Egypt. Acad. J. Biolog. Sci., 6(2): 107- 131 (2013) **A. Entomology**
Email: egyptianacademic@yahoo.com **ISSN: 1687–8809**
Received: 25 / 4 /2013 **www.eajbs.eg.net**

Biological and qualitative efficiencies of some insecticidal agents on the cotton leafworm *Spodoptera littoralis* (Boisd) under lab. conditions.

Reda, F. A. Bakr[1&4], Noha, A. M. Genidy[1], Mohamed, A. Hindy[2], Nevein, S. Ahmed[3] and Rehab, A. A. Dar[2]

1- Entomology Dept.; Fac. Of Science; Ain Shams univ. Cairo, Egypt.
2- Spray Tech. Res. Dept., Plant Protect. Res. Instit., Agric. Res. Center, Giza, Egypt.
3- Central Agric. Pest Lab., Agric. Res. Center, Dokki, Giza, Egypt.
4- Biology Department, Faculty of Science, King Khalid University, Abha, Saudi Arabia
e-mail: redabakr55@gmail.com

ABSTRACT

Four formulation products include Profenofos (OP), Pyriproxyfen (IGR)- Spinosad (Biotic agent) and Light mineral oil (CAPL-2) oil 96.62% E.C. were sprayed by using economy micron ULVA Sprayer in Laboratory with four different concentrations and control treatment with water on castor oil plant leaves and water sensitive paper to determine the spray coverage of each treatment.

Results indicated that Profenofos, Pyriproxyfen and Spinosad are the most effective in larval mortality and followed by CAPL-2. Also, Profenofos, Pyriproxyfen and Spinosad are more affected on pupation and pupal weights followed by CAPL-2. The adult emergence affected more at 30, 45 and 60 ppm of Profenofos, 400 ppm of Pyriproxyfen, 350 ppm of Spinosad followed by 200 ppm of CAPL-2 oil. The most efficient compounds are those of Pyriproxyfen and CAPL-2 oil that reduced a sever reduction in the fecundity and fertility followed by Spinosad and Profenofos,similarly longevity was strongly affected by Pyriproxyfen, but Spinosad, CAPL-2 and Profenofos has slightly effect under lab. Conditions Data showed also that, there was a negative correlation between N/cm² and the percentage corrected larval mortality in all treatments, except in the case of CAPL-2 oil, the correlation was positive. No significant differences between VMD of droplet sizes and the percentage corrected mortality. The ration [VMD],[N/cm²] was developed toward a tendency to homogeneity of spray spectrum with increasing the concentration used in all the treatments.

Keywords: *Spodoptera Littoralis* (Boisd.) – Pyriproxyfen (IGR) – CAPL – 2 Oil – Profenofos – Spinosad – Ultra low volume and spray quality.

INTRODUCTION

Cotton leaf worm *S.Littoralis* (Boisd.) is a key pest for wide range of economical pests on cotton. Controlling larval stage with recommended pesticides became insufficient and cause many side effects on agricultural environment, therefore the efforts are directed recently towards evaluation of some new formulation (mineral oil, IGR and Biotic agents like Spinosad), which are more safe, cheap, available and probably less causing development of insect resistance than recommended pesticides. Moreover, these products have anti feedant developmental and toxic effects against *Spodoptera Littoralis* larvae (Badr *et al*. 1995).

The aim of the present work is to find safe solutions for controlling the high infestation of *S. Littoralis* larvae under laboratory conditions and determine the biological and qualitative efficiencies of certain insecticides and alternatives.

MATERIALS AND METHODS

Maintenance of the culture: *Spodoptera Littoralis* (Boisd) larvae obtained from the laboratory culture of plant protection research institute, agricultural research center. Resulting from a maintained culture reared in the laboratory for at least four generations as described by EL-Defrawi *et al.* (1964). Egg patches were kept in glass jars.The hatched larvae were provided daily with fresh castor bean leaves *Ricinus Communis.* Each 20-Pupa allowed pupating in glass jars. The resulting pupas were then placed on filter paper discs in uncovered petri dishes which were kept in 1-cubic foot wire screen cages. The resulting moths were fed on 20% sugar solution. Egg patches were collected daily, and transferred into Petri-dishes for another generation.

The Tested Compounds:

1. Pyriproxyfen: IGR Compound, Admiral®.
2. Light Mineral oil (CAPL-2), (96.9% E.C.).
3. Profenofs: Organophosphorous insecticide.
4. Spinosad: Bio-insecticide.

The susceptible strain was reared without contamination with pesticides for more than two years. One of IGR compounds (JHM S-31193 10% E.C.), mineral oil (CAPL-2 96.62%), OP (Profenofos 720 E.C.) and Biotic agent (Spinosad 24 E.C.) were tested against the 4th instars larvae of *S.Littoralis* through using castor leaves spraying technique by using the Economy Micron ULVA sprayer.

Serial of aqueous concentrations of each compound are prepared (V/V) at the rate of ppm, e.g. four concentrations (400, 200, 100 and 50 ppm) for Pyriproxyfen; 200, 150, 100 and 50 ppm for mineral oil; 60, 45, 30 and 15 ppm for Profenofos; and four concentrations 350, 250, 150 and 50 for Spinosad. Castor oil plant leaves were sprayed by each concentration of the four selected compounds at 0.5m spray height by Micron ULVA sprayer, in the same time, another set of castor oil plant leaves sprayed with water (as control treatment) then all leaves well separate and allowed to overcome excess moisture which leads to insect subjected to Nuclear Polyhedrosis Virus (NPV) and molds. Water sensitive paper (Novartis cards) were fixed besides castor oil leaves in each treatment to determine both number of droplets per square centimeter and volume mean diameter (VMD). From the resultant droplets at 31°C, and 57% RH, with a minimum spot diameter of 50 micrometers were calculated by Struben lens 15X and all previous concentrations of the four compounds to evaluate the spray coverage of this sprayer. After dryness of leaves they introduced to the starved larvae for only 24 hours. Then, the larvae were fed on fresh, clean and untreated leaves until pupation. Twenty of 4th instar larvae were put in labeled plastic cans (½ Kilo) during the whole period of experiment. five replicates were made for each concentration of the four tested compounds. All the tested larvae were starved for a period of 8 hours before they fed on the treated or untreated leaves to ensure rapid ingestion (Afifi *et al*. 1969). The resulted pupae were kept in plastic labeled cans (½ kilo) till adult emergence. These tests were carried out to define, the larval mortality, percentage of pupation, pupal weight, adult emergence, sex ratio, number of egg laying/female, fertility and adult longevity. The mortality rate was recorded daily and corrected according Abbott's formula (Abbott, 1925).

RESULTS

Effect of Spinosad on some biological aspects

From data presented in Table (1) showed that the larval mortality increased with the increase in the concentrations as expressed in corrected percentages by 80.6, 81.7, 84.9 and 90.3%, respectively at the concentrations of 50, 150, 250 and 350 ppm, respectively. The response is relatively high in all concentrations for larval mortality.

Table 1: Effect of Spinosad on some biological aspects of *Spodoptera littoralis* treated as 4th larval instar.

Conc. ppm		Total larval mortality % ± S.E.	Corrected larval mortality %	Pupation % ± S.E.	Inhibition of Pupation %	Pupal Weight (g) ± S.E.	Adult Emergence % ± S.E.	Total Inhibition of Adult Emergence %	Sex ratio %	
									Male	Female
Control		7 ± 1.1	—	91 ± 3.67	—	0.3656 ± 0.00038	90 ± 2.74	—	56	44
50		82 ± 3.74	80.6	17 ± 2.025	81.3	0.3463 ± 0.0004	16 ± 1.3	82.2	56	44
150		83 ± 2.074	81.7	17 ± 1.87	81.3	0.3208 ± 0.00052	14 ± 1.87	84.4	50	50
250		86 ± 3.674	84.9	13 ± 3.15	85.7	0.3122 ± 0.00141	11 ± 2.24	87.8	54	46
350		91 ± 1.22	90.3	8 ± 1.049	91.2	0.3038 ± 0.00037	7 ± 1.87	92.2	43	57
Regression Values	a	84.3666	—	19.82	—	0.374995	16.9667	—	—	—
	B	0.017333	—	-0.0303*	—	-0.000136**	-0.0273*	—	—	—
	R^2	0.1401	—	0.3668	—	0.9065	0.358	—	—	—

* Significantly different.
** Highly significant different.
A = Intercept.
B = Regression coefficient.
R^2 = Determintion Factor.

Continued table (1)

Conc. ppm		No. of eggs / female (Fecundity) ± S.E.	O.D.I. %	Egg hatching % ± S.E. (Fertility)	Sterility %	Longevity (days) Mean ± S.E.	
						Male	Female
Control		850 ± 3.78	0	96 ± 1.61	0	7.5 ± 0.258	7 ± 0.516
50		783 ± 3.55	4.1	63 ± 3.22	38.9	8 ± 0.516	7.5 ± 0.258
150		686 ± 7.44	10.7	60 ± 2.79	49	8.25 ± 0.224	7.75 ± 0.224
250		635 ± 4.84	14.5	55 ± 2.05	56.7	8.75 ± 0.428	8 ± 0.365
350		520 ± 3.49	24.1	40 ± 2.37	74.2	9 ± 0.258	8 ± 0
Regression Values	a	824.0	—	46.35	—	8.01667	7.5833
	b	-0.84**	—	0.007	—	0.003667	0.001667
	R^2	0.9716	—	0.005	—	0.2444	0.1429

O.D.I : Oviposition detterent index.
* Significantly different.
** Highly significant different.
a = Intercept.
b = Regression coefficient.
R^2 = Determintion Factor.

On the other hand, the data in Table (1) indicated that there was inverse significant relationship between the Spinosad concentrations and the pupation percentages 17, 17, 13 and 8% at concentrations of 50, 150, 250 and 350 ppm, respectively, as compared with 91% in the control.

