EFFECT OF TWO CHEMICAL INSECTICIDES ON THE EGG PARASITOID *TRICHOGRAMMA EVANESCENS* WEST. (HYMENOPTERA: TRICHOGRAMMATIDAE) AND ON SOME NOCTUID LARVAE

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INTRODUCTION

In Egypt, natural enemies such as parasitoids of several insect pests play an important natural role in suppressing their population density. *Trichogramma* spp. (Trichogrammatidae), naturally parasitize eggs of many lepidopterous pests. These pests attack agricultural crops just after the first appearance of seedlings until harvesting (King *et al.*, 1985, and Abd El-Hafez & Nada, 2000). They affect directly or indirectly plants growth and crops yield. For example, family Noctuidae (Lepidoptera) contains three major insect pests; the pinkborer *Sesamia cretica* Led. (Semeada, 1998), the cotton leafworm *Spodoptera littoralis* (Boisd.) (Magd El-Din and El-Gengaihi, 2000) and the black cutworm *Agrotis ipsilon* (Hufn.) (Abdel-Rady and Osman, 2005), that causes sever damage to many agricultural crops.

The intensive and continuous applications of chemical insecticides against various insect pests are usually accompanied with environmental problems, resistance of the target pest and destruction of natural enemies (Ahmed, 1998; Salwa *et al.*, 2001 and Abdel-Rahman *et al.*, 2005). As awareness of the benefits of minimizing adverse environmental effects of insecticides grows, it becomes necessary to investigate the efficacy of new materials which can deliver an acceptable level of control and pose little risk to non-target organisms and environment. Searching for alternative safe pest control methods other than harmful insecticides, such as the utilization of Insect Growth Regulators (IGRs) are increasingly developed and encouraged (Attia *et al.*, 1984). They represent one of the recent components of Integrated Pest Management (I.P.M.) strategies, that are used to maintain pests population under the economic injury levels. The efficiency of using IGRs against *S. cretica* was studied by Ebaid (2001), against *S. littoralis* by Magd El-Din and El-Gengaihi (2000) and against *A. ipsilon* by Abdel-Rady and Osman (2005).

Limited information is available on the relative toxicity of insecticides to natural enemies and this makes the selection of insecticides suitable for IPM difficult (Stevenson and Walters, 1983). Besides, it is of great importance to know the effects of various insecticides on useful insects (Varama and Singh, 1987). Therefore, the present study was conducted under laboratory conditions to evaluate the effect of an insect growth regulator (Lufenuron), in comparing with a chemical insecticide (Salabeed), on the emergence of adults of the egg-parasitoid *Trichogramma evanescens* West. The two products were also tested against the fourth instar larvae of *S. cretica, S. littoralis* and *A. ipsilon*. These studies are needed when *T. evanescens* is released and used as a biological control agent and also for using IGRs with other safe control methods in IPM programs against the three pests in many agricultural fields.

MATERIAL AND METHODS

Laboratory studies were carried out to evaluate the effects of two materials (Lufenuron and Salabeed); on the emergence of adult parasitoids of *Trichogramma evanescens* from parasitized *Sitotroga cerealella* eggs and also on the fourth instar larvae of three major insect pests namely; *Sesamia cretica, Spodoptera littoralis* and *Agrotis ipsilon*.

Rearing of *S. cerealella* was made for its utilization as a laboratory host for the egg parasitoid, *T. evanescens*. It was reared on wheat grains after being heated. This was achieved by maintaining grains in water (kg/ 100 cc water) in the oven for 4 hours at 200 ° C. Rearing took place in a rearing cage (2X1X1 m), made of wood and wire (80 mesh) (Abbas, 1991, personal communication). Referring to Wishert (1929), heating wheat grains before use eliminates many problems. Adults of *T. evanescens* parasitoids were obtained from collected field parasitized eggs of *Ostrinia nubilalis* Hb. (Lepidoptera: Pyralidae), a major insect pest of maize plants. The parasitoids were reared on *S. cerealella* eggs for several generations, using the technique described by Abbas *et al.* (1989). However, eggs of *S. cretica, S. littoralis* and *A. ipsilon,* were collected from several agricultural fields in Qalubia Governorate. These three pests were reared for several generations according to the techniques described by Eabid (2001); El-Defrawi *et al.* (1964) and Gesraha (1993), respectively. The laboratory rearing provided the needed fourth instar larvae for bioassay tests. All the previous rearing techniques were made under laboratory conditions of 25±2 °C and 65±5 % R.H.

