DELAYED EFFECT OF CERTAIN INSECTICIDES ON SOME BIOLOGICAL ASPECTS OF THE PINK AND SPINY BOLLWORMS

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Abstract

The present work was planned to evaluate the delayed effect of certain insecticides, cypermethrin, esfenvalerate, fenpropathrin, cyanophos, methomyl, diflubenzuron and Deenate on the eggs (1-3 days old eggs) and larval stages (newly hatched and 10- day old larvae of the pink bollworm, *Pectinophora gossypiella* (Saund.) and spiny bollworm, *Earias insulana* (Boisd.). The following biological aspects were studied for the alive larvae after treatment:

Larval duration, pupal duration, larval and pupal mortality percentages, pupal weight (mg.) and pupal reduction percentage.

Delayed effect of insecticides were recorded as follows: pr-eoviposition, oviposition & post-oviposition periods, adult longevity, egg laying rate (no. of eggs/female), percentages of egg hatchability, control of hatchability, fecundity and sterility. Fenpropathrin: gave the highest effect on larval duration, pupal weight for male & female, adult longevity, post-oviposition period, egg laying rate, percentages of hatchability, fecundity and sterility.

While, Deenate gave the highest delayed effect on larval and pupal durations, percentages of larval and pupal mortality, pre-oviposition and oviposition periods, percentages of egg hatchability, control of hatchability and sterility.

The other tested insecticides caused intermediate delayed effect on the treated stages of PBW and SBW.

INTRODUCTION

The pink bollworm, *Pectinophora gossypiella* (Saund.) and the spiny bollworm, *Earias insulana* (Boisd.) are the most pests caused financial lost in the cotton crop in Egypt. Although a great deal of effort has been directed towards their control, these two insects seem to be difficult to overcome inspite of the various ways of the control. However, the chemical control considered the important way for controlling these insects (Sammour & Abdallah (1989) and Moawad *et al.* (1990).

Chemical insecticides may be affect the embryonic development, disturbances the normal development of larvae & pupae and anatomical abnormalities in all stages. Several years ago, various bioassay methods were proposed for antimoulting compounds and insecticides which have delayed effect (Moawad *et al.* (1990) and Shalaby (1996)).

The present study is concern with the effect of certain commonly insecticides used against cotton bollworm in Egypt representing the different chemical groups i.e. pyrethroids, organophosphorus, carbamate and insect growth regulator on the delayed effect of sublethal concentrations (LC_{50}'s).

MATERIALS AND METHODS

A laboratory strain of the larvae and eggs of the pink and spiny bollworms were reared in the Bollworms Department, Plant Protection Research Institute, Agricultural Research Center on semi artificial diet for the pink bollworm as described by Abdel-Hafez *et al.,* (1982) and the diet for the spiny bollworm described by Rashad and Ammar (1985). Rearing conditions were controlled at 27±1°C and 65-75% RH with complete darkness all day time.

Tested compounds:

Synthetic pyrethroid compounds:

1. Cypermethrin (polytrin 20% SP.): (±) α – cyano – (3-phenoxy phenyl methyl) (±) cis, trans - 3- (2,2- dichloro ethenyl) – 2,2- dimethylcyclopropane carboxylate.
2. Esfenvalerate (Sumi-alpha 5% EC.): (S)- α – cyano -3-phenoxy benzyl) (s) – 2-(4-chlorophenyl)-3-methylbutyrate.
3- Fenpropathrin (Danitol 30 % EC.): alpha-cyano- 3 – phenoxy phenyl methyl 2,2,3,3-tetra methyl cyclopropane carboxylate.

Organophosphorous compound:

Cyanophos (Cyanox 50% EC.): 0,0 dimethyl o-(4-cyanophenyl) phosphorothioate.

Carbamate compound:

Methomyl (Lannate 90% SP.): S-methyl N-(methyl carbamoyloxy) thioacetimidate.

Insect growth regulator (IGR):

Diflubenzuron (Dimilin 4% SP.): 1-(4-chlorophenyl)-3-(2,6 diflurobenzoyl) urea.

Carbamate/ IGR combination:

Methomyl 27% / Diflubenzuron 4% mixture (Deenate 31% FL.).

The delayed effect of sublethal concentrations (LC_{50}) of certain insecticides on some biological aspects of the pink and spiny bollworms:

The (LC_{50}) of the tested compounds, cypermethrin, esfenvalerate, fenpropathrin, cyanophos, methomyl, diflubenzuron and Deenate were used for studying the delayed effect of the compounds on some biological aspects of the different stages, 1-3 days old eggs, newly hatched and 10- day old larvae of the pink and spiny bollworms. The LC_{50}'s of the tested compounds were 3.80, 4.60, 6.0, 3.70, 2.10, 2.40& 1.70 ppm, respectively for 1-day old eggs of the pink bollworm & 3.90, 4.20, 5.0, 3.80, 2.30, 3.0 & 2.20 ppm, respectively for 1-day old eggs of the spiny bollworm, 2.90, 2.85, 2.0, 2.0, 0.29, 0.40& 0.23 ppm, respectively for 2-day old eggs of the pink bollworm & 2.80, 2.70, 2.60, 2.10, 0.32, 0.48&0.32 ppm, respectively for 2-day old eggs of the spiny bollworm, 2.10, 2.10, 1.0, 1.0, 0.22, 0.37&0.20 ppm, respectively for 3-day old eggs of the pink bollworm & 2.10, 2.0, 0.90, 0.90, 0.21, 0.60&0.14 ppm, respectively for 3-day old eggs of the spiny bollworm, 3.40, 3.20, 4.60, 3.30, 1.90, 1.40&1.80 ppm, respectively for newly hatched larvae of the pink bollworm & 3.50, 2.90, 4.50, 3.70, 2.10, 1.70& 1.25 ppm, respectively for newly hatched larvae of the spiny bollworm, 2.0, 1.90, 2.50, 1.80, 2.0, 1.75 & 1.60 ppm, respectively for 10-day old larvae of the pink bollworm & 1.70, 2.0, 2.70, 2.40, 1.80, 2.0 & 1.50 ppm, respectively for 10-day old larvae of the spiny bollworm. The dipping technique was used for egg treatments and the residual film technique used for larva treatments.