The weights of resulted pupae were highly significant affected as shown in Table (1). The percentage of the adult emergence was significantly decreased with an increase in the concentrations as indicated by 16, 14, 11 and 7%, respectively at ascending successive concentrations. The present results indicated that the sex ratio shifted to male side at the concentrations of 50, 250 ppm, while shifted to female side at the concentration of 350 ppm but equal in males to females at 150 ppm. On the other hand, results tabulated in continued Table (1) showed that Spinosad has oviposition deterring activity. The ovipositon deterrent index (O.D.I) was 4.1, 10.7, 14.5 and 24.1% and 24.1% at the concentrations of 50,150,250, and 350 ppm, respectively. In addition, the percentage of sterility was 38.9, 49, 56.7 and 74.2 at the same concentrations. The observation showed that the longevity of both sexes was slightly prolonged especially at higher concentrations. The longevity of males was non significantly increase with the increase in concentration. It was 8, 8.25, 8.75 and 9 days at the concentrations of 50, 150, 250 and 350 ppm, respectively, as compared with 7.5 days in the case of control. Also, the corresponding figures for females were non significantly increase with the increase in the concentration. It was 7.5, 7.75, 8 and 8 days at the same concentrations compared with 7 days in control group. Also, it was observed that the affected larvae showed some effects such as slow movement, loss of appetite, change in the skin colour from dark green or black to reddish gray and paralysis, then dead.

Effect of CAPL-2 oil on some biological aspects

The data given in Table (2) show that there was an obvious increase in the corrected larval mortality as expressed in percentages by 54.8, 72, 73.1and 81.7% at concentrations of 50, 100, 150, and 200 ppm, respectively. Also, the results showed that there was a highly significant reduction in pupation percentages that given by 40, 26, 25 and 17% as compared with 91% in the control. The weights of resulted pupae were highly significant affected as shown in Table (2). The percentage of the adult emergence was highly significant decreased with an increase in the concentrations as indicated by 31, 21, 18 and 13%, respectively at ascending successive concentrations. The results indicated that the sex ratio shifted to male side at the concentrations 100, 200, ppm, while shifted to female side at the concentrations of 50, 150 ppm. On the other hand, results tabulated in continued Table (2) showed that CAPL-2 oil has a highly significant oviposition deterring activity. It was 18.2, 33.9,49 and 61.9 % at the concentrations of 50, 100, 150, and 200 ppm, respectively. In addiation, the percent of sterility was 76.9, 100, 100 and 100% for the concentrations of 50, 100, 150 and 200 ppm, respectively. The observation showed that the longevity of both sexes was highly significant prolonged especially at higher concentrations. The longevity of males was 8, 8.5, 9 and 9.25 at the concentrations of 50, 100, 150 and 200 ppm, respectively, as compared with 7.5 days in the case of control. And the corresponding Figures for females were 7.25, 8, 8.5 and 9 days at the concentrations of 50, 100, 150, and 200 ppm, respectively, as compared with 7 days in the control group. Also, it was observed that the larvae suffered from loss of apetite after feeding on treated leaves; it begin eating the lower surface of leaves and left the upper surface of the untreated fresh leaves after 24h; their appetite decrease with the increase in the concentration. The dead larvae were dark black in colour like burned ones. As soon as moulting to 5^{th} instar the larvae have new mouth parts and normally eat again.

Table 2: Effect of CAPL-2 on some biological aspects of *Spodoptera littoralis* treated as 4th larval instar.

Conc. ppm		Total larval mortality % ± S.E.	Corrected larval mortality %	Pupation % ± S.E.	Inhibition of Pupation %	Pupal Weight (g) ± S.E.	Adult Emergence % ± S.E.	Total Inhibition of Adult Emergence %	Sex ratio %	
									Male	Female
Control		7 ± 1.1	—	91 ± 3.67	—	0.3656 ± 0.00038	90 ± 2.74	—	56	44
50		58 ± 1.22	54.8	40 ± 2.24	56	0.3571 ± 0.00037	31 ± 1.87	66.7	35	65
100		74 ± 2.92	72	26 ± 1	71.4	0.3536 ± 0.00074	21 ± 1.87	76.7	63	37
150		75 ± 1.87	73.1	25 ± 1.87	72.5	0.3421 ± 0.00035	18 ± 2.74	80	39	61
200		83 ± 3.74	81.7	17 ± 1.12	81.3	0.3081 ± 0.00155	13 ± 2.5	85.6	62	38
Regression Values	a	51.333	—	45.5	—	0.37985	35.5	—	—	—
	b	0.12067	—	-0.154**	—	-0.000317**	-0.118667**	—	—	—
	R^2	0.1635	—	0.8582	—	0.8319	0.5959	—	—	—
* Significantly different.						a = Intercept.				
** Highly significant different.						b = Regression coefficient.				
						R^2 = Determintion Factor.				

Continued table 2

Conc. ppm		No. of eggs / female (Fecundity) ± S.E.	O.D.I. %	Egg hatching % ± S.E. (Fertility)	Sterility %	Longevity (days) Mean ± S.E.	
						Male	Female
Control		850 ± 3.78	—	96 ± 1.61	—	7.5 ± 0.258	7 ± 0.516
50		588 ± 2.62	18.2	32 ± 1.88	76.9	8 ± 0.365	7.25 ± 0.224
100		420 ± 4.98	33.9	0	100	8.5 ± 0.258	8 ± 0.516
150		290 ± 2.24	49	0	100	9 ± 0.365	8.5 ± 0.258
200		200 ± 4.1	61.9	0	100	9.25 ± 0.428	9 ± 0.516
Regression Values	a	693.333	—	32.666	—	7.3333	6.5
	b	-2.56**	—	-0.196**	—	0.012**	0.014**
	R^2	0.9817	—	0.59	—	0.5586	0.5158
O.D.I : Oviposition detterent index.				a = Intercept.			
* Significantly different.				b = Regression coefficient.			
** Highly significant different.				R^2 = Determintion Factor.			

Effect of Pyriproxyfen on some biological aspects

Results recorded in Table (3) show that there is a significant effect on the larval mortality that given in corrected percentages by 71, 75.3, 87 and 89%, respectively at the concentrations of 50, 100, 200 and 400 ppm, respectively. Also, the pupation percentages were significantly reduced to 24, 22, 10 and 7% as compared with 91% in the control. The weights of resulted pupae were high significantly reduced as shown in Table (3). The percentage of adult emergence was significantly decreased with an increase in the concentrations as indicated by 17, 15, 9 and 5%, respectively at ascending successive concentrations.

Table 3: Effect of Pyiproxyfen on some biological aspects of *Spodoptera littoralis* treated as 4th larval instar.

Conc. ppm		Total larval mortality % ± S.E.	Corrected larval mortality %	Pupation % ± S.E.	Inhibition of Pupation %	Pupal Weight (g) ± S.E.	Adult Emergence % ± S.E.	Total Inhibition of Adult Emergence %	Sex ratio %	
									Male	Female
Control		7 ± 1.1	—	91 ± 3.67	—	0.3656 ± 0.00038	90 ± 2.74	—	56	44
50		73 ± 1.87	71	24 ± 1.87	73.6	0.3444 ± 0.001969	17 ± 1.87	81.2	70	30
100		77 ± 1.87	75.3	22 ± 2	75.8	0.3401 ± 0.000908	15 ± 2.92	83.4	47	53
200		88 ± 4.06	87	10 ± 2.74	89	0.3112 ± 0.001146	9 ± 2	90	78	22
400		90 ± 2.74	89.3	7 ± 1.76	92.3	0.3085 ± 0.001025	5 ± 1.81	94.5	80	20
Regression Values	a	76.4	—	23.75	—	0.346322	16.6598	—	—	—
	b	0.0376 *	—	-0.045 *	—	-0.000111**	-0.03041 *	—	—	—
	R^2	0.4053	—	0.4942	—	0.7073	0.415	—	—	—
* Significantly different.						a = Intercept.				
** Highly significant different.						b = Regression coefficient.				
						R^2 = Determintion Factor.				

Continued table 3

Conc. ppm		No. of eggs / female (Fecundity) ± S.E.	O.D.I. %	Egg hatching % ± S.E. (Fertility)	Sterility %	Longevity (days) Mean ± S.E.	
						Male	Female
Control		850 ± 3.78	--	96 ± 1.61	—	7.5 ± 0.258	7 ± 0.516
50		678 ± 5.42	11.3	41 ± 2.55	66	8.25 ± 0.428	8 ± 0.365
100		402 ± 4.73	36	26 ± 2.24	87.2	9.5 ± 0.258	8.75 ± 0.224
200		319 ± 3.22	45.4	13 ± 1.18	95	10 ± 0.516	9.75 ± 0.224
400		0	100	0	100	10 ± 0.633	10 ± 0.447
Regression Values	a	676.9	—	42.529	—	9.057377	8.325
	b	-1.756 **	—	-0.118279**	—	0.003443	0.006175**
	R^2	0.9026	—	0.8252	—	0.187	0.7423
O.D.I : Oviposition detterent index.				a = Intercept.			
* Significantly different.				b = Regression coefficient.			
** Highly significant different.				R^2 = Determintion Factor.			

The present results indicated that the sex ratio shifted to male side at the higher concentrations. The results indicated that the sex ratio shifted to male side at the concentrations of 50, 200, and 400 ppm, while shifted to female side at the concentrations of 100 ppm. On the other hand, results tabulated in continued Table (3) indicated that, Pyriproxyfen has an ovipsoition dettereing. It was 11.3, 36, 45.4 and 100% at the concentrations of 50, 100, 200, 400 ppm, respectively. In addition, the percentage of sterility was 66. 87.2, 95 and 100% at the previous concentrations. The observation showed that, the longevity of both sexes was prolonged especially at higher concentrations. The longevity of males was 8.25, 9.5, 10 and 10 days at the concentrations of 50,100, 200 and 400 ppm, respectively, as compared

with 7.5 days in the case of control. And the corresponding figures for females were 8, 8.75, 9.75 and 10 days at the same concentrations compared with 7 days in control group. It was observed that the skin of affected larvae has light and dark green patches instead of dark green or black in normal case.

Effect of Profenofos on some biological aspects

The data given in Table (4) show that there is an obvious increase in the corrected larval mortality as expressed in percentages by 90, 39.5, 97.8 and 98.9% at concentrations of 15, 30, 45 and 60 ppm, respectively. While, there was a decrease in the pupation percentage, till reatching 1% at the concentration of 60 ppm.

Table 4: Effect of Profenofos on some biological aspects of *Spodoptera littoralis* treated as 4th larval instar.