The following two materials were tested:

1- Lufenuron (30 % E.C), an insect growth regulator. A volume of 2 ml. of Lufenuron was diluted in water to obtain a volume of 200 ml., to give the stock solution of 3000 p.p.m.

2- Salabeed (30 % E.C), a chemical insecticide. A volume of 2 ml. of Salabeed was diluted in water to obtain a volume of 200 ml., to give the stock solution of 3000 p.p.m.

The present work dealt with studying the effects of two insecticides on *T. evanescens* parasitoids and also on the fourth instar larvae of *S. cretica*, *S. littoralis* and *A. ipsilon.*

I-Insecticidal effects on *T. evanescens* parasitoids

Groups of 250 parasitized *S. cerealella* eggs by *T. evanescens* parasitoids (50 eggs in each group) representing 5 replicates, were used. Each group was immersed for 10 seconds in five different concentrations of either Lufenuron or Salabeed. These five concentrations were; 0.32, 0.63, 1.25, 2.50 and 5.00 p.p.m., which were prepared by diluting with water 0.01, 0.02, 0.04, 0.08 and 0.17 ml. of the stock solution (3000 p.p.m.), respectively, to obtain a total constant volume of 100 ml., for each concentration. Eggs of each replicate were placed in a glass test tube (10X2.5 cm.) covered with muslin and set in position by a rubber band. The treated parasitized eggs were left until emergence of either adult parasitoids or pest larvae. Untreated control of parasitized *S. cerealella* eggs was conducted by dipping only in water. Replicates were checked daily and the percentages of adult parasitoids emergence were calculated.

II - Insecticidal effects on the fourth instar larvae

To study the insecticidal effects of Lufenuron and Salabeed on 4th instar larvae of *S. cretica*, pieces of maize, each of about 0.5 cm. long, were dipped for a half minute in each concentration of the two tested compounds and then left for one minute to dry. The same technique was also followed for *S. littoralis* and *A. ipsilon*, except that the food source was castor bean leaves. In case of Lufenuron treatment, five concentrations of 2.50, 5.00, 10.00, 20.00 and 40.00 p.p.m., were prepared by diluting with water 0.08, 0.17, 0.33, 0.66 and 1.32 ml. of the stock solution (3000 p.p.m.) , respectively, to obtain a total constant volume of 100 ml., for each concentration. But, for Salabeed treatment, five concentrations of 0.63, 1.25, 2.50, 5.00 and 10.00 p.p.m., were prepared by diluting with water 0.02, 0.04, 0.08, 0.17

and 0.33 ml. of the stock solution (3000 p.p.m.), respectively, to obtain a constant total volume of 100 ml. for each concentration. In addition, for each concentration, 10 fourth instar larvae of each of the three tested pests were placed separately in a 15X7.5 cm. cup (these larvae were left without feeding for six hours before treatments). Larvae were allowed to feed on the treated food for 24 hours in case of the two tested materials, compared with the same numbers for the untreated control of each pest. The mortality percentages among *S. cretica, S. littoralis* and *A. ipsilon* larvae were daily recorded. Survived larvae after treatments were transferred to other clean cups containing untreated food until pupation and adult emergence. Tests of the untreated control were conducted using the same source of food, but dipped only in water. All the previous experiments were carried out under laboratory conditions of 25±2 °C and 65±5 % R.H.

The obtained data concerning the effects of the two tested insecticides were corrected according to the formula given by Abbott (1925). The effectiveness of the different treatments was expressed in terms of LC_{50} and LT_{50} values at 95 fiducial limit. If mortality percentages ranged between 16 to 84 %, the values of LC_{50} or the LT_{50} were estimated. Statistical analysis of data was based on the probit analysis, according to statistical method of Litchfield and Willcoxon (1949).

RESULTS AND DISCUSSION

1-Insecticidal effects on *T. evanescens* parasitoids

After 2 days of Lufenuron treatments, the percentages of emergence of adult *T. evanescens* parasitoids ranged from 66.20 to 18.40 % by using the concentrations ranged from 0.32 to 5.00 p.p.m., respectively. Data in Table (1) revealed that the mortality percentages of *T. evanescens* increased by increasing the tested concentrations of the insect growth regulator Lufenuron. Results confirmed those of El-Khawas *et al.* (2003), who tested Cascade (IGR) against parasitized *Ostrinia nubilalis* Hn. eggs, by the egg parasitoid *T. evanescens.*

After 2 days of Salabeed treatments, the percentages of emergence of adult *T evanescens* parasitoids ranged from 38.80 to 6.00 %, , by using the concentrations ranged from 0.32 to 5.00 p.p.m. Data in Table (1) showed also that, the mortality percentages of *T. evanescens* increased by increasing the tested concentrations of the chemical insecticide Salabeed.

