table (3) the hatchability was the highest in Pasha by which being 90.9%.

Table (3): Ovicidal activity of four insecticides applied against *C. carnea* eggs.

Insecticides	Rec. Conc. ml/L.	Eggs one day old		Eggs three days old	
		% Egg Hatchability	% Reduction	% Egg Hatchability	% Reduction
Axon 5%EC	0.94	42.85	57.15	36.54	63.46
Spintor 24%SC	1.25	59.52	40.48	88.88	11.12
Dimilin 48%SC	0.3125	11.63	88.37	70.00	30.00
Pasha 1.5%EC	0.625	70.69	29.31	90.9	9.10
Control	-	100	0.00	100	0.00

In this respect, some researchers evaluated the effect of different types of insecticides on this predator under laboratory conditions. The results are going on line with those published by Ferreira *et al*., (2005) they found that tebufenozide, emamectin benzoate and spinosad were harmless to *Chrysoperla externa* eggs. The obtained results are accordance with those of, Rugno *et al*., (2015) revealed that Esfenvalerate, was harmless to *Ceraeochrysa cubana* (Hagen) eggs. In this field of study, Bueno and Freitas (2004) showed that abamectin is innocuous and that lufenurom is toxic to *C. externa* eggs.

Data associated to the toxicity and latent effect of the tested compounds against one day old treated pupae of *P. gossypiella* are presented in (Table 4). Results showed that Axon caused 46.7 % pupal mortality and 20% and 26.67% resulted adult in male and female emergence; respectively. % eggs hatchability was the

lowest for Dimilin treatment which was 36.28% followed by Axon which being 47.37% compared with 98.86% in control. Insecticide exposure did not affect the longevity of adults. Shortest male longevity 17.50 days was noticed in Pasha treatment and female longevity was 17.75 days was recorded in Axon treatment, compared with 18.14 and 19.50 days untreated males and females; respectively.

Table (4): Biotec potential of *P. gossypiella* resulted from treating one day old pupae with four insecticides

Insecticides	% Pupal Mortality	% Adults Emergence ♂	% Adults Emergence ♀	Oviposition period: Pre-oviposition	Oviposition period: Oviposition	Oviposition period: Post-oviposition	Incubation period± SE	% Egg Hatchability	Longevity± SE ♂	Longevity± SE ♀
Axon	46.7	20.00	26.67	4.5	1.5	5.5	5.00^{a}±1.45	47.37	19.33^{a}±1.16	17.75^{c}±1.68
Spintor	0	53.33	46.67	5.33	8.0	7.33	5.12^{a}±1.21	50.00	18.25^{b}±1.76	19.14^{a}±1.16
Dimilin	0	13.33	73.33	7.0	1.0	7.33	5.00^{a}±2.03	36.28	17.50^{c}±2.32	18.80^{b}±1.42
Pasha	0	26.67	73.33	5.0	8.0	8.33	4.56^{b}±1.18	66.34	17.50^{c}±0.76	18.50^{b}±1.88
Control	0	46.67	53.33	3.0	12	2.6	4.26^{c}±1.39	98.86	18.14^{b}±1.16	19.50^{a}±1.74
LSD							0.22		0.30	0.42

Table (5): Biotec potential of *P. gossypiella* resulted from treating three day old pupae with four insecticides

Insecticides	% Pupal Mortality	% Adults Emergence ♂	% Adults Emergence ♀	Oviposition period: Pre-oviposition	Oviposition period: Oviposition	Oviposition period: Post-oviposition	Incubation period± SE	% Egg Hatchability	Longevity ± SE ♂	Longevity ± SE ♀
Axon	26.67	46.67	26.67	5.5	1.0	7.5	5.00^{a}±1.15	34.78	13.71^{c}±1.20	16.00^{b}±1.15
Spintor	0.00	40.00	60.00	4.3	6.0	9.0	4.88^{b}±1.13	80.00	15.20^{b}±1.13	15.5^{cd}±1.30
Dimilin	6.70	33.33	66.67	5.0	5.7	7.0	5.12^{a}±1.48	47.55	13.33^{d}±1.16	15.33^{d}±1.73
Pasha	0.00	53.33	46.67	4.0	9.3	6.0	4.49^{c}±1.74	51.30	15.0^{b}±1.15	15.71^{c}±1.29
Control	0.00	46.67	53.33	3	10	2.4	4.37^{c}±1.78	97.29	18.30^{a}±1.06	18.50^{a}±1.45
LSD							0.21		0.29	0.33

Data of treated three days old of *P. gossypiella* pupae are presented in Table (5). Percentages of pupal mortality were 26.67 for Axon treatment with adult emergence percentages of 46.67% male and 26.67% female while, pupal mortality was 6.70% for Dimilin treatment with adult male emergence percentage of 33.33% and 66.67% of female.