Conc. ppm		Total larval mortality % ± S.E.	Corrected larval mortality %	Pupation % ± S.E.	Inhibition of Pupation %	Pupal Weight (g) ± S.E.	Adult Emergence % ± S.E.	Total Inhibition of Adult Emergence %	Sex ratio %	
									Male	Female
Control		7 ± 1.1	–	91 ± 3.67	–	0.3656 ± 0.00038	90 ± 2.74	–	56	44
15		91 ± 2.57	90	9 ± 2	90.1	0.3312 ± 0.00048	8 ± 2	91	25	75
30		94 ± 1.79	93.5	6 ± 1.58	93.4	0.3250 ± 0.00059	0.2 ±0. 316	97.7	100	–
45		98 ± 1.22	97.8	2 ± 0.707	97.8	0.3135 ± 0.00117	1 ±0. 316	98.9	–	100
60		99 ± 0.63	98.9	1 ± 0.32	98.9	0.3044 ± 0.0011	1 ± 0.45	98.9	100	–
Regression Values	a	90.41667	–	8.916	–	0.339292	8.583	–	–	–
	b	0.191667	–	-0.1416	–	-0.000526 **	-0.158	–	–	–
	R^2	0.3502	–	0.2977	–	0.9851	0.3862	–	–	–

* Significantly different.
** Highly significant different.
a = Intercept.
b = Regression coefficient.
R^2 = Determintion Factor.

Continued table 4

Conc. ppm		No. of eggs / female (Fecundity) ± S.E.	O.D.I. %	Egg hatching % ± S.E. (Fertility)	Sterility %	Longevity (days) Mean ± S.E.	
						Male	Female
Control		850 ± 3.75	0	96 ± 1.61	0	7.5 ± 0.258	7 ± 0.516
15		240 ± 6.45	56	60 ± 2.05	82.4	8 ± 0.365	7.5 ± 0.185
30		–	–	–	–	8 ± 0.45	–
45		–	–	–	–	–	7.5 ± 0
60		–	–	–	–	9 ± 2.01	–
Regression Values	a	300.0	–	75.0	–	7.91667	8.75
	b	-6.0 *	–	-1.5 *	–	-0.041667	-0.125
	R^2	0.7464	–	0.7442	–	0.0565	0.3725

O.D.I : Oviposition detterent index.
* Significantly different.
** Highly significant different.
a = Intercept.
b = Regression coefficient.
R^2 = Determintion Factor.

The weights of resulted pupae were highly significant reduced as shown in Table (4). The percentage of adult emergence was decreased with an increase in the concentrations as indicated by 8, 2, 1 and 1% at ascending successive concentrations.

The results indicated that the sex ratio shifted to male side at the concentration of 30 ppm, while shifted to female side at the concentration of 15 ppm. On the other hand, results tabulated in continued Table (4) showed that, Profenofos has an oviposition deterring activity. It was 56% at the concentration of 15 ppm. In addition, the percentage of sterility was 82.4 at 15 ppm. The observation showed that, the longevity of both sexes was slightly prolonged. The longevity of males was 8, 8 and 9 days at the concentrations of 15, 30 and 60 ppm, respectively as compared with 7.5 days in the case of control. And the corresponding figures for females were 7.5 and at the concentrations of 15, 45 ppm compared with 7 days in control group.

Developmental events:

The developmental events of larvae, pupae and adults which were found malformed after treated 4th instar larvae with biotic agent, mineral oil and IGR could be grouped into three major categories (malformed larvae, malformed pupae and malformed adults as shown in Figures (Figs. 1-9).

In the case of treated with Spinosad (Figs. 1-3), malformations were appeared in both the higher and lower concentrations. For instance, at concentration 50 and 250 ppm the larval malformation showed intermediate stage between 4th and 5th, 5th and 6th instar which failed to moult into pupa. Also, at 350 ppm the larval malformation showed symptoms of enlargement dark colour larvae with swelling segments.

Dwarfed larvae, also appeared at 150 ppm with dark pigments unable to form the normal pupa. Pupae fully enclosed by exuvium or partially attached to larval exuvium at 250 ppm also appeared. Poorly developed pupa, bad formed head and thorax found at 250 and 350 ppm. In addition, adult abnormalities were showed curling of both fore and hind wings, the attachement of adult to old excuvium of pupae by the abdomen prevented it to fly at 150, 250, and 350 ppm were abserved. Distended abdomen with poorly developed wings at 350 ppm, also appeared.

In the case of treated with CAPL-2 oil, the larval malformation Fig. (4) showed symptoms of shrinkage, dark black and C- shaped unable to form the normal pupa at concenterations of 50 and 150 ppm, dwarfism and swelling abdomen at 100 ppm. Also, the larval instar intermediate between 4th, 5th and 5th, 6th which failed to moult into 5th, 6th were represented at concenterations 50, 150 and 200 ppm. Larval pupal intermediate with larval head and thoracic legs, but the abdomen is pupal stage were observed at 200 ppm. In addition shrinked pupa failed in shedding off the larval exuvium were represented at 150 ppm. Pupal-adult intermediate, abdomen enclosed by old pupal cuticle. Also, moths with poorly developed, curling and twisted wings and constricted abdomen were appeared at 50, 100, 150 and 200 ppm.

In the case of treated with Pyriproxyfen, malformations were appeared in all concentrations, Figs. (7-9). The larval malformation showed shrinkage, C- shaped and dark black coloured all body larvae at 50, 200 and 400 ppm. Intermediate stage between 4th and 5th larval instar which failed to moult to 5th instar were represented at concentrations 50 and 400 ppm. Larval - pupal intermediate, all pupal body enclosed in larval exuvium were represented at 50 ppm. Adult abnormalities observed at concentrations 50, 100, 200 and 400 ppm included larval-pupal intermediate and wings curling, twisted or poorly developed.

Relationship between laboratory spray quality of certain insecticidal materials by Economy Micron ULVA sprayer and the corrected larval mortality of *spodoptera littoralis* treated as 4th larval instar.

*** Statistical aspects**

To study the influence of various compounds and spraying techniques, Abott's formula (1925) was adopted to calculate the percentage corrected larval mortality of

4th larval instar treated with different concentrations. Table (5) shows the percentage reduction of 4th larval instar treated by four compounds Spinosad, CAPL-2 oil, Profenofos and Pyriproxyfen. Each compound had four concentrations applied by the Economy Micron ULVA sprayer.

Table 5: Relationship between laboratory spray quality of certain insecticidal materials by the Hand-Held-Economy Micron ULVA sprayer and the corrected larval mortality of *S. littoralis* treated as 4th larval instar.

Sparay quality						
Insecticide used	Concentation ppm	VMD	N/cm^2	VMD / N/cm^2	% Corrected Larval mortality	Remarks
Spinosad 24 SC	50	142	115	1.2	80.6	*Saccharopolyspora spinosa (Tracer)*
	150	139	113	1.2	81.7	
	250	138	110	1.25	84.9	
	350	127	116	1.1	90.3	
Pyriproxyfen 10 % E.C.	50	137	170	0.8	71	IGR (JHM) (Admiral®)
	100	129	126	0.98	75	
	200	139	138	1	87	
	400	140	131	1	89	
CAPL-2 oil 96.62 % E.C.	50	138	149	0.9	54.8	Mineral oil
	100	136	121	1.1	72	
	150	137	140	0.98	73.1	
	200	137	126	1.1	81.7	
Profenofos 720 E.C.	15	140	129	1.1	90	Organoposphorous SELECRON®
	30	135	138	0.98	93.5	
	45	136	126	1.08	97.8	
	60	137	122	1.1	98.9	
Water	-	153	109	1.4	-	Control

The spray height is constant ≈ 0.5 meter in all treatments.
VMD = Volume mean diameter.
N/cm^2 = Number of droplets / cm^2
VMD / N/cm^2 = Degree of homogeneity .

The following results were obtained:

- There was a negative complete correlation between N/cm^2 and the percentage corrected larval mortality in all treatments, except in the case of CAPL-2 oil, the correlation was positive.
  No significant differences between VMD of droplet sizes and the percentage corrected larval mortality.
- The ratio [VMD/N/cm^2] was developed toward a tendency to homognity of spray spectrum with increasing the concentration used in all the treatments.
- The range of [VMD/N/cm^2] was ranged from 1.2 to 1.1, 0.8 to 1, 0.9 to 1.1 and 1.1 when used concentrations of Spinosad, Pyriproxyfen, CAPL-2 oil and Profenofos, respectively. But the worst ratio of [VMD/N/cm^2] was 1.4 for water only.
- Pyriproxyfen concentrations revealed a significant larval mortality between the lowest and highest concentration treatments from 50 to 400 ppm.

DISCUSSION

In order to overcome the farmer proplems with toxicity, expenses and resistance development, the need to develop novel alternative methods of pest control is urgently required. Attention has therefore been paid to control insects by using Bio Agents, Mineral oils and IGR's which are nowadays considered as main components of integrated pest management programs (IPM).

A-Toxicological and developmental effects of Biotic agents, Mineral oils IGR's and OP's:

The perferance of Spinosad in controlling Lepidopteran pests according to Binning (2000) is due to:

Spinosad a new biochemical insecticide classified as environmentally friendly may soon become a widely accepted alternative to the chemical insecticides used today for the control of insect pests. Spinosad is the naturally occurring metabolite derived from fermentation of the soil bacterium *Saccharopolyspora spinosa.* Spinosad posses less risk than most insecticides to mammals, birds, fish, and beneficial insects. Due to its low toxicity and perceived low impact on the environment, the Environmental Protection Agency (EPA) registered Spinosad as a reduced-risk material. Spinosad has low toxicity and pest specific with primary efficacy against the Lepidoptera.

*** The preference of mineral oils according EL-Sisi (2002a) is due to:**

- Safe for man and animals if compared with insecticides which have great hazards on man, animal and beneficial insects.
- Their cheap price, hence lower coasts in control and make less crop production coasts.
- There is no aquired resistance of pests against mineral oils, but it still achieves success in pest control for many years.
- There broad spectrum against many pests, it considered the main alternaive insecticide for scale insects, sucking insects and many pests.
- Local production by 100% using local ores and products which make less coasts and encourage our industry.

*** The perferance of juvenoid pesticides according to Novak (1975) is due to:**

- Not toxic to other form of life and also their breakdown products.
- It is the best persistent in active form until the sensitive period to Juvenile Hormone action is passed.
- Do not kill immediately and cause developmental disturbances.
- No resistance yet recorded.
- Selective action, so they did not cause any harm to beneficial insects and natural enemies.
- Have high biological activites, thus used in minute doses.