The following biological aspects were investigated as follows:

1- Larval duration: from larval stage until pupation (in days).

2- Pupal duration: from pupal stage until adult emergence (in days).

3-Larval and pupal mortality percentages: were corrected according to Abbott's formula (1925) and computed according to Finney (1952).

4- Pupal weight: For male and female pupae (mg.).

5- Percentage of reduction in pupal weight: Was calculated as follows:

$$\frac{\text{Pupal weight (check)} - \text{pupal weight (treatment)}}{\text{Pupal weight (check)}} \times 100$$

6- Pre-oviposition period: 2-5 pairs of emerged moths were placed in a clean glass cages (17 cm height and 7-12 cm in diameter) to determine the period from adult emergence until the egg laying in days.

7- Oviposition period: This period from the first deposited egg until the last deposited egg (in days).

8- Post-oviposition period: This period from the last deposited egg until adult female dead (in days).

9- Adult longevity: Data obtained were based upon cumulative number of males and females remaining alive each day.

10- Egg laying rate (No. of eggs/female): The total production and the number of eggs per female were calculated from daily counts of eggs deposited on the peace of paper. Each treatment yielded data on the daily egg production and on the differential survival of females.

11- Egg hatchability percentage: The deposited eggs in clean tubes (5 cm height and 3 cm diameter) until hatching. Egg hatchability percentage was counted as follows:

$$\frac{\text{No. hatched eggs}}{\text{No. deposited eggs}} \times 100$$

12- Control of hatchability percentage: was calculated according to Zidan and Abdel-Megeed (1987) as follows:

$$\frac{\text{No. hatchability egg in check} - \text{No. hatchability egg in treatment}}{\text{No. hatchability egg in check}} \times 100$$

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

$$\frac{\text{No. eggs/ treated female}}{\text{No. eggs/ untreated female}} \times 100$$

14- Sterelity percentage: was calculated according to Zidan and Abdel-Megeed (1987) as follows: % Sterelity noticed = 100 – Egg hatchability percentage

$$\text{\% Corrected sterility} = \frac{\text{\% Sterelity noticed - Check}}{\text{100 - Check}} \times 100$$

RESULTS AND DISCUSSION

The delayed effect of sublethal concentrations (LC_{50}) of certain insecticides on some biological aspects of the pink and spiny bollworms:

1-Larval duration: Data presented in Table (1) indicate that LC_{50} of fenpropathrin caused significant increase in larval duration of both insects when treated as 1-3 days old eggs and the newly hatched larvae. On the contrary in 10- day old larvae treatment it was decreased the duration as the other insecticides in the most eggs and larvae treatments compared with the check values except cypermethrin against spiny bollworm treated as 2-day old eggs had slightly elongated (19.9 day) and treated as 3-day old eggs (20.0 day) against the same insect as esfenvalerate against spiny bollworm treated as 1-day old eggs (20.0 day). Also, the pink bollworm treated as newly hatched larvae gave 23.6 day. Cyanophos had slightly elongated duration against the spiny bollworm treated as 1-day old eggs (20.3 day), 2-day old eggs (20.0 day) and the newly hatched larvae (27.2 day), while in 3- day old eggs treatment the same compound had the same record of check for the same insect. Also Deenate had slightly elongated larval duration against spiny bollworm treated as newly hatched larvae.

Table 1. Delayed effect of certain insecticides on larval & pupal durations and larval & pupal mortality percentages of the bollworms.