Percentage of eggs hatchability was the highest for Spintor treatment by 80.00% and the lowest one was 34.78% for Axon treatment compared with 97.29% in control.

Adult male longevity was 13.71 and 13.33 days for Axon and Dimilin treatments; respectively compared with 18.30 days in control, whereas, female longevity was almost equal in Spintor and Pasha treatments, which recorded 15.5 and 15.71 days; respectively compared with 18.50 days in control.

Results presents in Figure (1) showed that the deformation of pupae after treatment with insecticides using field recommended concentration.

Fig. (1): Normal and deformed *P. gossypiella* pupae after exposure to insecticides.

1: Normal pupa
2: Pupa resulted from Axon treatment of one day old pupae.
3 Adult resulted from Dimilin treatment of one day old pupae.
4: Adult resulted from Dimilin treatment of three day old pupae.
5:Normal adult.

Table (6): Biotec potential of *C. carnea* resulted from treating one day old pupae with four insecticides

Insecticides	% Pupal Mortality	% Adults Emergence ♂	% Adults Emergence ♀	Oviposition period: Pre-oviposition	Oviposition period: Oviposition	Oviposition period: Post-oviposition	Incubation period± SE	% Egg Hatchability	Longevity± SE ♂	Longevity± SE ♀
Axon	66.67	20.0	13.3	-	-	-	-	-	-	-
Spintor	0.0	60.0	40.0	7.0	8.0	12.00	4.84^{b}±1.25	63.24	13.7^{c}±1.27	21.5^{a}±1.26
Dimilin	60.0	40.0	0.0	-	-	-	-	-	-	-
Pasha	0.0	40.0	60.0	5.0	12.0	11.33	5.59^{a}±1.03	79.71	18.33^{a}±0.94	19.11^{b}±1.16
Control	0.0	46.67	53.3	6.0	15.0	14.00	4.72^{b}±1.14	94.65	16.63^{b}±1.34	17.71^{c}±1.30
LSD							0.32		0.59	0.67

Few authors investigated the effect of insecticides on pupal stage; Pineda *et al*., (2004) found that methoxyfenozide caused pupal mortality and deformed adults of *S. littoralis*. Also, Sammour *et al*., (2008) investigated that treatment of leufenuron on *S. littoralis* decrease the adult emergence, reduction in longevity and egg hatchability. Moreover, Mahmoud (2014) found that Mectin followed by Radiant were toxic against the egg and pupal stages of *Palpita unionalis* and caused the highest impacts on adult emergence and malformed adults percentages.

Data presented in Table (6) showed the toxicity and latent effect of four insecticides applied against one day old of *C. carnea* pupae. Percentages of pupal mortality were 66.67 and 60.0% for Axon and Dimilin treatments with adult emergence percentages 20.00%

adult male and 13.3% female emergence while, it was 40.00% for male adult emergence for Dimilin treatment. Percentage of eggs hatchability were 63.24 and 79.71% for Spintor and Pasha treatments; respectively compared with 94.65% in control.

Adult male longevity was 13.7 and 18.33 days for Spintor and Pasha treatments; respectively compared with 16.63 days in control, whereas, female longevity reached 21.5 and 19.11 days in Spintor and Pasha treatments; respectively compared with 17.71 days in control.

Results of three days old treated *C. carnea* pupae with the tested toxicants are presented in Table (7). Treated pupae with Axon caused 86.67 % pupal mortality and the adult emergence was 13.33% male only. Eggs hatchability was 87.18 and 80.82% after treatment with Spintor and Pasha compared with 92.73% in control. For Spintor and Pasha treatments; male longevity recorded 17.00 and 20.00 days and female longevity exhibited 19.00 and 18.00 days compared with untreated male and female which they were 22.00 and 21.3 days. Figure (2) illustrated adults photos after treating the pupae with each insecticide using the recommended concentration and clarified deformation of emerged adults resulted from the treatments.

Table (7): Biotec potential of *C. carnea* resulted from treating one day old pupae with four insecticides

Insecticides	% Pupal Mortality	% Adults Emergence		Oviposition period			Incubation period± SE	% Egg Hatchability	Longevity± SE	
		♂	♀	Pre-oviposition	Oviposition	Post-oviposition			♂	♀
Axon	86.67	13.33	0.0	-	-	-	-	-	8.00^{a}±2.60	-
Spintor	40.0	26.67	33.33	8.0	10.0	12.67	6.29^{b}±1.16	87.18	17.00^{c}±2.65	19.00^{b}±1.20
Dimilin	73.33	26.67	0.0	-	-	-	-	-	9.00^{d}±2.60	-
Pasha	0.0	60.0	40.0	5.0	15.0	13.33	6.58^{a}±1.44	80.82	20.00^{b}±3.76	18.00^{c}±1.53
Control	0.0	53.33	46.67	5.0	17.0	14.00	4.67^{c}±1.18	92.73	22.00^{a}±2.40	21.3^{a}±2.31
LSD							0.16		1.63	0.20

Fig. (2): Normal and malformed adults after expose *C. Carnica* pupae to insecticides

1: Normal adult
2, 4: Adult resulted from Dimilin treatment of one day old pupae.
3 Adult resulted from Spintor treatment of one day old pupae.
5: Adult resulted from Dimilin treatment of three day old pupae.