The usage of one Organophosphorous insecticide and three different alternative insecticides to control the cotton leafworm, *Spodoptera littoralis* aims to choose one of them thought to be effective in the control of this pest. In the present study four insecticides were tested (Profenofos, Spinosod, CAPL-2 oil and Pyriproxyfen) against 4th larval instar of *S. littoralis.* Sensitive insects exposed to Spinosad exhibit unique symptomology that is typified by a general paralysis accompanied by loss of body fluids resulting in flaccid paralysis. Under close examination, minute tremors of the mandibles and crochets can be seen. The onset of paralysis is quite rapid for a biological material (Salgado, 1998).

CAPL-2 mineral oil its effect on insect is death after suffocation (Deong *et al*., 1927) or may be due to inhibition to physiological procesess (Ebeling, 1936).

Pyriproxyfen is one of IGR compounds; Juvenile Hormone Mimic. Slama *et al*. (1974) outline that the possible use of Juvenoids as pesticides is based on:

Their ability to inhibit differentiation in embryonic development and metamorphosis.

Causing disturbances in reproduction.

Inducing egg development in diapausing adults.

Profenofos is one of Organophosphorous compounds, which is toxic to insects by acting as nerve poison and killing insect by inhibition of acetyl cholinestrase (Du-Bois, 1961).

In the present study, nearly the same path way were recorded when the 4th instar larvae of *S.littoralis* were treated with Spinosad, CAPL-2, Pyriproxyfen and Profenofos.

The results of of this study indicated that the superiority of the insecticidal activity of Profenofos, Spinosad and Pyriproxyfen against the 4th larval instar of *S.littoralis*. CAPL-2 oil showed inferior effectiveness in this respect. These finding are in contorary to El-Sweerki (1994), who revealed that, Dipel 2X *B. thuringiensis* showed superior insecticidal activity against the 4th instar larvae of S. *littoralis*, while KZ oil and Pyirproxyfen showed inferior effectiveness; this may be due to the different insecticides used.

Profenofos induces the heighest larval mortality followed by Spinosad, Pyriproxyfen and CAPL-2, respectively. Mode of. The mortality of larvae from insecticides explained by Sudderuddin and Tan (1973) who investigated that the nerve synapses of insects contain a chemical mediator known as Acetylcholine (Ach), through which never impulses transmits from one nerve axon to another. Acetylcholinestrase hydrolyzes Acetylcholine to prevent its accumulation at the nerve synapses since its accumulation leads to death as a result of disruption of nerve transmission. In insects, the mode of action of Spinosad is associated with excitation of insect nervous system, uniquely alters the function of ion channels in a manner consistent with the observed neuronal excitation (Salgado, 1998). A common side effect of high doses of Juvenoids is the high mortality associated with ecdysial failure or other non-specific developmental abnormalities.

The mortality of larvae from CAPL-2 oil explained by Ismail *et al*. (1995), who concluded that all cocenteration of oils showes a strong deterrent activity against *S. littoralis* larvae reducing the food consumption significantly. Deterrency increased with increase of oil concentration and antifeeding property increase too. Thus, the larvae were died due to starvation. The auther thought that the mineral oil when eaten by the larvae contacted to larval mouth which leads to malformation in their mouth parts, so when the untreated leaves offered to them after 24 hours it begin eating the lower surface and can not eaten the chitinized upper surface epidermis. It may be due to the malformed mouth parts. Also, it eat less food than normal ones. These finding are in agreement with those of other authors (Rizk, 1982; Bekhit, 1985; El-Hamaky *et al*., 1987; Gadallah *et al*., 1990; Mabrouk *et al*., 1995; Abd El-Halim *et al*., 1997; Abd El-Aziz, 2000, Mohamed *et al*., 2000; and El-Bokl *et al*., 2003), in the case of Bacteria, Nasr *et al*. (1972) who revealed the effect of Solar and Fuel Kerosene against larvae of *S. littoralis*, El-Sweerki (1994), Badr (1995) showed the toxicity of CAPL-1, CAPL-2, Paraffin oil and Solar oil against *S. littoralis* larvae, Abd El-Halim *et al*. (1991) observed the larval mortality caused by CAPL1, CAPL2 and Sisi-6 against *S. littoralis*, Aly *et al*. (1999) showed that Super Shekrona was the most effective of all followed by super Masrona and KZ oil against larvae of *S.littoralis*, El-Sisi (2002), Eughenol, Cinnamly alcohol and ∝- Agerin (*B. thuringiensis*) showed inferior effectiveness, in the case of mineral oils. Also, El-Hamaky *et al*. (1987) evaluated the larval mortality of Chlorfulazuron and Triflumuron against larvae of *S. littoralis*, Mourad *et al*., 1989 showed that AIMX was most effective followed by DC-902 and Deenate against larvae of *S. littoralis*, (Abd El-Kerim and Shebl, 2002; Hamouda, 2002; Cook, 2003; Bakr *et al*., 2004; and Bakr *et al*., 2005), are in agreement with our results in the case of IGR's. Organophosphorous caused high

efficieny in larval mortality reviewed by many authors (Abdel-Fattah, 1970; El-Sawaf, 1971; Hodjat and Muini, 1971; Essac *et al*., 1972; El-Sheakh, 1988; and Abd El-Kader *et al*., 1995).

The results of this study have been shown that Profenofos, Pyriproxyfen, and Spinosad more affected the pupation of the treated larvae and inhibition percentage of pupation followed by CAPL-2 oil. El-Ibrashy (1970) explained that, the Corpora Alatta secrete the juvenile Hormone (JH) which stimulates larval development while preventing or retarding development of adult characteristics. During the earlier immature instars, both β-ecdysone and JH are produced. However, late in post-embryonic development, JH is not produced and hence the expression of adult characters is not inhibited and metamorphosis to the adult stage occurs. In holometabolous insects, the changes from immature instars to adult are compressed into the pupal stage. The author thought that the starvation of larvae due to antifeeding effect of mineral oils leads to deterrent pupation may be due to disturbances of insect physiology which depends on sufficient food to complete developmental processes. These findings are in agreement with that obtained by Salama *et al*. (1981); Bekhit (1985); El-Sweerki (1994); Abd El-Aziz (2000); Mohomed *et al*. (2000); and El Bokl *et al*. (2003); and Bakr *et al.* (2004), in the case of Bacteria. Also, Abd El-Kader *et al*. (1995) agreed with this concern in the case of Organophosphorous, Nasr *et al*. (1972) who indicated that Solar and Fuel Kerosene induces low pupation percentages of *S. littoralis* treated as larvae (Badr *et al*., 1995; Aly *et al*., 1999; and El-Sisi, 2002), in the case of mineral oils. Also, El-Sayed, 1981; El-Hamaky *et al*. (1987) and El-Sweerki (1994) who reported that the great effects of some IGR's on the pupation percentage of *S. littoralis*.

Results indicate that all of Profenofos, Spinosad, Pyriproxyfen, and CAPL-2 oil slightly affected the pupal weight. The reduction in the pupal weights may be due to larval starvation during larval stage or the malformation of the mouth parts, in the case of Spinosad. The reduction in pupal weights in treatment with mineral oils may be due to insuffecient food intake by larvae resulted from mouth parts malformation and anti-feedanty of mineral oils. Also, in the case of IGR's the detterent developmental processes by JH analogous may explain the reduction of pupal weight. These results are in conformity with those obtained by Salama *et al*., (1981); Bekhit (1985); Abd El-Aziz (2000); El-Bokl *et al*., (2003); and Bakr *et al,*. (2004), in the case of bacteria, El-Sweerki (1994); Aly *et al*., (1999) in the case of mineral oils. Also, El-Hammaky (1987), El-Sweerki (1994), El-Bokl *et al*., (2003), Bakr *et al*., (2004), and Bakr *et al*., (2005) in the case of IGR's. While, Abd El-Kader *et al*., (1995) disagreed with this concern in the case of Organophosphorous. But, Bahaa–El-Din (1977) agreed with our results.

The obtained data in the present work indicate that Profenofos, Pyriproxyfen, and Spinosad have the highest inhibition effect of adult emergence followed by CAPL-2 oil.

The main cause of inhibition of adult emergence in the case of treatment with mineral oils may be due to starvation of larvae which need sufficient food to complete its development into adults, and in the case of IGR's the inhibition of adult emergence was due to ecdysial failure during metamorphosis (Salama *et al*., 1974). There are two methods by which juvenoids disrupt insect development. The first method, juvenoids may act as perfect tebufenozides of JH causing disruptive effect by the presence of a relatively large amount of juvenoid, overpowering the homeostatic mechanisms present in the insect or from their presence at inopportune times. A second mechanism may involve juvenoids acting as imperfect tebufenozide of JH acting either as potent

JH tebufenozide at some sites or even as antagonist at other sites leading to disruption of insect development (Hammock and Quistad, 1981). The decrease of emergence following treatment with JH as is explained by blocking the maturatuin of imaginal discs, which are the primodia of adult integumentary structures (Schneiderman, 1972), These results are in harmony with the findings of Salama *et al*., (1981); Bekhit (1985); El-Sweerki (1994); Abd El-Aziz (2000); Mohammed *et al*., (2000); El-Bokl *et al*., (2003); and Bakr *et al*., (2004), in ther case of Bacteria, El-Sweerki (1994); Badr *et al*., (1995); Aly *et al*., (1999); and Bakr *et al.,* (2004), in the case of mineral oils, El-Sheakh (1988); Watson *et al*., (1986); and Abd El-Kader *et al*., (1995), in the case of Organophosphorous. Also, El-Sayed (1981); El-Hamaky *et al*., (1987); El-Sweerki (1994); Mourad *et al.,* (1989); El-Bokl *et al.,* (2003); Bakr *et al*., (2004); and Bakr *et al*., (2005); in the case of IGR.

The present findings show that, the most efficient compounds are CAPL-2 and Pyriproxyfen which induce sever reduction in the fecundity and fertility followed by Spinosad and Profenofos. The sterility of larvae treated with mineral oils may be due to the malnutrition caused by antifeeding effect of mineral oils which require food before they can deposit fertile eggs as many Lepidopteran species. Also, malnutrition may be leads to inhibition in the development of sex organs leads to produce unfertile eggs. In some Lepidoptera spp., Juvenoids inhibit ovarian growth and decrease female fecundity or have ovicidal effects (Salama *et al*., 1974). The supression of reproductive potential of *S. littoralis* females pretreated in the larval stage with Pyriproxyfen may be due to interference of this compound with gonadal development and sterilization of oocytes and sperms (Shaurub *et al*., 1998).

Moursy and Bartlett (1992) found that Pyriproxyfen decreased the number of spermatophores transferred into the female moths of the pink bollworm.