Insecticides	Larvae& Pupae treated as 1-day old eggs		Larvae& Pupae treated as 2-day old eggs		Larvae& Pupae treated as 3-day old eggs		Larvae& Pupae treated as Newly hatched larvae		Larvae& Pupae treated as 10-day old larvae*	
	P	E	P	E	P	E	P	E	P	E
	Larval duration (in days)									
Cypermethrin	12.0	13.0	18.9	19.9	18.5	20.0	16.3	15.4	16.5	15.4
Esfenvalerate	16.8	20.0	15.8	18.5	15.8	19.0	23.6	18.0	19.1	18.6
Fenpropathrin	25.0	25.8	25.7	25.0	25.5	25.0	26.0	26.0	15.7	16.1
Cyanophos	17.5	20.3	17.5	20.0	17.0	19.5	22.3	27.2	14.6	15.0
Methomyl	14.0	15.0	17.0	18.5	18.2	19.0	18.0	16.4	19.2	17.8
Diflubenzuron	14.0	15.0	16.0	16.3	16.0	18.0	18.2	16.0	16.5	15.7
Deenate	15.5	18.0	15.7	15.7	14.2	17.5	18.3	21.1	14.2	15.7
Check(untreated)	22.1	19.5	22.1	19.5	22.1	19.5	22.5	20.5	22.5	20.5
	Pupal duration (in days)									
Cypermethrin	10.0	10.3	10.7	10.0	15.5	10.5	9.0	8.50	10.8	11.3
Esfenvalerate	7.80	10.0	8.0	10.0	10.5	10.0	13.6	7.30	10.9	9.0
Fenpropathrin	14.0	16.8	14.8	14.0	15.0	14.0	9.0	13.0	10.0	10.1
Cyanophos	8.0	9.90	9.0	10.0	9.50	10.0	9.80	12.3	9.20	9.30
Methomyl	9.0	11.3	9.90	15.0	11.0	13.2	10.0	9.50	8.40	7.80
Diflubenzuron	14.0	10.0	15.5	15.5	15.5	18.2	11.3	11.6	8.90	10.4
Deenate	8.0	10.2	17.0	18.0	17.7	27.2	12.1	10.1	12.5	9.70
Check(untreated)	7.5	9.90	7.50	9.90	7.50	9.90	7.80	10.5	7.80	10.5
	% Larval mortality									
Cypermethrin	72.2	81.8	77.8	78.0	88.0	82.2	59.4	56.3	49.5	28.0
Esfenvalerate	74.2	66.6	76.5	72.8	80.0	78.4	52.6	27.8	50.1	27.0
Fenpropathrin	76.2	80.9	50.0	80.0	70.0	70.5	50.0	50.0	50.2	27.0
Cyanophos	76.2	78.9	85.7	85.7	72.0	81.8	62.5	38.8	49.6	27.8
Methomyl	78.9	78.9	82.6	68.0	74.0	70.3	55.6	50.0	70.8	30.0
Diflubenzuron	85.7	68.0	86.5	75.5	80.0	73.2	50.0	42.9	74.9	35.8
Deenate	50.0	71.4	88.3	79.9	83.5	77.5	52.2	32.1	77.0	38.0
Check(untreated)	45.0	27.0	45.0	27.0	45.0	27.0	45.0	27.0	45.0	27.0
	% Pupal mortality									
Cypermethrin	35.2	42.1	50.0	28.8	35.8	36.0	24.0	20.0	40.0	42.0
Esfenvalerate	58.2	30.3	48.8	12.2	32.0	35.5	20.0	14.0	15.6	12.6
Fenpropathrin	24.0	33.3	45.5	27.3	14.0	26.5	25.0	25.0	74.4	70.7
Cyanophos	40.0	50.0	49.0	28.3	19.9	28.5	25.0	40.0	38.8	38.8
Methomyl	52.2	55.5	52.1	20.2	16.5	15.8	25.0	40.0	77.4	73.2
Diflubenzuron	60.3	63.0	56.4	32.3	20.8	20.0	40.0	42.0	80.0	80.1
Deenate	76.0	74.0	60.0	38.8	28.0	30.0	50.0	50.0	87.3	85.1
Check(untreated)	12.5	11.3	12.5	11.3	12.5	11.3	12.5	11.3	12.5	11.3

* The total larval duration including the first 10-days

P= pink bollworm, *Pectinophora gossypiella*

E= spiny bollworm, *Earias insulana*

These results are in agreement with those obtained by Hewady (1990) indicated that selected larvae of *E. insulana* from cyanophos treatment caused more reduction in larval period.

2- Pupal duration: Data in Table (1) revealed that the LC_{50}'s of insecticides elongated the pupal duration in most treatments especially fenpropathrin when 1-3 days old eggs were treated. Also, diflubenzuron elongate this duration in 1-day old eggs of *P. gossypiella* and 2-3 days old eggs in both insects. These results are in agreement with those of Abdel Aal (1996) who found that four insect growth regulators IKI-7899, flufenoxuron, S-71624 and S-71639 caused significantly increase in pupal duration of *Agrolis ipsilon* treated as 4th instar larvae.

Also, Deenate elongated the pupal duration when compared with the other insecticides in 3-day old eggs treatments in both insects and I0-day old larvae of *P. gossypiella.* On contrary in the newly hatched and 10-day old larvae experiments of *E. insulana,* esfenvalerate decreased the pupal duration (7.30 and 9.00 days, respectively).

In addition, cypermethrin, methomyl and Deenate had shortened this duration against the same insect treated as newly hatched larvae (8.50, 9.50 and 10.1 days, respectively). Furthermore, all the tested insecticides decreased this duration in 10-day old experiments of *E. insulana* especially methomyl (7.80 day) compared with the control value (10.5 day).

3- Larval mortality percentage: LC_{50}'s of most experimented insecticides caused high larval mortality percentages than the check in all the eggs and larva treatments as shown in Table (1) especially cypermethrin, cyanophos, diflubenzuron and Deenate in some treatments. Cypermethrin caused high mortality percentage when *E. insulana* treated as 1-day old eggs and newly hatched larvae (81.8% & 56.3%), also the same insecticide caused high effect in this percentage in 3-day old eggs treatment of pink and spiny bollworms (88.0% & 82.2%). Cyanophos increased the mortality percentage of larvae resulted from 2-day old eggs of *E. insulana* treatment (85.7%) as the same record of *P. gossypiella.* On the other hand, in 10-day old larvae treatment, the same insecticide caused slightly larval mortality percentage from *P. gossypiella* (49.6%). Diflubenzuron caused high larval mortality percentages in 1-2 days old eggs treatments against *P. gossypiella* (85.7% & 86.5%, respectively), also in 10-day old larvae the same compound has a high efficiency against both insects (74.9% & 35.8%) for the pink and spiny bollworms.

Results of Moawad *et al.,* (1990) revealed that LC_{50} values of CME and IKI at diffirent concentrations of the two IGR induced greater mortality percentage in the larval stage of the pink bollworm. Also, Shalaby (1996) found that fresh specimens of spiny bollworm larvae at 5-day old were selected from 0.5 ppm treatment from IKI-7899, it was the most effective concentration on larval development inhibition. The insect growth regulator, cascade (flufenoxuron) acts as chitin inhibitor when 4th instar larvae of *P. gossypiella* were treated topically. The larval mortality percentages ranged 2.5-98.5% depend upon the concentration (Hussain 1992).