Comparing the effects of Lufenuron and Salabeed, at concentrations of 0.32, 0.63, 1.25, 2.50 and 5.00 p.p.m., (on parasitized *S. cerealella* eggs), the recorded values showed higher toxic effects of Salabeed than Lufenuron on the adult emergence of *T. evanescens* (Table,1). The percentages of reduction in adult parasitoids emergence at the concentrations of 0.32 , 0.63, 1.25, 2.50 and 5.00 p.p.m., compared to untreated control (85.20 %) were ; 22.30,26.76,34.74, 66.67 and 78.40 % for lufenuron. While, in case of Salabeed they were; 54.46, 76.06, 87.32, 92.49 and 100.00 %, respectively. Many authors reported the same toxic effects of harmful insecticides on beneficial parasitoids of Trichogrammatids. Beasley and Henneberry (1984) and Staten *et al.* (1987) indicated that, the major obstacle for successful establishment of *Trichogramma* in cotton is the heavy annual use of organophosphate and pyrethroid insecticides applied to cotton primarily for controlling *Pectinophora gossypiella* (Saund.). Hutchison *et al.* (1990) stated that, for successful establishment of *Trichogramma*, insecticide applications for *P. gossypiella* and other cotton pests must be minimized. Narayana and Babu (1992) revealed that, the efficacy of Trichogrammatids is influnced by the insecticide spray schedule imposed prior and after the release. Abd El-Hafez *et al.* (1996) found that, treatments with the insecticides; Sumialpha, Meothrin, Fenom, Ripcord, Polytrin, Delfos, Bulldok, Bestox, Cyanox, Dursban, Sevin and Larvin, led to significantly lower emergence of *T. evanescens* and *Trichogrammatoidea bactrae* adult parasitoids from treated parasitized eggs of *P. gossypiella,* where Dursban, Ripcord and Delfos completely inhibited the emergence of parasitoids. El-Khawas *et al.* (2003) reported the same toxic effects of harmful insecticides by testing Dursban on parasitized *O. nubilalis* eggs by the parasitoid *T. evanescens.*

II-Insecticidal effects on the fourth instar pests larvae

Effect of the insect growth regulator treatments

After 2 days of Lufenuron treatments, the mortality percentages among 4^{th} instar larvae of *S. cretica* (at LC_{50} value), ranged from 20.00 to 90.00 %, by using the concentrations ranged from 2.50 to 40.00 p.p.m., respectively (Table, 2). The LC_{50} value was 7.40 p.p.m. (Table, 5). The LT_{50} values (Table, 6), were 68, 46 and 29 hours, at the concentrations of 5.00, 10.00 and 20.00 p.p.m., respectively. As for *S. littoralis*, the mortality percentages among 4^{th} instar larvae (at LC_{50} value), ranged from 20.00 to 90.00 %, by using the concentrations ranged from 2.50 to 40.00 p.p.m., respectively (Table, 2). The LC_{50} value was 20.00 p.p.m. after 2 days from treatments (Table, 5). The LT_{50} values (Table, 6), were 60 and 40 hours at the concentrations of 5.00 and 10.00 p.p.m., respectively. In case of *A. ipsilon,* the mortality percentages among 4th instar larvae (at LC_{50} value), ranged from 22.22 to 88.89 %, by using the concentrations ranged from 2.50 to 40.00 p.p.m., respectively (Table, 3). The LC_{50} value after 2 days from treatments was 25.00 p.p.m., (Table, 5). The LT_{50} values (Table, 6), were 80, 58 and 29 hours at the concentrations of 10.00, 20.00 and 40.00 p.p.m., respectively.

TABLE (I)

Effects of Lufenuron and Salabeed on the egg parasitoid *T. evanescens* in parasitized eggs of *S. cerealella* (after 2 days of eggs treatments).