Riddiford and Williams (1967) pointed out that in some endopterygote insects, the juvenoids might cause female sterility when applied at certain determined stages of oocyte development.

Moriarty (1969) mentioned that the sub-lethal effects of synthetic insecticides (Organochlorine, Organophosphorous, and Carbamate compounds) can influence on the reproductive potential by increasing or decreasing the number of eggs produced or by affecting egg fertility or subsequent development. The reduced fecundity or fertility could be caused either directly by inhibition or distortion of ovary development or indirectly by reduced feeding. Moawad *et al*., (1996) found that Pyriproxyfen decreased hatchability of *S. littoralis*. Ibrahim and Shebl (2002) found that Pyriproxyfen induces pronounced sterility on *S. littoralis* and revealed that Pyriproxyfen have possible role as insecticide and chemosterilant. Bakr *et al*., (2005) found that Pyriproxyfen induce positive influence on larval mortality while negative influence on pupation and adult emergence. These finding are in full agreement with many authors, Abd Allah and Abul-Nasr (1970 b); Salama *et al*., (1981); El-Sweerki (1994); Mohamed *et al.,* (2000); and Abd El-Aziz (2000); El-Bokl *et al*., (2003); and Bakr *et al*., (2004), in the case of Bacteria, El-Sweerki (1994); and Bakr *et al*., (2004) in the case of mineral oils. Also, El-Hamaky *et al*., (1987); El-Sweerki (1994); Mourad *et al*., (1991); Abd El-Kerim and Shebl (2002); El Bokl *et al*., (2003); and Bakr *et al*., (2004); in the case of IGR's ,and El-Sawaf (1971); Ellabany (1972);Essac *et al*., (1972); El-Lakwah and Abd El-Salam (1974); El-Guindy *et al*., (1975a), Bahaa-El-Din (1977); Allam *et al*., (1978); El-Deeb *et al*., (1980); Watston *et al*., (1986); and Abd El-Kader *et al*., (1995), in the case of Organophosphorous.

These results declare that the longevity of the resulting adults of *S. littoralis* are strongly affected by Pyriproxyfen and slightly affected by, Spionosad, CAPL-2 and

Profenofos. The prolongation in the adult longevity in all tested compounds may be due to the detteret effects on reproduction and oviposition which they were the main characteristic object of adults indicated by the death of insect females after egg laid by them. These finding are in harmony with finding by El-Sweerki (1994) and Abd El-Aziz (2000); and Bakr *et al*., (2004), but in contrary to that finding by Abd Allah and Abul-Nasr (1970)[b] showed shortening of moth life-span were consistent features of the treatment and these effect became more pronounced as feeding period became more prolonged. Also, Rizk *et al*. (1977) disagree with our results about adult longevity, and El-Bokl *et al*. (2003), in the case of Bacteria. Also, these finding are in harmony with finding by El-Sweerki (1994) and Bakr *et al*. (2004) in the case of Mineral oils, El-Sweerki (1994); Bakr *et al.,* (2004); and Bakr *et al*. (2005) in the case of IGR's, but in contrary to that finding by Abd El-Kaderet *et al*. (1995) who revealed that the adult life span was shortened than the check, in the case of Organophosphorous.

B- Developmental events:

The present investigation reveals that, all tested alternative insecticides induce several abnormalities in larval, pupal and adult stage in various degress as a result of treatments, approximately in all concentrations. Larvae clear complete darkened, curved (C-shape) and some failed to moult to next larval instar. Also, many of deformed pupae appear in the form of larval-pupal intermediate and deformed puparium. Beside, incomplete adult eclosion, which varied from partial to complete eclosion of adults with legs or wings stuck to the puparium. Ingoffo and Gregory (1972), stated that, most larval mortality occur within the 1st few days during or shortly after moulting and initiation of the chitin biosynthesis. While the larvae, which could escape from dying, there were two ways: first one developed to normal pupa or can not developed to normal pupa and the larvae could not complete their last moulting process and forming intermediate form (larval-pupal intermediate form) or deformed form. These deformed forms were in different scores and shape that may by due to inhibition of protein synthesis which is essential in the forming of new cuticle (Bennett and Shotwell, 1972). The reasons of congenital malformation which were defined as teratology by Durham and Williams (1972) who stated that the teratogenecity was the results of damage of certain cells of a developing organism at a stage of maximum, susceptibility. Also, malformation may by due to inhibition of protein, lipid and LDH. Gilmor (1965) and Gilbert (1967) stated that lipids are important source of energy for insects, which was obtained from the diet and was synthesized by the insect to be utilize in metamorphosis of several insects. High score of adult malformation was noticed in the wings led to fly failure, that may be due to the inhibition of LDH and lipid, as explained, by Kitto and Briggs (1962). The cause of larval- pupal and pupal-adult intermediate in treatment with JH mimics may be due to the higher concentration of JH in the insect body which retain the immature characters and suppress metamorphosis to pupae and adults due to ecdysial failure. These findings are in agreement with that reported by Salama *et al*. (1981); El-Sweerki (1994); Abd El-Aziz (2000); El-Bokl *et al.* (2003); and Bakr *et al*. (2004) in the case of Becteria, El-Sweerki (1994); and Bakr *et al*. (2004) in the case of Mineral oils, Mourad *et al*. (1989); El-Sweerki (1994) in the case of IGR's who observed different morphological abnormalities including malformed larvae or pupae, larval-pupal and pupal-adult intermediates when larvae treated with Dipel 2X (*B. thuringiensis*), KZ oil and Pyriproxyfen; Moudgal *et al*. (2003); El-Bokl *et al*. (2003); Bakr *et al*. (2004) study the effect of Pyriproxyfen on *Spodoptera littoralis* and observed that, the skin of affected larvae has light and dark green patches instead of

dark green or black in normal case. Also, malformations were appeared in all concentrations; and Bakr *et al*. (2005) in the case of IGR's.

C-Relationship between laboratory spray quality and larval mortality of OP Compound, Bio agent, mineral oils and an IGR by compound the Economy Micron ULVA sprayer .

The usage of Economy Micron ULVA sprayer in order to resemble the spray in field with a number and volume of droplets can be identified. The range of [VMD/ N/cm^2] was ranged from 1.2 to 1.1, 0.8 to 1, 0.9 to 1.1 and 1.1 to 1.1 when used concentrations of Spinosad, Pyriproxyfen, CAPL-2 and Profenofos, respectively. But the worst ratio was 1.4 for water only. This phenomena was due to the physical properties of the used liquid certainly the ratio between viscosity and surface tention into the different concentrations used and effected on the homogeneity, this result agreed with both (Fraser and Eisenklan, 1956) & (Nordby and Skuteurd, 1975).

These results declare that there is no significant differences between VMD of droplet sizes and the percentage corrected larval mortality because of using one size spining disc which was responsible for producing droplet sizes and all the treatments were done with the same spining disc and one sprayer.

REFERENCES

Abbott, W. S. (1925): A method of computing the effectivenes of an insecticide. J. Econ. Entomol., 18: 265-277

Abdallah, M. D. and Abul-Nasr, S. (1970b): Effect of *Bacillus thuringiensis* on reproduction of the cotton leaf worm *Spodoptera littoralis*. Bull. Ent. Soc. Egypt, 4:171-176.

Abd El-Aziz, S. H. (2000): Physiopathological studies on bacterial infection of cotton leaf worm *Spodoptera littoralis*. M.Sc. Thesis, Fac. Sceince, Ain Shams Univ., Egypt, 144 pp.

Abd El - Fattah, M. S. (1970): The environmental toxicology of cotton leafworm *Spodoptera littoralis* (Boisd.) M.Sc. Thesis, Fac. Agric., Ain Shams Univ., Cairo, Egypt.

Abd El-Halim, S. M. (1997): Effect of certain bio-control agents against the cotton leaf worm, *Spodoptera littoralis* (Boisd.) in comparison with Methomyl. Egypt. J. of Biolog. Pest Control, 7 (1): 11-15.

Abd El-Halim, S.M.; Osman, M.S. and El-Hamaky, M.A. (1990): Role of emulsifying agents on ovicidal activity of a localy formulated petroleum oil as emulsifiable concentrates. Bull. Ent. Soc. Egypt, Econ. Ser., 18: 179-184.

Abd El-Kerim, A. I. and Shebl, D. A. (2002): Biological parameters for evaluating the effect of Insect Growth Regulators against grasshopper, *Euprepocnemis plorans plorans* Charp. and cotton leafworm, *Spodoptera littoralis* (Boisd.). Egypt. J. Agric. Res., 80. (2): 571-581.

Abd El-Kader, M. M.; Shaaban, M. N.; Abd El-Rahman, H. A.; Moustafa, O.K.and Radwan, E. M. (1995): Effect of insect growth inhibitors ,insecticides and their combinations on some biological aspects of *Spodoptera littoralis* (Boisd.). Egypt. J. Agric. Res., 37(3):677-685.

Afify, A.M. and Merdan, A.I. (1969): On tracing the responses of some Egyptian cotton worms in different larval ages to *Bacillus thuringiensis* Berliner. Z. Angew. Entomol., 63(3):263-267.

Aly, S. H.; Badr, N. A. and Abdel-Halim, S. M. (1999): Effects of some mineral oils on the Egyptian cotton leaf worm, *Spodoptera littoralis* (Boisd.). Minufiya. J. Agric. Res. Vol., 24 (6): 2041-2050.

Allam, S.; Gohar; K.; Kansouah A. S. and Zidan Z.H. (1978): The effect of sublethal doses of Cyolane, Dursban and Lannate on certain biological aspects and potentiality of *Spodoptera littoralis*. 4th Conf. pest. Control, NRC, Cairo: 406-414.

Badr, A.N.; El-Sisi, G. A. and Abdel Meguid, M. A. (1995): Evaluation of some locally formulated petroleum oils for controlling cotton leafworm. G, Agric. Sci. Mansoura Univ., 20(5):2557-2562.

Bakr, R. F.; Geneidy, N. A.; Hindy, M. A. and Dar, R. A. (2004): Boilogical and qualitative studies of some insecticidal agents on the cotton leafworm larvae under lab. Conditions. J.Egypt.Acad.Soc. Environ. Develop. (A. Entomology), 5(2):1-36.