Data in Table (1) showed that Deenate was the most efficient compound against the pink bollworm in 2-day old egg treatment (88.3%), also in 10-day old larvae treatment, it gave high larval mortality percentage than the other compounds against both the Pink and spiny bollworms, (77.0 and 38.0%, respectively).These results are agree with the data obtained by Sammour and Abdalla (1989) when diflubenzuron and triflumuron were tested alone or in binary mixtures with some conventional insecticides (Deenate, Tamaron, DC 702 and Gusathion combination) against larvae of *Heliothis armigera* in the laboratory, they found that Deenate was the best than others, it increased percentage of larval mortality.

The rest insecticides gave a moderate percentages in all treatments except 10-day old larvae which induced a low mortality percentage compared with the control.

4- Pupal mortality percentage: Data in Table (1) showed that Deenate had a high delayed effect on pupal mortality percentages in all the treatments against pink and spiny bollworms except for 3-day old eggs treatment when both insects treated as 3-day old eggs. The recorded data are agree with Sammour and Abdall (1989) who proved that Deenate was better than DC-702, Tamaron and Gusathion on pupal mortality percentages of *Heliothis armigera* treated as larvae.

In addition, the present data proved that cypermethrin was the most effective compound on pupal mortality percentages when used against both pink and spiny bollworms treated as 3-day old eggs. The percentages reached 35.8 and 36.0%, respectively. On the other hand, esfenvalerate gave slightly effect on pupal mortality percentage. Recorded data of *E. insulana* when treated as 1-2 days old eggs, newly hatched larvae and 10-day old larvae reached 30.3, 12.2, 14.0 and 12.6%, respectively. Fenpropathrin had little pupal mortality percentage when *P. gossypiella* treated as 1-3 days old eggs (24.0, 45.5 and 14.0%, repsectively). Also Methomyl showed the little pupal mortality percent when it tested against *E. insulana* treated as 3-day old eggs (15.8%). The other insecticides came in between.

5- Pupal weights and reduction percentage: As shown in Table (2), the male and female pupal weights (mg.) drastically affected by insecticidal treatments and the reduction percentages in both treated insects were recorded.

a- Male pupal weight:

- Pink bollworm As shown in Table (2), fenpropathrin reduced the male pupal weights of the pink bollworm treated as 2-3 days old eggs, newly hatched and 10-day old larvae. In addition cypermethrin caused high reduction percentage of male pupal weight which resulted from 1-day old egg treatment (68.6%) compared with the other insecticides. Also, Deenate caused a high decrease in pupal weight when pink bollworm treated as newly hatched larvae (9.90 mg.).

Generally, all the tested insecticides drastically affect the pupal weights compared with the control and caused clear reduction percentages of male pupal weights of the pink and spiny bollworms.

- Spiny bollworm: Table (2) showed that fenpropathrin caused a high decrease in male pupal weight of the spiny bollworm.

b- Female pupal weight

- Pink bollworm: Fenpropathrin was considered the best compound, showing a high reduction percentages in female pupal weights when treated as 1-2 days old eggs (53.0% and 39.4%) and 10-day old larvae (22.1%) compared with the other tested compounds. Deenate had high values of reduction in female pupal weight in case of those treated as 3-day old eggs and the newly hatched larvae (39.4% and 32.7%).

- Spiny bollworm: The female pupal weight of the spiny bollworm had a progressive reduction resulted from 1&3 days old eggs and 10-day old larvae treatments by cyanophos (25.2, 37.0 & 48.0 mg., respectively). Fenpropathrin was still highly efficient than the other tested compounds as shown in the same table especially when the spiny bollworm treated as 2-day old eggs and newly hatched larvae (36.3 & 46.8 mg.).

Generally, fenpropathrin caused a high delayed effect against pupal weight and reduction percentages as shown in Table (2) for males and females of both pink and spiny bollworms. In addition, Deenate caused a high reduction in the pupal weights for males and females of the pink bollworm. Also, cyanophos decreased sharply the female pupal weights of the spiny bollworm.

6- Adult longevity:

a- pink bollworm: Fenpropathrin treatments elongated the adult longevity than the other tested insecticides as shown in Table (3). Esfenvalerate caused a high delayed effect on longevity when the adults treated as 10-day old larvae (40.4 and 39.3 days) for males and females of the pink bollworm. The other compounds gave a moderate delayed effect.

Table 2. Delayed effect of certain insecticides on pupal weights (in mg.) and reduction percentage of the bollworms.