Treatments	Concentrations (p.p.m.)	Mean % of adult parasitoids emergence	Mean total numbers of emerged parasitoids	% reduction in adult parasitoids emergence (compared to untreated control)
Lufenuron	0.00	85.20 (74-96)	42.60 ±4.62 (37-48)	
	0.32	66.20 (38-94)	33.20 ±11.10 (19-47)	22.30 %
	0.63	62.40 (34-92)	31.20 ± 11.45 (17-46)	26.76%
	1.25	55.60 (30-86)	27.80 ± 10.83 (15-43)	34.74%
	2.50	28.40 (18-48)	14.20 ± 6.91 (9-24)	66.67%
	5.00	18.40 (10-28)	9.20 ± 3.83 (5-14)	78.40%
Salabeed	0.00	85.20 (74-96)	42.60 ± 4.62 (37-48)	
	0.32	38.80 (22-52)	19.40 ± 6.19 (11-26)	54.46%
	0.63	20.40 (4-32)	10.20 ± 5.81 (2-16)	76.06%
	1.25	10.80 (0-22)	5.40 ± 4.83 (0-11)	87.32%
	2.50	6.40 (0-14)	3.20 ± 3.11 (0-7)	92.49%
	5.00	0.00	0.00	100.00%

Results obtained from the treatments of the pests larvae of *S. cretica, S. littoralis* and *A. ipsilon*, showed a positive relationship between the larval mortality percentages and the different concentrations of Lufenuron applied, *i.e.* as the concentrations of Lufenuron increased, the larval mortality percentages of each of the three pests were also increased. Moreover, a negative correlation was shown between the applied concentrations of the insect growth regulator and the LT_{50} values. These results are similar to those of Mostafa *et al.* (1991), who tested three IGRs (Dimilan, BAY SIR 8514 and IKI 7899) on larvae of *A. ipsilon*. El- Khawas (2001) and Ebaid (2001) recorded the same relationships when they applied Consult (IGR) against larvae of *S. cretica* and *A. ipsilon*, respectively. Mansour (2001) showed similar correlations, when testing Mimic (IGR) against *S. littoralis* larvae. Results were also confirmed by those findings of El-Khawas *et al.* (2003) and Shoeb and EL-Khawas (2004), by testing Cascade and Lufenuron against 3rd and 4th instar larvae of *O. nubilalis* and *Phthorimaea operculella* (Zeller), respectively; where, the LC_{50} value in case of using Lufenuron was 1.20 p.p.m. after one day of treatments and the LT_{50} values were 64 and 30 hours, at the concentrations of 0.60 and 1.20 p.p.m., respectively.

TABLE (II)

Corrected mortality percentages for fourth instar larvae of *S. cretica* fed on maize pieces treated with different concentrations of Lufenuron and Salabeed.

Treatments	Concentrations (p.p.m.)	% cumulative mortality after (days)			
		1	2	3	4
Lufenuron	0.00	0.00	0.00	0.00	0.00
	2.50	10.00	20.00	30.00	40.00
	5.00	20.00	40.00	50.00	50.00
	10.00	30.00	50.00	60.00	60.00
	20.00	50.00	60.00	70.00	70.00
	40.00	80.00	90.00	100.00	100.00
Salabeed	0.00	0.00	0.00	0.00	0.00
	0.63	30.00	50.00	70.00	60.00
	1.25	50.00	70.00	80.00	80.00
	2.50	70.00	80.00	90.00	90.00
	5.00	80.00	90.00	100.00	
	10.00	90.00	100.00		

Effect of the chemical insecticide treatments

Tests involving treatments with the chemical insecticide Salabeed on the 4th instar larvae of *S. cretica, S. littoralis* and *A. ipsilon* are listed in Table (2), where the mortality percentages for *S. cretica* ranged from 30.00 to 90.00 % (at LC_{50} value), at the concentrations ranged from 0.63 to 10.00 p.p.m., respectively. The LC_{50} value was 1.40 p.p.m., after one day of treatments (Table, 3). The LT_{50} values were 42 and 24 hours (Table,4), at the concentrations of 0.63 and 1.25 p.p.m., respectively. For *S. littoralis* treatments, the mortality percentages ranged from 20.00 to 90.00 % (at LC_{50} value), at the concentrations ranged from 0.63 to 10.00 p.p.m., respectively. The LC_{50} value was 2.20 p.p.m., after one day of treatments (Table, 3). The LT_{50} values were 52 and 32 hours (Table,4), at the concentrations of 0.63 and 1.25 p.p.m., respectively.

For *A. ipsilon* treatments, the mortality percentages ranged from 20.00 to 90.00 % (at LC_{50} value), at the concentrations ranged from 0.63 to 10.00 p.p.m., respectively. The LC_{50} value was 3.50 p.p.m., after one day of treatments (Table, 3). The LT_{50} values were 54 and 40 hours (Table, 4), at the concentrations of 1.25 and 2.50 p.p.m., respectively.