Bakr , R.F.; Geneidy, N.A.; El-Baramawy, S.M; Emara, S.A. and Hassan, H.A. (2005): Toxicological and biological activities of three IGRs against fourth instar of the cotton leafworm, *Spodoptera littoralis* (Boisd). J. Egypt. Acad. Soc. Environ. Develop., 6(4): 103-132.

Bahaa-El-Din, O. (1977): The effect of some insecticides on the biotic potential of *S. littoralis* (Boisd.). M. Sc Thesis, Fac. Agric., Al-Azhar Univ. Egypt.

Bekhit, H. K. M. (1985): Effect of certain synthetic pyrethriods and *Bacillus thuringiensis* on cotton leaf worm and American bollworm. M. Sc. Thesis, Fac. Agric., Zagazig Univ., Egypt.

Bennett, G. A. and Shotwell, O. L. (1972): Heamolymph Lipids of healthy and diseased Japanese beetle larvae. J. Insect Physiol., 18: 53-62.

Binning, L. K. (2000): Commercial vegetable production in Wisconsin (A3422). University of Wisconsin-Extension Publications. 131 pp.

Cook, S.P. (2003): Laboratory and field evaluation of Tebufenozide, Diflubenzuron and *Bacillus thuriengiensis* Var. Kurstaki for suppression of *Douglasfir tussock* moth *(Orgyia pseudotsugata)* (McDunnough). J. Econ. Entomol., 69 (2): 396-400.

Deong, E. R.; Knight, R. and Joseph, C. (1927): A pre-Luminary study of petroleum oil as an insecticide for citrus trees. Hitgardia., 2 (9): 351-384.

Durham, F. W. and Williams, C. H. (1972): Mutagenic, tetratological, carcinogenic 6022 properties of pesticides. Annu. Rev. Ent., 17: 123-148.

Du-Bois, K. P. (1961): Potentiation of the toxicity of Organophosphorous compounds. Advances Pest. Contr. Res., 4:117-151.

Ebeling, W. (1936): Effect of oil sprays on California red scale at various stages of development. Hilgardia, 10 (4):95-125.

EL-Bokl, M. M.; Emara, S. A.; Abdallah, G. A. and Mohamed, M. H. (2003): Biological effects of Insect Growth Regulator (Flufenoxuron) and bacterial formulation (Agerin®) on cotton leafworm *Spodoptera littoralis* (Boisd.). J. Egypt. Acad. Environ. Soc. Develop., (A. Entomology), 3 (2) :175-190.

El-Defrawi, M. E.; Tappozada, A.; Mansour, M. and Zaid, M. (1964): Toxicological studies on the Egyptian cotton leafworm *Prodenia littora* L. susceptibility of different larval instars of *Prodenia littora* to insecticides. J. Econ. Ent., 57:591-593.

El-Deeb, W. M.; Ali, M. A. and Wahba, M. E. (1980): A note on the effect of Cypermethrin and Curacron on some biological aspects of susceptible and

resistant strain of the cotton leafworm, *Spodoptera littoralis* (Boisd). First Conf. Plant Protection Research Institute, Cairo, Egypt, 1:351-359.

El-Guindy, M. A.; El-Sayed, G. N., and Guirgis, I. I. (1975a): The effect of selection with Cyolane on the resistance spectra to various insecticides in the Egyptian cotton leafworm, *Spodoptera littoralis* (Boisd.). Bull. Ent. Soc. Egypte, Econ. Ser., 9:183-189.

El-Hamaky, M. A.; Watson, W. M. and El-Fatteh, S. M. (1987): Potency of certain insecticides and Insect Growth Regulators and their mixtures, on *Spodoptera littoralis* (Boisd.). J. Agric. Res. Tanta Univ., 13(4): 1198-1212.

El-Ibrashy, M. T. (1970): Insect hormones and analogues: Chemistry, biology and insecticidal potencies. Z. Angew. Ent., 66: 113-144.

El-Lakwah, F. and Abd El-Salam, F. A. (1974): The action of some organophosphorus in sublethal doses on *Sopdoptera littoralis* (Boisd.). Pflanzen-Und Umweltschutz, 47 (2): 28-30.

El-Sawaf, B. M. (1971): Effect of some chemical insecticides on the reproductive system and reproduction in the cotton leafworm, *Spodoptera littoralis* (Boisd.). Ph. D. Thesis, Fac. Science, Ain Shams Univ., Egypt.

El-Sayed, E. I. (1981): Effect of Diflubenzuron and Diflubenzuron-hosta-thion on larvae and adult of Egyptian cotton leaf worm, *Spodoptera littoralis* (Boisd.). Bull. Ent. Soc. Egypt, Econ. Ser^{o}., 12: 195-201.

El-Sheakh, A. A. (1988): Physiochemical effect of some Organophosphorus insecticides on the cotton leafworm, *Spodoptera littoralis* (Boisd.). Ph. D. thesis, Fac. Agric., Cairo Univ., Egypt.

El-Sisi, G. A. (2002a): Mineral oils, plant products, plant extracts and promising future in pest control. The First. Conf. of the Central Agric. Pesticide Lab, 142-149.

El-Sweerki, I. F. (1994): Integrated management of the cotton leaf worm control with the minimized environmental pollution by insecticides. M. Sc. Thesis, Institue of Environ. Studies and Research, Ain Shams Univ., Egypt, 132 pp.

Essac, E. G.; El-Gogary, S.; Abd El-Fattah, M. S.; and Ali, A. M. (1972): Effect of Carbarhl, methyl parathion and Endrin on egg production and percent pupation of cotton leafworm, *Spodoptera littoralis* (Boisd.). Z. Ang. Ent., 71: 263-270.

Fraser, R. P. and Eisenklum, P. (1956): Liquid atomization and the drop size of sprays. Trans. Instn. Chem. Engrs., 34 (4): 294-319.

Gadallah, A. I.; Emara, A. S.; Hosein, M. N.; El-Kordy. W. M. and Abd El-Halim, M. S. (1990): Bioactivity of four commercial *B. thuringiensis* formulation on some phytophagous Lepidopterous insect pests of vegetables. 3rd Conf. Agric. Dev. Res., Fac. Agric., Ain Shams Univ. Cairo. Egypt. Ann. Agric. Sci., pp. 545-553.

Gilbert, L. L. (1967): Lipid metabolism and function in insects. Adv. Insect. Physiol., 4: 69-211.

Gilmour, D. (1965): Lipids and their metabolism in insects. Ann. Rev. Ext., 15: 141-160.

Hamouda, L. S. (2002): Toxicological and biochemical studies on the effect of Admiral (IGR) and Nuclear PoIyhedrosis Virus (SNPV) on *Spodoptera littoralis* (Boisd.) larvae. J. Egypt. Acad. Soc. Environ. Develop. (A. Entomology), 2 (1): 15-29.

Hammock, B. D. and Quistad, G. B. (1981): Metabolism and mode of action of juvenile hormone, Juveniods and other insect growth regulators, in the Juvenile hormone. (Ed. L. L. Gilbert) PP: 374-394 Plenum press New York.

Hodjat, S. H. and Muini, M. (1971): The effect of Folithion and Dimecron treatment on the survivors of *Spodoptera littoralis* (Boisd.). Rev. Appl. Ent., 59:882.

Ibrahim, A. A. and Shebl, D. E. A. (2002): Biological parameters for evaluating the effect of insect growth regulators against grasshopper. *Euprepocnemis plorans* charp. And cotton leafworm, *Spodoptera littoralis* (Boisd.) Egypt. J. Agric. Res., 80(2):571-581.

Ignoffo, M.C. and Gregory,B. (1972): Effect of *Bacillus thuringiensis* γ-endotoxin on larval maturation, adult longevity, fecundity, and egg viability in several species of Lepidoptera. Entomol. Soc. Amer. 1 (3): 269-272.

Ismail, I. A.; Gesraha, M. A. and Salem, N. Y. (1995): Biodetrimental effects of Egyptian sweet *Majoram hortensis* Moench essential oil on the cotton leafworm, *Spodoptera littoralis* (Boisd.). Egypt. J. Biol. Pest Cont., 5(1): 21-24.

Kitto, G. B. and Briggs, M. H. (1962): Lactate dehydrogenase in some insect muscles. Nature, 193: 1003-1004.

Mabrouk, A. M.; Bekheit, H. K. M. and Moawad, G. A. (1995): Efficacy of new isolates of *Bacillus thuringiensis* against the cotton leaf worm, *Spodoptera littoralis* (Boisd.). Egypt. J. Biol. Pest Cont., 5(2): 123-125.

Moawad, G. M. ; Salem, I. E. M.; Desuky, W. M. H; El-Sheakh, A. A. and Raslan, S. A. A. A. (1996): Latent effect of IGR's on egg-masses of *Spodoptera littoralis* (Boisd.) treated with three IGR's in Egypt. Egypt. J. Agric. Res., 74 (1): 115-122.

Mohamed, S. A.; Badr, N. A. and Abd El-Hafez, A. (2000): Efficiacy of two formulations of pathogenic bacteria *Bacillus thuringiensis* against the first instar larvae of *Spodoptera littoralis* (Bosid.) and *Agrotis ipsilon* (HÜfn.) (Lepidoptera-Noctuidae). Egypt. J. Agric. Res., 78 (3): 1025-1040.

Moriarty, F. (1969): The sublethal effects of synthetic insecticides on insect. Biol. Rev., 44: 321-357.

Moudgal, R. K.; Sucheta, K. and Dahiya, B. (2003): Evaluation of Methoxy Fenoizide against cabbage semilooper, *Thysanoplusia orichalcea* (Fabricius). Pesticide. Res. J., 15(1):28-31.

Moursy, E. B. and Bartlett, A. C. (1991-1992): Effect of Pyriproxyfen as Juvenile hormone analogue on the reproductive potentiality of the pink boll worm, *Pectinophora gossypiella* (Saunders). Bull. Ent. Ser^{o}. Sec., 19:191-197.

Mourad, A. K.; El- Kady, M., Abou Kahla, M and Mesbah, H. A. (1989): Evaluation of certain new Insect Growth Inhibitors on the cotton leafworm *Spodoptera littorallis* (Boisd) (lep., Noctuidae). J. Agric. Sci. Mansoura Univ., 14(2):827-934.

Nasr, A. E.; Ali, A. M.; Tohami, M. and El-Kifl, A. H. (1972): Effect of petroleum fractions and two emulsifiers on the full-grown larvae and pupae of *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae). Bull. Ent. Egypt, Econ. Ser^{o}., VI:127-136.