Insecticides	Pupae treated as 1-day old eggs		Pupae treated as 2-day old eggs		Pupae treated as 3-day old eggs		Pupae treated as newly hatched larvae		Pupae treated as 10-day old larvae	
	P	E	P	E	P	E	P	E	P	E
	Male pupal weight (mg.)									
Cypermethrin	5.30	34.1	9.50	39.0	13.1	43.0	10.1	47.0	13.1	47.1
Esfenvalerate	9.20	29.3	11.5	34.5	14.4	40.0	15.3	46.7	17.3	47.2
Fenpropathrin	7.20	20.0	9.00	25.0	12.0	32.5	10.0	39.8	12.3	32.1
Cyanophos	16.7	20.4	13.2	29.0	14.5	35.8	14.7	40.0	17.2	40.1
Methomyl	15.0	35.4	15.8	44.4	15.1	48.5	15.0	47.0	16.2	49.1
Diflubenzuron	12.2	31.5	15.4	39.0	13.9	42.3	11.9	45.0	14.0	48.2
Deenate	9.30	28.1	12.0	35.5	12.1	36.7	9.90	42.0	13.2	46.1
Check(untreated)	16.9	53.5	16.9	53.5	16.9	53.5	17.9	54.3	17.9	54.3
% Reduction in male Pupal weight										
Cypermethrin	68.6	36.3	43.8	27.1	22.5	19.6	43.6	13.4	26.8	13.3
Esfenvalerate	45.6	45.2	31.9	35.5	14.8	25.2	14.5	14.0	3.35	13.1
Fenpropathrin	57.4	62.6	46.7	53.3	28.9	39.3	44.1	26.7	31.3	40.9
Cyanophos	1.18	61.9	21.9	45.4	14.2	33.1	17.9	26.3	3.91	26.2
Methomyl	11.2	33.8	6.51	17.0	10.7	9.35	16.2	13.4	9.49	9.58
Diflubenzuron	27.8	41.1	8.88	27.1	17.8	20.9	33.5	17.1	21.8	11.2
Deenate	44.9	47.5	28.9	33.6	28.4	31.4	44.7	22.7	26.3	15.1
Check(untreated)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Female pupal weight (mg.)										
Cypermethrin	10.4	39.0	13.1	43.5	15.9	48.4	17.0	51.0	18.3	51.3
Esfenvalerate	10.1	35.3	15.8	38.5	15.3	42.1	16.0	50.9	19.1	50.0
Fenpropathrin	9.30	27.8	12.0	36.3	15.2	39.5	17.0	46.8	16.2	48.2
Cyanophos	12.2	25.2	16.0	37.0	17.2	36.3	17.9	47.9	19.1	48.0
Methomyl	17.0	40.6	17.8	47.1	17.2	51.1	16.8	50.4	18.5	53.3
Diflubenzuron	14.0	35.1	15.9	45.4	15.4	49.1	16.0	49.8	18.2	54.4
Deenate	12.1	32.2	13.8	40.0	12.0	42.2	14.0	47.8	17.3	49.2
Check(untreated)	19.8	56.6	19.8	56.6	19.8	56.6	20.8	57.8	20.8	57.8
% Reduction in female Pupal weight										
Cypermethrin	47.5	31.1	33.8	23.1	19.7	14.5	18.3	11.8	12.0	11.2
Esfenvalerate	48.9	37.6	20.2	31.9	22.7	25.6	23.1	11.9	8.17	13.5
Fenpropathrin	53.0	50.9	39.4	35.9	23.2	30.2	18.3	19.0	22.1	16.6
Cyanophos	38.4	55.5	19.2	34.6	13.1	35.9	13.9	17.1	8.17	16.9
Methomyl	14.1	28.3	10.1	16.8	13.1	9.72	19.2	12.8	11.1	7.79
Diflubenzuron	29.3	37.9	19.7	19.8	22.2	13.3	23.1	13.8	12.5	5.88
Deenate	38.9	43.1	30.3	29.3	39.4	25.4	32.7	17.3	16.8	14.9
Check(untreated)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

P= pink bollworm, *Pectinophora gossypiella*

E= spiny bollworm, *Earias insulana*

b- spiny bollworm: The recorded data in table (3) showed that fenpropathrin had the highly delayed effect on the longevity of both males and females in all treatments of the spiny bollworm. Deenate had the best delayed effect on adults longevity when males and females treated as 3- day old eggs (33.0 and 37.8 days). Cyanophos had a high delayed effect on the adult longevity initiated from newly hatched larvae treatment (29.5 and 33.5 days). Also, cypermethrin caused good delayed effect on the longevity of males and females adults when treated as 1-day old egg (45.9 and 44.9 days). Another insecticides (esfenvalerate, methomyl and diflubenzuron) gave a moderate delayed effect on the adult longevity of the spiny bollworm compared with the previous compounds.

7- Pre-oviposition period: Table (3) revealed that Deenate has a high delayed effect on the prolongation of pre-oviposition period of both pink and spiny bollworms in all treatments, followed by diflubenzuron. The other tested insecticides had a moderate effect in this respect.

8- Oviposition period: Table (3) showed that Deenate was the most effective chemical compound shortened the oviposition period in all treatments of both pink and spiny bollworms, followed by diflubenzuron.In addition the other tested compounds shortened the oviposition period than the check and had a little delayed effect compared with the previous two compounds.

9- Post-oviposition period: Data in Table (3) showed that Deenate, diflubenzuron and methomyl had a slight delayed effect on post-oviposition period in adult females of both tested insects in all the treatments. Opposite was record with fenpropathrin inducing the most delayed effect on prolongation of this period. In addition, esfenvalerate and cyanophos were effective in prolonging this period when the adult females of the pink bollworm treated as 10-day old larvae (18.2 & 12.4 days). In spiny bollworm when newly hatched larvae were treated with cyanophos, the post-oviposition period of the adult females initiated from the treatment was 17.0 days.

10- Egg laying rate (No. of eggs / female): Female moths of *P.gossypiella* and *E. insulana* that resulted from all described treatments were allowed to deposit their eggs until mortality. All the tested compounds (Table 4) caused reduction in egg laying rate especially fenpropathrin that had the highest reduction rate compared with the other tested insecticides in both two insects with all treatments, but when the adult females treated as 10-day old larvae by Deenate, the females laid very low number of eggs (19.6 and 15.3 eggs) for pink and spiny bollworms. However, in esfenvalerate treatment, the females laid the highest number of eggs in all treatments compared with the other compounds, but it gave low number of eggs compared with the control values.

Table 3. Delayed effect of certain insecticides on adult longevity, pre-oviposition, oviposition and post-oviposition periods of the bollworms.