TABLE (III)

Corrected mortality percentages for fourth instar larvae of *S. littoralis* fed on caster bean leaves treated with different concentrations of Lufenuron and Salabeed.

Treatments	Concentrations (p.p.m.)	% cumulative mortality after (days)			
		1	2	3	4
Lufenuron	0.00	0.00	0.00	10.00	10.00
	2.50	10.00	20.00	22.22	33.33
	5.00	10.00	30.00	44.44	55.56
	10.00	20.00	40.00	55.56	66.67
	20.00	40.00	50.00	66.67	77.78
	40.00	70.00	90.00	100.00	
Salabeed	0.00	0.00	0.00	10.00	
	0.63	20.00	40.00	44.44	
	1.25	40.00	50.00	66.67	
	2.50	60.00	70.00	77.78	
	5.00	70.00	80.00	88.89	
	10.00	90.00	100.00		

TABLE (IV)

Corrected mortality percentages for fourth instar larvae of *A. ipsilon* fed on castor bean leaves treated with different concentrations of Lufenuron and Salabeed.

Treatments	Concentrations (p.p.m.)	% cumulative mortality after (days)			
		1	2	3	4
Lufenuron	0.00	0.00	10.00	10.00	10.00
	2.50	0.00	22.22	22.22	33.33
	5.00	10.00	22.22	33.33	44.44
	10.00	20.00	33.33	44.44	55.56
	20.00	30.00	44.44	55.56	66.67
	40.00	60.00	88.89	100.00	
Salabeed	0.00	0.00	10.00	10.00	
	0.63	20.00	33.33	44.44	
	1.25	30.00	44.44	55.56	
	2.50	50.00	55.56	66.67	
	5.00	60.00	66.67	77.78	
	10.00	90.00	90.00	100.00	

Similar to Lufenuron treatments, the chemical insecticide treatments showed a positive correlation between the different applied concentrations of the insecticide and the percentages of larval mortality. A negative correlation was also reported between the LT_{50} values and the different applied concentrations, for the three tested pests. Zidan *et al.* (1998) found the same correlations, when the 4th instar larvae of *A. ipsilon* were exposed to Cynophos, Fenvalerate, Prempet and Pyriproxyfer. Also, El-Khawas (2001) and El-Khawas *et al.* (2003) reported the same findings by using the two chemical insecticides Marchal and Dursban against 4th and 3rd instar larvae *of A. ipsilon* and *O. nubilalis*, respectively.

TABLE (V)

Comparative toxicity in fourth instar larvae of *S. cretica*, *S. littoralis* and *A. ipsilon*, fed on different food, treated with Lufenuron and Salabeed

Treatments	*S. cretica*					*S. littoralis*					*A. ipsilon*				
	Days after treatments	LC_{50}	Slope	Confidence limits at P 0 0.05		Days after Treatments	LC_{50}	Slope	Confidence limits at P 0 0.05		Days after treatments	LC_{50}	Slope	Confidence limits at P 0 0.05	
				LC_{50}	Slope				LC_{50}	Slope				LC_{50}	Slope
Lufenuron	2	7.40	3.95	3.97 : 14.43	1.32 : 11.58	2	20.00	4.90	5.68 : 27.50	1.36 : 17.64	2	25.00	6.88	9.23 : 62.40	1.43 : 33.02
Salabeed	1	1.40	3.32	1.06 : 3.42	2.08 : 5.31	1	2.20	3.71	1.22 : 3.96	1.61 : 8.53	1	3.50	4.20	1.67 : 7.35	1.40 : 12.60

TABLE (VI)

Comparative mortality time for Lufenuron and Salabeed in fourth instar larvae of *S. cretica*, *S. littoralis* and *A. ipsilon*.