Nordby, A. and Skuterud, B. (1975): The effect of boom height, working pressure and wind speed on spray drift. Weed Res. 14: 385-395.

Novak, V. J. A. (1975): Insect Hormones. Chapman and Hall, London, 2nd ed.

Riddiford, L. M. and Williams, C. M. (1967): The induction of ovarian dysfunction in *Thermobia domestica* by the cercopia juvenile hormone. Experientia, 28:1099-1101.

Rizk, G. A.; Steta, B. F. and Gharib, H.A. (1977): The eficiency of *Bacillus thuringiensis* for control cotton leafworm, *Spodoptera littoralis* (Boisd.). Proc. 2nd Arab Pesticides Conf. Tanta Univ., Egypt.

Rizk, M. A. M. (1982): Certain silk worm pathogens as potential agents for microbial control of some injurious pests. Ph.D. Thesis, Fac. Agric., Ain Shams Univ., Egypt.

Salgado, V. L. (1998): Studies on the mode of action of Spinosad: Insect symptoms and physiological correlates. Pestic. Biochem. Physiol, 60:91-102.

Salama, H.S.; Foda, S.M.; El-Shabrawy, A.; Matter, M. and Khalafallah, M. (1981): Development of some lepidopterous cotton pests as affected by exposure to sublethal levels of endotoxins of *Bacillus thuringiensis* for different periods. J. Invert. Pathol., 38: 220-229.

Schneiderman, H. A. (1972): Insect hormone and insect control.p. 3-27. In: Menn, J. J & beroza, M. (eds) insect juvenile hormone, chemistry and action. Academic Press, New York & London, 352 pp.

Shaurub, E. H.; Ahmed, Z. A. and El-Naggar, S. E. M. (1998): Impacts of Pyrpiproxyfen and extracts of *Schinus terebinthifolius* Raddi on development, reproduction and reproductive organs in *Spodoptera littoralis* (boisd) (Lepidoptera: Noctuidae). J. Egypt. Ger. Soc. Zool., 27 (A. Entomology), 57-82

Slama, K.; Romanuk, M. and Sorm, F. (1974): Insect Hormones and Bioanalogues. Spring verlag, Wien, New York.

Sudderuddin, K. I. and Tan, H. H. (1973): Some hydrolasess and their involvement in insecticidal resistance. Pest. Art. News Summ., 19: 24-35.

Watson, M. W.; El-Hamaky, M. and Guirguis, M. W. (1986): Ovicidal action and latent toxicity of certain chitin synthesis inhibitors and their mixtures with natural oil and wetting agent. J. Agric. Res. Tanta Univ., 13 (4): 1185-1197.

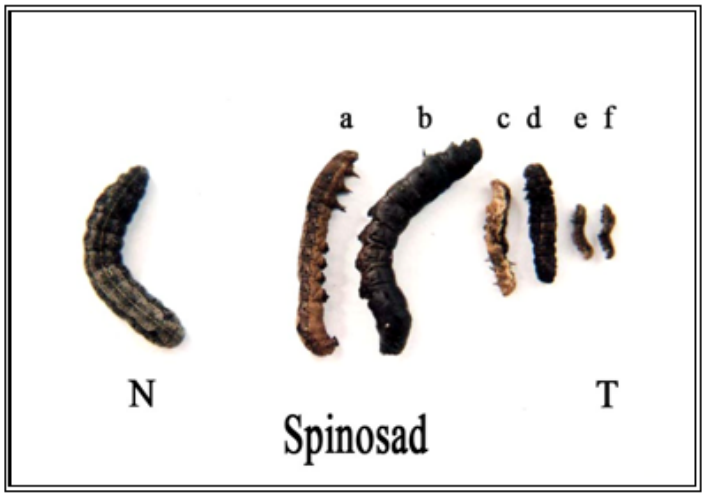

Fig. 1

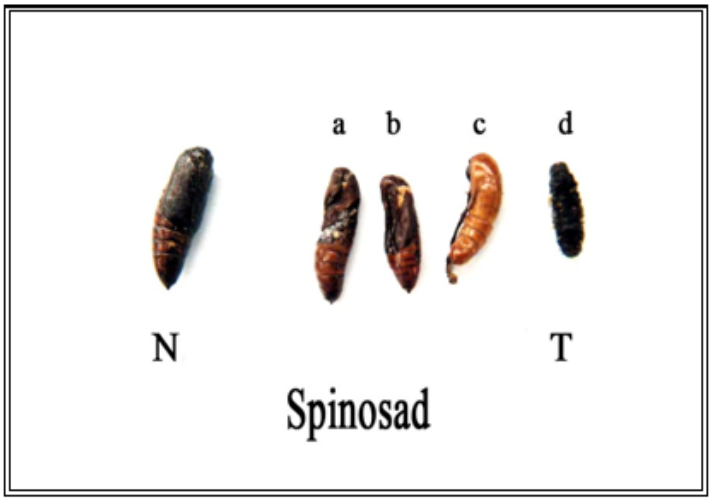

Fig. 2

Fig. 1: Malformed larvae were produced by Spinosad.
N- Normal 6th instar larva.
T- Treated larvae.
a&b- Enlarged dark colour larva with swelling segments.
c- Intermediate instar between 5th and 6th larval instar which failed to moult into 6th instar larva.
d- The 6th instar larva showing symptoms of dwarfism and body shrinkage.
e&f- 5th instar larvae surrounded by old exuvium of 4th instar larva in the hind part of larva.
Fig. 2: Malformed pupae produced by Spinosad.
N- Normal pupa.
T- Treated pupae.
a&b- poorly developed pupae, bad formed head and thorax.
c- Light brown colour pupa failed in shedding off the larval exuvium from head, thorax and posterior of the abdomen.
d- pupa fully enclosed by larval exuvium.

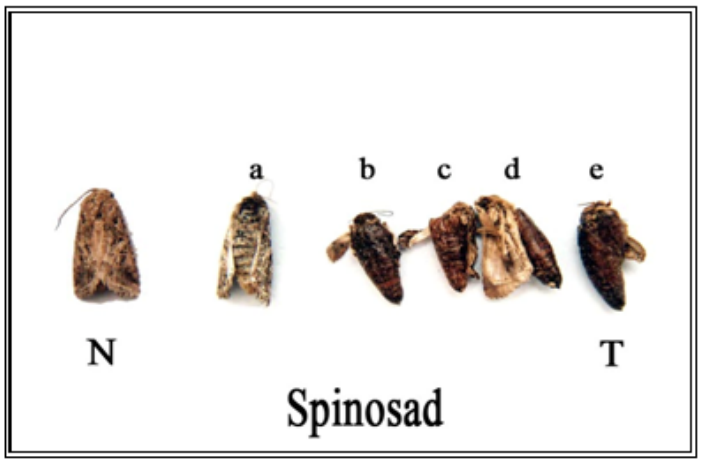

Fig. 3

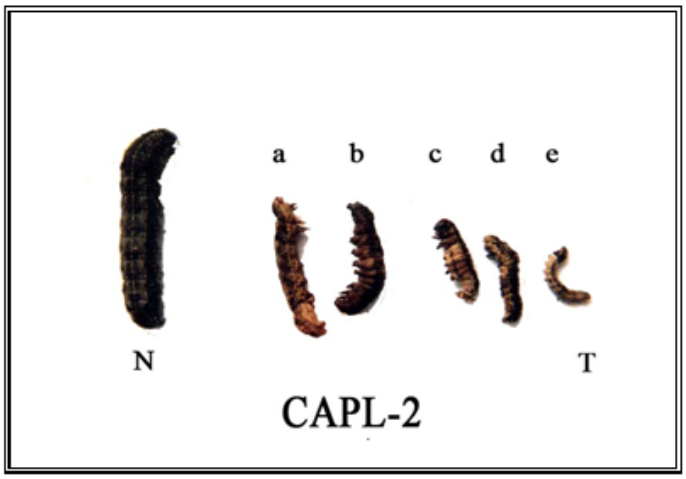

Fig. 4

Fig. 3: Malformed adults were produced by Spinosad.
N- Normal adult.
T- Treated adults.
a- Moth with distended abdomen and curling hind wings which preventing the fore wings from attachement.
b,c,d&e- Pupal - adult intermediates, abdomen enclosed by old cuticle of pupae. Also, moths with poorly developed curling or twisted wings.
Fig. 4: Malformed larvae were produced by CAPL-2 oil.
N- Normal 6^{th} instar larva.
T- Treated larvae.
a&d- Intermediate instar between 5^{th} and 6^{th} instar larvae which failed to moult into 6^{th} instar larva.
b- Shrinked, dark black and C- shaped larva unable to from the normal pupa.
c- The 6^{th} instar larva showing symptoms of dwarfism, body shrinkage and swelling abdomen which failed to pupate.
e- 5^{th} instar larva surrounded by old exuvium of 4^{th} instar larva in the hind part of larva.

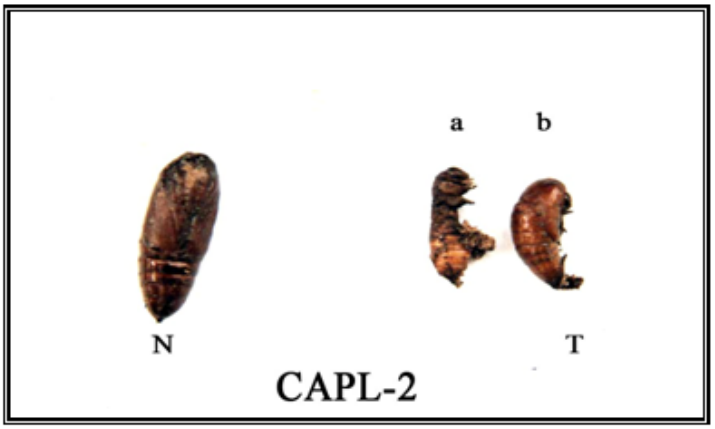

Fig. 5

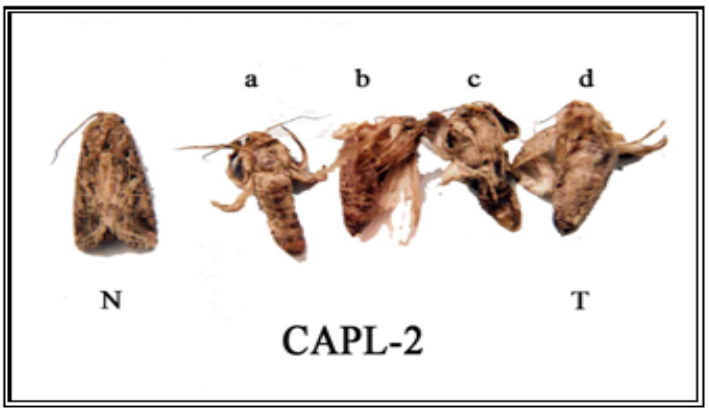

Fig. 6

Fig. 5: Malformed pupae were produced by CAPL-2 oil.
N- Normal pupa.
T- Treated pupae.
a- Larval- pupal intermediate with larval head and thoracic legs, but the abdomen in pupal stage.
b- Larval- pupal intermediate with larval head and thoracic legs, but the abdomen in pupal stage and pupa from posterior and attached with larval exuvium.
Fig. 6: Malformed adults were produced by CAPL-2 oil.
N- Normal adult.
T- Treated adults.
a&c- Moths with constricted abdomen, poorly developed, curling and twisted wings.
b & d- Pupal - adult intermediate, abdomen enclosed by old cuticle of pupa , curling and twisted poorly developed wings.