In this field of study, Medina *et al*. (2001) found that spinosad and tebufenozide are not toxic against eggs and pupae of the predator *C. carnea*. And, Rugno *et al*. (2015) evaluated the tolerance of *C. cubana* 48 hours old pupae to insecticides. All types of insecticides were considered harmless when applied at the pupal stage. Khan *et al*. (2015) showed that, emamectin benzoate has moderate effect against egg and pupa of *C. carnea*, they caused 50% and 45% mortality; respectively followed by spinosad 52.5% and 85% mortality respectively. Shankarganesh *et al*. (2016) evaluated the field recommended doses of synthetic pyrethroids, cypermethrin and bifenthrin, were highly toxic to the pupae of *C. zastrowi sillemi*.

CONCLUSION

It could be concluded that Dimilin was the most toxic compound against one day old eggs in both *P. gossypiella* and *C. carnea*, while, Axon was most toxicity to three days old eggs and pupae in both prey and the predator, but the most least harmfull insecticde to *C. carnea* was Pasha.

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مقارنة سمية بعض المبيدات الحشرية ضد دودة اللوز القرنفلية والمفترس الحشرى أسد المن

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تمت مقارنة سمية اربع مبيدات حشرية ضد دودة اللوز القرنفلية بالاضافة الى المفترس الحشرى اسد المن تحت الظروف المعملية. فى هذه الدراسة تم استخدام التركيزات الموصى بها حقليا للمبيدات المختبرة. بالنسبة لدودة اللوز القرنفلية أظهر فعل المبيدات على البيض ان بيض عمر ثلاثة أيام كان الاكثر تأثيرا عن بيض عمر يوم واحد بإستثناء معاملة الديميلين حيث بيض عمر يوم أظهر حساسية طفيفة عن بيض عمر ثلاثة أيام. فيما يتعلق ببيض عمر يوم، معاملة الديميلين كانت الأعلى تأثيرا كمبيد للبيض بينما اظهر معدل فقس البيض ٨٢.٦١% بإنخفاض ٩.٦٧% مقارنة بالبيض غير المعامل، فى حين مبيد الاكسون كان الأعلى تأثيرا كمبيد للبيض عند معاملة بيض عمر ثلاثة أيام حيث معدل فقس البيض المقابل سجل ٧٧.٣٣% بإنخفاض ١٦.٠٧% مقارنة بالبيض غير المعامل. من ناحية اخرى، كان سبنتور أقل تأثيرا على البيض عمر يوم وثلاثة ايام. وكان معدل الفقس المقابل ٨٩.٤٧ و ٨٨.٠٠% بمعدل إنخفاض ٢.١٧ و ٤.٤٩% على التوالي، بينما معدل فقس البيض الغير معامل عمر يوم وثلاثة أيام كان ٩١.٤٥ و ٩٢.١٤ على التوالى، أظهرت النتائج نفس الاتجاه فى سمية المبيد على البيض المرتبط بتعرض بيض عمر يوم وثلاثة أيام لنفس المبيدات المختبرة بينما فعل المبيد على البيض كان أكثر تأثيرا فى حالة بيض المفترس (اسد المن) عن بيض الفريسة (دودة اللوز القرنفلية). بناءا على تأثير المبيدات الحشرية المختبرة على طور العذراء لدودة اللوز القرنفلية واسد المن وتأثيرها المتأخر على الكفاءة الحيوية لكل من الكائنات المستهدفة، كان مبيد الاكسون أعلى تأثيرا تجاه عذارى عمر يوم وثلاثة أيام لكل من دودة اللوز القرنفلية و أسد المن يليه الديميلين تجاه عذارى عمر يوم وثلاثة أيام لمفترس اسد المن. أظهر الديميلين أعلى تأثيرا متأخرا على ذكور الحشرة الكاملة لدودة اللوز القرنفلية وأقل تأثيرا متأخرا على الإناث لكلا العمرين المختبرين من العذارى. أدى مبيدى سبينتور وباشا أقل تأثيرا متأخرا على خروج الحشرة الكاملة لأسد المن. أظهر مبيدى الأكسون والديميلين أعلى تأثير متأخر على نسبة فقس البيض لكل من دودة اللوز القرنفلي ة واسد المن.