Treatments	*S. cretica*					*S. littoralis*					*A. ipsilon*				
	concent. (p.p.m.)	LT_{50} (hrs)	Slope	Confidence limits at P 0 0.05		concent. (p.p.m.)	LT_{50} (hrs.)	Slope	Confidence limits at P 0 0.05		concent. (p.p.m.)	LT_{50} (hrs.)	Slope	Confidence limits at P 0 0.05	
				LT_{50}	Slope				LT_{50}	Slope				LT_{50}	Slope
Lufenuron	5.00	68	3.56	30.91: 149.60	0.40 : 32.40	10.00	60	2.70	33.33 : 108.00	0.67 :10.80	10.00	80	3.50	36.36 :176 .00	0.39 :31.50
	10.00	46	3.62	21.91 : 96.60	0.30 : 43.44	20.00	45	2.77	25.00 : 81.00	0.55 : 13.85	20.00	58	3.26	27.62 :121.80	0.54 :19.56
	20.00	29	4.09	12.08 : 69.60	0.37 : 44.99						40.00	29	1.49	20.00 :42.05	0.93 :2.38
Salabeed	0.63	42	3.00	15.56 : 113.40	0.25 : 36.00	0.63	52	1.94	32.50 : 83.20	1.34 : 2.81	1.25	54	4.66	13.50: 216.00	0.09 :233.00
	1.25	24	3.43	8.00 : 72.00	0.09 : 137.20	1.25	32	2.94	11.85 : 86.40	0.24 : 35.16	2.50	40	3.57	12.50: 128.00	0.09 :142.80

In general, as shown in Table (2), Lufenuron and Salabeed had different effects on the emergence of adult parasitoids of *T. evanescens* and also on the 4th instar larvae of *S. cretica, S. littoralis* and *A. ipsilon,* in comparison with the untreated control. Salabeed was more toxic on the parasitoids, although it had more insecticidal effects on the three pests' larvae, comparing with Lufenuron treatments. So, it could be concluded that, the treatment with the insect growth regulator Lufenuron indused lower harmful effects on the emergence of adult parasitoids of *T. evanescens* from parasitized *S. cerealella* eggs. Lufenuron had also an acceptable level for controlling *S. cretica, S. littoralis* and *A. ipsilon* fourth instar larvae. This IGR could be applied and integrated with other safe control methods, when planning I.P.M. programs against the three pest species in crops that are subjected to their attack. Using IGRs will minimize the environmental pollution and will also be safer to man. The chemical insecticides must only be used in the occurrence of severe infestations with the three pests. Similar results concerning the possibility of using IGRs were shown by Raslan (2002) who indicated that, using IGRs is considered as the possible alternative way for controlling the newly hatched *S. littoralis* larvae. Anwar and Abd El-Mageed (2005) revealed that, chlorfluazuran had high potency against *S. littoralis* and many insects, together with lower toxicity to man and his surrounding environment.

SUMMARY

Laboratory studies were conducted to evaluate the effects of two different insecticides including an insect growth regulator (Lufenuron) and a chemical insecticide (Salabeed) on the emergence of adult parasitoids of *Trichogramma evanescens* from parasitized eggs of *Sitotroga cerealella*. Also, the study was made for evaluating their effects on the fourth instar larvae of the three insect pests; *Sesamia cretica, Spodoptera littoralis* and *Agrotis ipsilon* (Lepidoptera: Noctuidae). A positive relationship was reported between the concentrations of Lufenuron and Salabeed and the percentages of adult parasitoids emergence, and also with the percentages of 4th instar larval mortality of the three tested pests. A negative correlation was found between the LT_{50} values and the applied concentrations of the two materials.

The LC_{50} values obtained were; 7.40, 20.00 and 25.00 p.p.m., after 2, 2 and 2 days of treatments, in case of Lufenuron treatment, respectively. While, the LC_{50} values were; 1.40, 2.20 and 3.50 p.p.m., in case of Salabeed treatment after 1, 1 and

1days of treatments, for the previous three pest species, respectively. The LT_{50} values recorded were (68, 46 & 29), (60 & 40) and (80,58 & 29) hours, with the concentrations of (5.00, 10.00 & 20.00), (5.00 & 10.00) and (10.00, 20.00 & 40.00) p.p.m., for *S. cretica, S. littoralis* and *A. ipsilon*, respectively, for Lufenuron treatments. The corresponding LT_{50} values recorded in case of Salabeed treatments were (42 & 24), (52 & 32) and (54 & 40) hours, with the concentrations of (0.63 & 1.25), (0.63 & 1.25) and (1.25 & 2.50) p.p.m., for *S. cretica, S. littoralis* and *A. ipsilon*, respectively.

In general, although Salabeed had higher efficient mortality percentages on the 4th instar larvae of the three pest species, it had higher effect on the emergence of adult parasitoids of *T. evanescens*, *i.e.* it was more toxic to the parasitoid, comparing with the insect growth regulator Lufenuron. Therefore, using the insect growth regulators (IGRs) such as Lufenuron, can be applied when planning I.P.M. programs against *S. cretica, S. littoralis* and *A. ipsilon* in many agricultural fields. As, they possess an expectable level of effect on target pests and lower toxicity on natural enemies.