Insecticides	♂& ♀ adult moths treated as 1-day old eggs		♂& ♀ adult moths treated as 2-day old eggs		♂& ♀ adult moths treated as 3-day old eggs		♂& ♀ adult moths treated as newly hatched larvae		♂& ♀ adult moths treated as 10-day old larvae	
	P	E	P	E	P	E	P	E	P	E
	Male adult longevity (in days)									
Cypermethrin	34.1	45.9	35.5	33.0	37.5	25.0	25.4	21.0	34.5	30.6
Esfenvalerate	40.5	36.3	32.8	26.0	31.0	27.9	28.8	21.5	40.4	30.0
Fenpropathrin	43.9	48.2	40.0	35.8	35.5	30.5	36.0	28.5	37.5	37.2
Cyanophos	36.5	44.5	31.5	32.0	28.0	24.0	27.8	29.5	34.5	30.7
Methomyl	32.0	33.4	27.0	25.5	26.0	22.0	27.5	23.9	29.6	27.0
Diflubenzuron	32.7	36.6	32.5	28.2	31.0	27.0	35.1	27.8	32.7	30.0
Deenate	37.0	38.2	34.2	29.0	32.0	33.0	35.2	28.5	38.1	35.4
Check(untreated)	19.8	22.5	20.5	16.9	20.8	16.5	20.5	18.5	20.8	17.5
	female adult longevity (in days)									
Cypermethrin	33.4	44.9	34.3	38.9	36.2	29.0	24.4	25.0	33.4	34.3
Esfenvalerate	40.4	35.2	31.7	31.0	29.6	31.8	28.0	25.1	39.3	35.8
Fenpropathrin	42.9	48.2	39.3	41.9	34.2	34.5	34.5	30.7	36.4	41.1
Cyanophos	36.3	43.6	29.8	36.0	27.0	28.0	26.6	33.5	33.3	35.7
Methomyl	31.5	32.1	26.0	30.3	24.9	26.0	26.2	27.6	28.4	32.1
Diflubenzuron	32.4	35.6	31.3	32.0	29.7	31.0	34.2	30.2	31.6	35.0
Deenate	36.5	37.6	33.1	32.0	30.7	37.8	34.2	32.6	36.3	39.4
Check(untreated)	19.9	20.8	19.9	20.8	19.9	20.8	19.8	20.4	19.8	22.4
	Pre-oviposition period (in days)									
Cypermethrin	15.9	15.5	16.3	11.0	17.2	8.00	6.10	6.00	9.80	8.80
Esfenvalerate	15.0	12.4	8.10	10.1	5.50	7.00	5.00	6.00	9.30	7.90
Fenpropathrin	16.3	20.0	14.0	17.0	11.2	11.8	10.0	8.40	10.1	10.1
Cyanophos	13.1	16.2	9.00	12.5	7.00	9.00	6.50	6.00	9.50	8.40
Methomyl	18.0	19.0	15.0	16.9	12.0	12.0	12.0	12.0	12.5	15.7
Diflubenzuron	21.2	24.1	20.1	19.0	18.5	17.0	19.3	16.9	16.1	18.5
Deenate	25.5	25.8	21.5	20.9	19.9	19.1	20.0	19.0	20.6	20.1
Check(untreated)	3.50	3.40	3.50	3.40	3.50	3.40	3.50	3.10	3.50	3.10
	Oviposition period (in days)									
Cypermethrin	9.00	9.00	9.00	9.90	9.00	9.00	8.30	9.00	9.80	10.5
Esfenvalerate	6.30	11.1	7.40	10.9	10.1	10.8	9.00	11.0	11.8	11.5
Fenpropathrin	7.00	10.5	8.10	9.20	7.00	8.20	7.40	8.30	10.2	11.0
Cyanophos	7.50	11.4	9.00	9.10	10.0	7.00	9.10	10.5	11.4	11.1
Methomyl	9.50	8.00	7.00	9.30	8.90	8.90	9.20	10.0	10.5	10.8
Diflubenzuron	6.20	5.00	6.20	7.80	6.00	8.00	8.50	7.30	8.00	10.5
Deenate	4.80	4.00	5.00	5.20	4.80	6.30	6.30	6.00	6.20	9.30
Check(untreated)	11.9	11.8	11.9	11.8	11.9	11.8	11.8	11.8	11.8	13.8
	Post-oviposition period (in days)									
Cypermethrin	8.50	20.4	9.00	18.0	10.0	12.0	10.0	10.0	12.0	15.0
Esfenvalerate	20.0	10.8	17.3	9.00	14.0	8.00	14.0	8.10	18.2	16.4
Fenpropathrin	20.3	17.9	17.2	15.7	16.0	14.5	17.1	14.0	16.1	20.0
Cyanophos	15.7	16.0	11.8	14.4	10.0	12.0	11.0	17.0	12.4	16.2
Methomyl	5.00	5.90	4.60	5.70	4.60	5.80	5.00	5.60	5.40	5.60
Diflubenzuron	5.00	6.50	5.00	5.80	5.20	6.00	8.20	6.30	7.50	6.00
Deenate	6.20	7.80	6.60	5.90	6.00	12.5	8.40	7.60	9.50	10.0
Check(untreated)	4.50	5.60	4.50	5.60	4.50	5.60	4.50	4.50	4.50	5.50

P= pink bollworm, *Pectinophora gossypiella* E= spiny bollworm, *Earias insulana*

11- Rate of hatchability: The oviposited eggs by the adult females initiated from the treatments used were subsequently left until hatching. Table (4) revealed that all the tested insecticides reduced the rate of hatchability percenatges in both insects in all treatments. Esfenvalerate gave highly delayed effect against rate of hatchabillity percentage of eggs deposited by adult females which initiated from 1-day old eggs treatment of the pink and spiny bollworms (10.1% and 17.2%). On the other hand, cyanophos had a high delayed effect on reduction the hatchability of eggs deposited by adult females initiated from 2-3 days old eggs of the spiny bollworm (18.9 and 19.0%).

Deenate had the same trend of hatchability rate in the pink bollworm when the adult females treated as 2-3 days old eggs, the eggs deposited by the females had hatchability percentage 18.9 and 16.7%. In addition, Deenate reduced the egg hatchability deposited by adult females which initiated from 10-day old larvae in both insects (12.6 and 16.0% for pink and spiny bollworms).