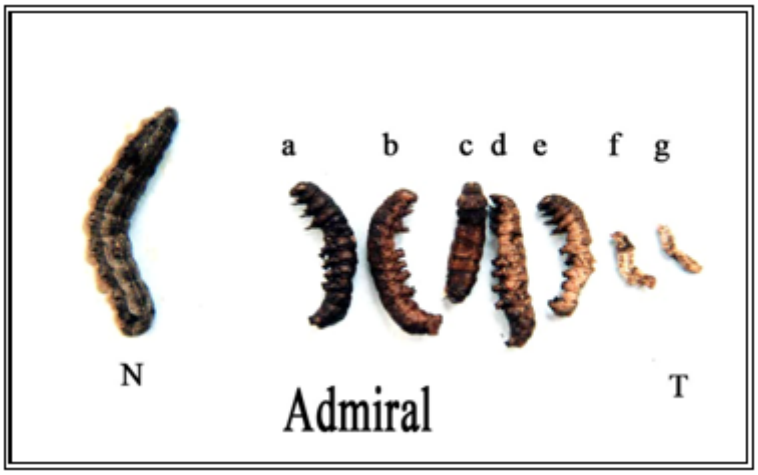

Fig. 7

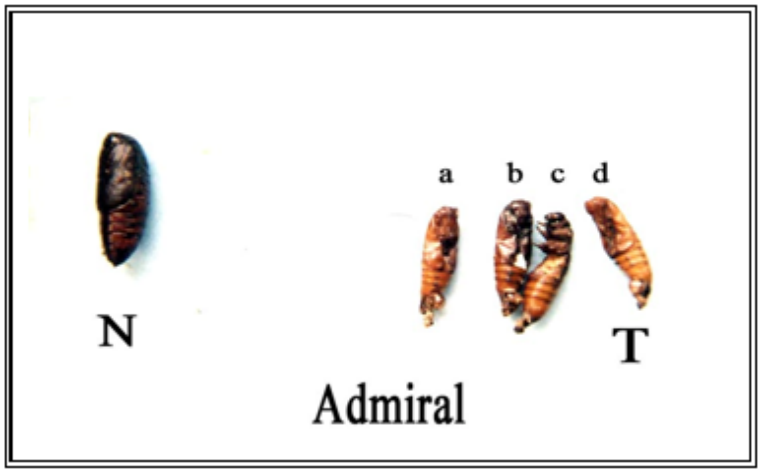

Fig. 8

Fig. 7: Malformed larvae were produced by Pyriproxyfen.
N- Normal 6th instar larvae.
T- Treated larvae.
a&b - The 6th instar larvae showing symptoms of body
shrinkage, C- shaped and dark black coloured all body which failed to moult into pupa.
c- The 6th instar larva showing symptoms of dwarfism, body shrinkage and swelling abdomen which failed to pupate.
d&e- Shrinked 6th instar larvae without moulting into pupae.
f&g- Intermediate instar between 4th and 5th larval instar which failed to moult into 6th instar.
Fig. 8: Malformed pupae produced by Pyriproxyfen.
N- Normal pupa.
T- Treated pupae.
a,b&d- Poorly developed pupa, bad formed head, thorax pupa from thorax and posterior end attached to larval exuvium .
c- Larval-pupal intermediate with larval head and thoracic legs, but the abdomen is in pupal stage.

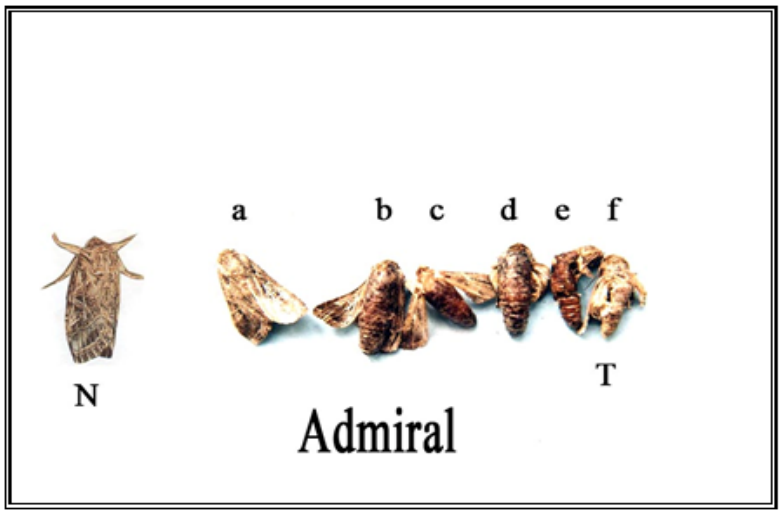

Fig. 9

Fig. 9: Malformed adults were produced by Pyriproxyfen.
N- Normal adult.
T- Treated adults.
a- Moth with slight curling and pale hind wing scales.
b,c&d- Pupal - adult intermediate, thorax, abdomen enclosed by old cuticle of pupa and curling poorly developed wings.
e- Adult attached to old cuticle of pupa by the abdomen and poorly developed very small wings which prevented it to fly.
f- Moth with constricted abdomen, poorly developed, curling and frizzled wings which prevented it to fly.

ARABIC ABSTRACT

التأثيرات البيولوجية والتقييم الكيفى لكفاءة بعض المبيدات على يرقات دودة ورق القطن تحت الظروف المعملية

رضا فضيل على بكر[1&4]، نهى عونى محمد جنيدى[1]، محمد عبد العزيز هندى [2]، نيفين صلاح الدين أحمد [3] رحاب عبد المطلب عبد المقصود محمد دار[2]

1- جامعة عين شمس – كلية العلوم – قسم علم الحشرات

2- معهد بحوث وقاية النباتات – قسم تكنولوجيا الرش – الدقى – الجيزة.

3- المعمل المركزى للمبيدات قسم تحليل متبقيات المبيدات – الدقى – الجيزة.

4- قسم الاحياء – كلية العلوم –جامعة الملك خالد – ابها – المملكة العربية السعودية

المبيدات الحشرية لها أضرار هائلة على كل من الإنسان والحيوان والنبات والبيئة هذا بالإضافة إلى زيادة مقاومة الآفات لكثير من المبيدات التقليدية مما أدى إلى زيادة مقاومة الآفات لكثير من المبيدات التقليدية مما أدى إلى بحث العلماء عن بدائل جديدة للمبيدات مثل المكافحة الحيوية والزيوت المعدنية ومنظمات النمو الحشرية التي أنجزت نجاحاً كبيراً فى مكافحة الكثير من الحشرات مثل دودة ورق القطن بوسائل حديثة وآمنة ورخيصة وأيضاً فعالة ، من خلال إستخدام وسائل الرش الأرضية المناسبة فى الحقل وإستعمال كمية مقننة من المبيد والماء مع نسبة ضئيلة من الفاقد فى الرش بين النباتات. وقد حددت الدراسة المعملية تأثير أربع مركبات كل على حدة، وهذه المركبات هى :بروفينوفوس (فوسفورى) وسباينوساد (مبيد حيوى) وكابل –2(زيت معدنى) وبيروبروكسفين (منظم نمو حشرى). وسجلت النتائج المعملية لتشمل كل من نسبة الوفاة فى اليرقات والتعذر ووزن العذارى وخروج الحشرات اليافعة ، وخصوبة الذكور والإناث وعمر كل الحشرات البالغة الناتجة من كل معاملة، وذلك بعد رش ورق الخروع بأربع مركبات بواسطة الرشاشة ميكرون أولفا الاقتصادية تحت ظروف المعمل، وتم تقييم النتائج فى مجموعتين أساسيتين هما :

(أ) التأثيرات البيولوجية للمركبات الفوسفورية والمبيدات الحيوية والزيوت المعدنية ومنظمات النمو الحشرية بعد معاملة الطور اليرقى الرابع لدودة ورق القطن (سبودوبترا ليتورالز) .

أشارت النتائج إلى أن جميع المركبات المستخدمة أدت إلى حدوث تأثيرات سلبية على اليرقات الحية وكذلك أوزان العذارى وخروج الحشرات اليافعة وكان أكثرهم تأثيراً مركبات (بروفينوفوس – بيروبروكسيفين – سباينوساد) يليهم (كابل- 2)، ومن ناحية أخرى فلقد أدى المركبين (بيروبروكسيفين وكابل – 2) إلى حدوث إختزالاً حاداً فى خصوبة كل من الذكور والإناث يليهما (سباينوساد وبروفينوفوس) . أما بالنسبة لطول حياة الحشرة فقد أدى مركب (بيروبروكسيفين) إلى استطالة عمر الحشرات اليافعة الناتجة ثم تلاه بقية المركبات.

(ب) العلاقة بين كفاءة الرش بواسطة الرشاشة ميكرون أولفا الاقتصادية ونسبة الموت لليرقات المعاملة بكل من بروفينوفوس وسباينوساد وبيروبروكسفين وزيت كابل – 2 تحت ظروف المعمل ، تراوحت درجة تجانس الرشد من 1.2 – 1.1 ، 1-0.8 ، 0.9 –1.1 ، 1.1 – 1.1 عند استخدام تركيزات مختلفة من كل من سباينوساد وبيروبروكسيفين وكابل –2 وبروفينوفوس على التوالى ولكن كانت أقل درجة تجانس للرش هى 1.4 للماء فقط تحت ظروف المعمل.