REFERENCES

ABBAS, M.S.T.; A.H. EL-HENEIDY; M. M. EMBABY and M. A. EWAISE (1989): Utilization of *Trichogramma evanescens* West. to control the lesser sugar cane borer, *Chilo agamennon* Bles. in sugar cane fields in Egypt: three wave release technique. *(Proc. 1st Int. Con. Econ. Ect., 87 – 97).*

ABBOTT, W. S. (1925): A method of computing the effectiveness of an insecticide *(J. Econ. Entomol. 18(2): 262 – 267).*

ABD EL-HAFEZ, A.; G. M. MOAWAD; H. M. EL-GEMEIY and A. M. RASHED (1996): Effect of some insecticides on *Trichogramma evanescens* Westwood, *Trichogrammatoidea bactrae* Nagaraja, and the hatchability of *Pectinophora gossypiella* (Saund.) eggs. *(Egypt. J. Biol. Pest Control. 6(1): 1-5).*

ABD EL-HAFEZ, A. and M. A. NADA (2000): Augmentation of *Trichogrammatoidea bactrae* Nagaraja in the IPM programme for control of pinkbollworm *Pectinophora gossypiella* (Saund.) in Egypt. *(Cotton Insect Research and Control Conference – Beltwide Cotton Conferences-, 4 – 8 Jan. 2000, 2: 1009 – 1014).*

ABDEL-RADY, A. M. and S. M. OSMAN (2005): Toxicological and biological effects of neem and Jojoba oils on the black cutworm *Agrotis ipsilon* (Hufn.) in the laboratory. *(Egypt. J. Agric. Res. 83(3): 937- 948).*

ABDEL-RAHMAN, G.A.; M. H. BELAL; N. M. IBRAHIM and E. A. ALI (2005): Observations of the toxic effects of some desert plant extracts on the cowpea aphid *Aphis craccivora* Koch. *(Egypt. J. Agric. Res. 83(2): 609 – 621).*

AHMED, A. A. I. (1998): Chinaberry fruit extracts as bioinsecticide against black cutworm larvae *Agrotis ipsilon* Hufn. *Egypt. (J. Biol. Pest Control. 8(1): 45 – 50).*

ANWAR, E. M. and A. E. M. ABD EL-MAGEED (2005): Toxicity impacts on certain insect growth regulators on some biochemical activities of the cotton leafworm. *(Egypt. J. Agric. Res. 83(3): 915 – 935).*

ATTIA, M. B.; A. GHATTAS and M. R. ABO-ELGHAR (1984): Chitin synthesis inhibitor IKI-7899, its efficiency and residuality against cotton leafworm as compared to diflubenzuron and triflumuron. *(5^{th} Ann. Conf. Afr. Assoc. Insect Sci., Section 3, paper No. 38).*

BEASLEY, C. A. and T. J. HENNEBERRY (1984): Combining gossyplure and insecticides in pink bollworm control. *(Calif. Agric. 38(1): 22 – 24).*

EBAID, G. H. (2001): Studies on some corn borers parasitoids *(Unpublished Ph. D. Thesis, Moshtohor, Benha Univ., Egypt, 205pp).*

EL-DEFRAWI, M. E.; A. TOPPOZADA; N. MANSOUR and M. ZEID (1964): Toxicological studies on Egyptian cotton leafworm *Prodenia litura* (F.). I- Suceptibility of different larval instars to insecticides. *(J. Econ. Entomol. 57(4): 591 – 593).*

EL-KHAWAS, M. A. M. (2001): Joint action due to combination of bacterial insecticide, Agerin with insect growth regulator or chemical insecticide on *Agrotis ipsilon* (Hufn.) larvae (Lepidoptera: Noctuidae). *(Annals of Agric. Sci., Moshtohor.39(3): 1723 – 1729).*

EL-KHAWAS, M. A. M.; G. H. EBAID and E. S. MANSOUR (2003): Effect of some chemical and biological pesticides on *Trichogramma evanescens* Westwood (Hymenoptera: Trichogrammatidae) and its host *Ostrinia nubilalis* Hn. (Lepidoptera: Pyralidae). *(Bull. ent. Soc. Egypt, Econ. Ser. 29: 1 – 19).*

GESRAHA, M. A. M. (1993): Ecological and biological studies on the hymenopterous parasitoids *Meteorus* spp. (Braconidae: Hymenoptera). *(Unpublished Ph. D. Thesis, Cairo Univ., Egypt).*