From the same table, fenpropathrin still has the highest delayed effect on the hatchability percenatge of the eggs which deposited by the females initiated from newly hatched larvae treatment of the pink and spiny bollworms (10.8 and 12.7%). The other insecticides (cypermethrin, methomyl and diflubenzuron) had the least delayed effect on the rate of hatchability compared with the previous insecticides, but gave lower hatchability compared with the check.

12- Control of hatchability percentage: Data in Table (4) showed that delayed effect of the most tested insecticides gave highly control of hatchability percentages of eggs deposited by adult females initiated from the treatments used especially fenpropathrin and diflubenzuron. Deenate had excellent delayed effect against both insects in all treatments. Also, cypermethrin and methomyl gave a high result especially when the eggs deposited by the adult females initiated from 1-3 days old eggs treatments. In addition methomyl gave a high delayed effect when the eggs deposited by adult females initiated from 10-day old larvae treatment (95.8% & 95.0%) of the pink and spiny bollworms. However, esfenvalerate and cyanophos gave good delayed effect, but considered had low effective compared with the previous insecticides.

13- Fecundity percentage: Data in Table (4), proved that the delayed effect of fenpropathrin caused excellent reduction from fecundity percentages in all treatments of both insects, but when the adult females treated as 10-day old larvae, the Deenate gave a high delayed effect on the fecundity percentage than the other insecticides (13.5% for pink bollworm and 10.7% for spiny bollworm). Diflubenzuron and methomyl gave very good results in reduction of the fecundity percentages compared with cypermethrin. These results are agree with Shalaby (1996) who found that all doses of IKI-7899 produced progressive reductions in fecundity of the pink and spiny bollworms. While, esfenvalerate and cyanophos gave the least percentages of fecundity than the other tested compounds.

14- Sterelity percentage: Data in Table (4) revealed varied increase of sterelity percentages by the tested insecticides depends mainly on the chemical nature of tested compound.

Cypermethrin: Caused good sterelity in all treatments except when the adult moths treated as newly hatched larvae, it caused least effect (34.5% for pink bollworm and 66.7% for spiny bollworm).

Esfenvalerate: Caused a high delayed effect in the most treatments especially when the adult moths treated as 1-day old eggs (89.9% for pink bollworm and 82.8% for spiny bollworrn), while the adult moths of the pink bollworm treated as 2-day old eggs and the adult moths of both insects initiated from treated newly hatched larvae caused a low delayed effect on the sterelity percentages compared with the other tested compounds, compared with the control (check).

Fenpropathrin: Caused a high delayed effect in all treatments especially when the adult moths of both pink and spiny bollworms treated as newly hatched larvae than the other insecticides.

Cyanophos: Casued a high delayed effect in all treatments especially when the adult moths of the spiny bollworm treated as 2-3 days old eggs (81.1 and 81.0%) than the other compounds.

Methomyl and diflubenzuron: Caused good percentages in all treatments.

Deenate: Caused high delayed effect in all the treatments especially when the adult moths of the pink bollworm treated as 2-3 days old eggs (81.1 and 83.3%), also the adult moths of both insects initiated from treated 10-day old larvae (87.4% for pink bollworm and 84.0% for spiny bollworm) than the other tested compounds.

On basis of the different criteria used, the delayed effect of tested insecticides could be classified into two categories as follows:

1- The first category represented the insecticides with a high delayed effect i.e. fenpropathrin and Deenate.
2- The second category represented the insecticides that revealed an intermediate delayed effect, i e. cypermethrin, esfenvalerate, cyanophos, methomyl and diflubenzuron.

Table 4. Delayed effect of certain insecticides on egg laying rate, hatchability rate, control of hatchability, fecundity and sterelity of the bollworms.

Insecticides	adult ♀ treated as 1-day old eggs		adult ♀ treated as 2-day old eggs		adult ♀ treated as 3-day old eggs		adult ♀ treated as newly hatched larvae		adult ♀ treated as 10-day old larvae	
	P	E	P	E	P	E	P	E	P	E
	Egg laying rate (No. of eggs / female)									
Cypermethrin	31.1	28.9	39.9	30.1	49.3	38.3	61.2	40.8	51.5	38.3
Esfenvalerate	65.5	87.0	70.2	94.4	86.4	105.3	89.1	98.3	60.2	99.5
Fenpropathrin	15.4	13.5	17.2	14.9	19.3	20.1	18.5	15.8	20.4	18.1
Cyanophos	50.0	85.0	50.0	90.1	63.2	100	60.0	100	50.5	85.2
Methomyl	25.9	19.0	20.0	24.4	30.1	27.5	38.4	20.0	28.0	20.5
Diflubenzuron	19.1	18.9	21.0	21.8	26.9	26.4	22.9	29.8	25.5	19.8
Deenate	18.5	16.0	18.9	18.2	24.1	24.5	20.8	20.0	19.6	15.3
Check(untreated)	145	140.6	145	140.9	145	140.6	145	143.5	145	143.5
% hatchability										
Cypermethrin	26.0	27.0	20.0	29.9	24.5	39.5	70.5	33.3	25.2	27.0
Esfenvalerate	10.1	17.2	76.4	20.0	23.3	25.7	68.8	52.3	30.0	29.0
Fenpropathrin	25.8	18.0	29.4	23.0	36.8	35.0	10.8	12.7	15.2	18.8
Cyanophos	26.9	19.8	20.9	18.9	31.7	19.0	28.4	18.5	28.3	27.9
Methomyl	23.8	40.0	22.8	43.5	29.2	44.4	40.0	30.0	18.8	23.0
Diflubenzuron	21.5	25.0	20.0	33.2	24.0	37.6	30.4	20.9	15.0	20.8
Deenate	17.5	22.9	18.9	28.0	16.7	36.0	30.0	18.5	12.6	16.0
Check(untreated)	84.2	64.6	84.2	64.6	84.2	64.6	87.2	65.6	87.2	65.6
% Control of hatchability										
Cypermethrin	93.4	91.4	93.5	92.6	90.1	83.4	68.3	85.6	89.7	89.1
Esfenvalerate	94.6	83.6	56.3	84.5	83.5	70.2	51.5	47.7	85.7	69.3
Fenpropathrin	96.7	97.4	95.9	97.2	94.2	92.2	98.4	97.9	97.5	96.4
Cyanophos	88.9	81.5	91.4	86.1	83.6	79.1	86.5	80.3	88.7	74.7
Methomyl	94.9	91.6	96.2	91.3	92.8	86.6	87.8	83.6	95.8	95.0
Diflubenzuron	96.6	94.8	96.6	94.1	94.7	89.1	94.5	95.6	96.9	95.6
Deenate	97.4	95.9	97.1	95.8	96.7	90.3	95.3	96.1	98.0	97.5
Check(untreated)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Fecundity										
Cypermethrin	21.4	20.6	27.5	21.4	34.0	27.2	42.2	28.4	35.5	26.7
Esfenvalerate	45.2	61.9	48.4	67.1	59.6	74.9	61.4	68.5	41.5	69.3
Fenpropathrin	10.6	9.60	11.9	10.6	13.3	14.3	12.8	11.1	14.1	12.6
Cyanophos	34.5	60.5	34.5	64.1	43.6	71.1	41.4	69.7	34.8	59.4
Methomyl	17.9	13.5	13.8	14.2	20.8	19.6	26.5	13.9	19.3	14.3
Diflubenzuron	13.2	13.4	14.5	15.5	18.6	18.8	15.8	17.8	17.6	13.8
Deenate	12.8	11.4	13.0	12.9	16.6	17.4	14.3	13.9	13.5	10.7
Check(untreated)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Sterelity										
Cypermethrin	74.0	73.0	80.0	70.1	75.5	60.5	34.5	66.7	74.8	73.0
Esfenvalerate	89.9	82.8	23.6	80.0	76.7	74.3	31.2	50.0	70.0	71.0
Fenpropathrin	74.2	82.0	70.6	77.0	63.2	65.0	89.2	87.3	84.8	81.2
Cyanophos	73.1	80.2	79.1	81.1	68.3	81.0	71.6	81.5	71.7	72.1
Methomyl	76.2	60.0	77.2	56.5	70.8	55.6	60.0	70.0	81.2	77.0
Diflubenzuron	78.5	75.0	80.0	66.8	76.0	62.4	69.6	79.1	85.0	79.2
Deenate	82.5	77.1	81.1	72.0	83.3	64.0	71.5	81.5	87.4	84.0
Check(untreated)	15.8	35.4	15.8	35.4	15.8	35.4	12.8	34.4	12.8	34.4

P= pink bollworm, *Pectinophora gossypiella* E= spiny bollworm, *Earias insulana*

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المرجع العربى :

الإتجاهات الحديثة فى المبيدات ومكافحةالحشرات – الجزء الثانى (١٩٨٧)

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التأثير المتأخر لبعض المبيدات على بعض الظواهر البيولوجية لدودتى اللوز القرنفلية و الشوكية

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تهدف هذه الدراسة إلى تقييم التأثير المتأخر لبعض المبيدات (سيبرمثرين cypermethrin - إس.فينفاليرات esfenvalerate - فينبروباثرين fenpropathrin - سيانوفوس cyanophos - ميثومايل methomyl - دايفلوبنزورون diflubenzuron - دينيت Deenate) على أطوار البيض (عمر يوم و يومين و ثلاثة أيام) و الطور اليرقى (الفقس الحديث و يرقات عمر ١٠ أيام) لدودة اللوز القرنفلية (.Pectinophora gossypiella (Saund* و دودة اللوز الشوكية (.Earias insulana* (Boisd *المرباة بالمعمل على بيئات صناعية.

و قد إشتملت دراسة الظواهر البيولوجية على: فترة الطور اليرقى- فترة طور العذراء- النسبة المئوية لموت الطور اليرقى و العذرى- وزن العذارى (مللجم) للذكور و الإناث - النسبة المئوية للخفض فى وزن العذارى.

تم عمل تزاوجات للفراشات الناتجة فى فوانيس تربية بمعدل زوج فى كل فانوس و تم تسجيل التأثير المتأخر للمبيدات على فترة حياة الطور البالغ - فترات ما قبل وضع البيض ووضع البيض و ما بعد وضع البيض- معدل وضع البيض - النسبة المئوية لكل من فقس البيض و التحكم فى الفقس و الخصوبة و العقم.

و قد أظهر مبيدى الفينبروباثرين و الدينيت أعلى تأثير متأخر بالنسبة للتركيز النصفى المميت LC_{50} على دودتى اللوز القرنفلية و الشوكية فى معظم الظواهر البيولوجية التى ظهرت على الأطوار المختلفة للحشرتين كما يلى:

الفينبروباثرين: أعطى أعلى تأثير متأخر على فترة الطور اليرقى- وزن العذارى الذكور و الإناث- فترة حياة الطور البالغ للذكور و الإناث- فترة ما بعد وضع البيض- معدل وضع البيض- النسبة المئوية لكلا من التحكم فى الفقس و الخصوبة و العقم.

الدينيت: أعطى أعلى تأثير متأخر على فترة الطور العذرى- النسبة المئوية لموت الطور اليرقى و العذرى- فترتى ما قبل وضع البيض و فترة وضع البيض- النسبة المئوية لكلا من فقس البيض و التحكم فى الفقس و العقم.

كما أظهرت باقى المبيدات تأثيرا متأخرا متقاربا على بعض الظواهر البيولوجية.