HUTCHISON, W. D.; M. MORATORIO and J. M. MARTIN (1990): Morphology and biology of *Trichogrammatoidea bactrae* (Hymenoptera: Trichogrammatidae) imported from Australia as a parasitoid of pink bollworm (Lepidoptera: Gelechiidae) eggs. *(Ann. Entomol. Soc. Am. 83: 46 – 54).*

KING, E. G., D. L. BULL; L. F. BOUSE and J. R. PHILIPS (1985): Biological control of bollworm and tobacco budworm on cotton by augmentative release of *Trichogramma. (Southwest. Entomol. 8:191 : 198).*

LITCHFIELD, J. T. JR. and F. WILLCOXON (1949): A simplified method of evaluating dose Effects Experiments. *(J. Pharmacol. Exp. Therap. 96: 99 – 113).*

MAGD EL-DIN, M. and S. E. EL-GENGAIHI (2000): Joint action of some botanical extracts against the Egyptian cotton leafworm *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae). *(Egypt. J. Biol. Pest Control. 10(1): 51- 56).*

MANSOUR, E. S. (2001): New approaches for controlling the cotton leafworm and bollworms in relation to abundance of parasitoids and predators. *(Unpublished Ph. D. Thesis, Fac. of Agric., Moshtohor, Benha Univ., Egypt 262pp).*

MOSTAFA, S. A.; F. A. F. ALI; M. G. ABBAS and M. ABDEL-AZEEM (1991): Effect of some insect growth regulators on the greasy cutworm, *Agrotis ipsilon* (Hufn.). *(Egypt. J. Agric. Res. 69(1): 1-10).*

NARAYANA, L. M. and R. T. BABU (1992): Evaluation of five insect growth regulators on the egg parasitoid *Trichogramma chilonis* (Ishii) (Hym.,Trichogrammatidae) and the hatchability of *Corcyra cephalonica* Staint. (Lep., Galleriidae). *(J. Appl. Entomol. 113(1): 56-60).*

RASLAN, S. A. A. (2002): Preliminary Report on initial and residual mortality of the natural product, Spinosad for controlling cotton leafworm egg masses in 2002 cotton season at Sharkia Governorate. *(Egypt, 2nd International Conference, Plant Protection Research Institute, Cairo Egypt, 21 – 24 December. 1: 635 – 637).*

SALWA, M.S.A.; S. A. SHEMAIS and S. R. KASSIS (2001): Evaluation of *Brassica rapa* (Rape) seed extracts for control of cowpea beetle, *Callosobruchas maculatus* (F.). *(Arab. Univ. J. Agric. Sci., Ain Shams Univ., Cairo. 9(1): 433 – 445).*

SEMEADA, A. M. (1998): On utilization of the fungus *Beauveria bassiana* (Bals.) Vuill. for controlling *Sesamia cretica* Led. (Lepidoptera: Noctuidae). *(Egypt. J. Biol. Pest Control. 8(1): 37 – 44).*

SHOEB, M. A. and M. A. M. EL-KHAWAS (2004): Performance and efficacy of some pesticides on the larvae of potato tuber moth. *(Bull. ent. Soc. Egypt, Econ. Ser. 30: 183 – 190).*

STATEN, R. T.; H. M. FLINT; R. C. WEDDLE; E. QUINTERO; R. E. ZARATE; C. M. FINNEL; M. HERANANDDES and A. YAMAMATO (1987): Pink bollworm (Lepidoptera: Gelechiidae): large-scale field trials with a high rate pheromone formulation. *(J. Econ. Entomol. 80: 1267 – 1271).*

STEVENSON, J. H. and J. H. H. WALTERS (1983): Evaluation of pesticides for use with biological control. *(Agric. Ecosystems Environ. 10: 201 – 215).*

VARAMA, G. C. and P. P. SINGH (1987): Effect of insecticides on the emergence of *Trichogramma brasiliensis* (Hymenoptera: Trichogrammatidae) from parasitized host eggs. *(Entomophaga. 32(5): 443 – 448).*

WISHERT, G. (1929): Large-scale production of the egg parasite *Trichogramma minutum* Riley. *(Cana. Entomol. 41 (4): 73 – 76).*

ZIDAN, Z. H.; A. AMIN; A. I. GADALLAH; K. H. GH. EL-MALKI and M. A. EISSA (1998): Performance and efficacy of certain pesticides on the black cutworm under laboratory and field conditions. *(Annals of Agric. Sci., Cairo 3: 1069 – 1084).*