RESULTS AND DISCUSSION

I. Laboratory studies:

1. Residual toxicity of different tested commercial microbial products on larvae of *Spodoptera littoralis*:

Protecto, Ecotech-bio and Dipel-2x are the commercial microbial products used in these experiments, in which the active ingredients based on bacterium, *Bacillus thuringiensis* var. *kurstaki* containing (32.000 IU/mg). Also, Viroset is one of the microbial products in which the active ingredient based on the nuclear polyhedrosis virus (NPV) containing $1X10^6$ PIB.

1.1. Residual toxicity of Protecto on:

Newly hatched larvae:

Results in Tables (1&2) show the potency of Protecto against the newly hatched larvae of the cotton leafworm, *Spodoptera littoralis* (Boisd.) after feeding on Castor bean treated leaves under laboratory conditions.

Results in Table (1) show the effect of Protecto on mortality percentages of newly hatched larvae of *S. littoralis* (Boisd.). Percentages of mortality were increased gradually (after 1 day of treatment till 9 days) with increasing concentration of Protecto compound. After 1 day from treatment those were 6.25, 4.16, 16.66, 19.79 and 23.95% for the successive concentrations ($0.32X10^6$), ($1.6X10^6$), ($3.2X10^6$), ($16X10^6$) and ($32X10^6$), respectively. While the previous concentrations gave 92.85, 97.61 and 100% mortality, respectively after 9 days.

Table (1)

Table (2): LC values and slopes of Protecto on the newly hatched larvae of *S. littoralis* after feeding on treated Castor bean leaves.

Parameters	Protecto	
	5 days	7 days
LC_{50}	11608E+1	19038E+1
LC_{90}	38107E+5	50203E+2
Slope	0.284	0.902

When compare between the effects of Protecto on the newly hatched larvae after 5 and 7 days from treatment, it can be concluded that the LC_{50} values of Protecto were 11608E+1 and 19038E+1 for 5 and 7 days, respectively. While, after 9 days all concentrations gave approximately 100% mortality (Table, 2).

On base of the LC_{90} values, Protecto show the same trend, whereas these LC_{90} values were 38107E+5 and 50203E+2 after 5 and 7 days, respectively. While after 9 days, these concentrations gave approximately 100% mortality (Table 2). It is means that the newly hatched larvae are highly susceptible to Protecto.

These results are in harmony with those obtained by **Queed *et al*. (1988)** who studied the efficacy of a microbial insecticide containing 3% *B. thuringiensis var. kurstaki* (Bactospeine) on survival and development of the 1st larval instar of *S. Littoralis*. They found that the1st instar was the most susceptible and mortality increased with increasing dosage.

The slope of line is useful to know the homogenecity of different instars of leafworm insect population, which collected from the field. When the population of leafworm insect is similar

in homogeneity or the degree of resistant meaning the slope is big or increase in regression.

On base of the slop values, Protecto gave 0.284 and 0.902, respectively. While, after 9 days the concentrations gave approximately 100% mortality.

The 2nd larval instar:

Data in Table (1) show the potency of Protecto against the 2nd larval instar of *S. littoralis* after feeding on Castor bean treated leaves**.**

Data in Table (1) show the effect of Protecto on mortality percentage of the 2nd larval instar of *S. littoralis* (Boisd.), where mortality percentage was increased gradually after 1 day of treatment till 9 days with increasing concentration of Protecto compound. It were 2.00, 4.00, 2.00 and 4.00% for the successive concentrations ($0.32X10^6$) 0.01, ($1.6X10^6$) 0.05, ($3.2X10^6$) 0.1, ($16X10^6$) 0.5 and ($32X10^6$) 1.0 g after one day from treatment, respectively, while, the previous concentrations gave 20.83, 25.00, 31.25, 37.50 and 45.83% mortality after 9 days from treatment, respectively.

In this respect, **Broza *et al* (1984)** mentioned that the microbial insecticide successfully controlled first and second instars of the Egyptian cotton leafworm, *S. littoralis.*

Also, **Rizk *et al.* (1981)** observed that the 1st three larval instars of *S. littoralis* were significantly more susceptible than the latter larval instars. **Sneh *et al.* (1981)** found that the 1st and 2nd larval instars of the Egyptian cotton leafworm, *S. Littoralis* were the most susceptible to *B. thuringiensis*. The susceptibility decreased with larval development.

The 4th larval instar:

Data in Table (1) show the potency of Protecto against the 4th larval instar of *S. littoralis* after feeding on treated Castor bean leaves under laboratory conditions.

Data in Table (1) show the effect of Protecto on mortality percentages of the 4th larval instar of *S. littoralis* (Boisd.). Protecto did not effect on 4th instar larvae after 1 day, but larval mortality began to appear after 3 days from treatment and % of mortality was increased gradually until reached 18.36, 25.53, 34.69, 36.73 and 48.97% for the successive concentrations ($0.32X10^6$) 0.01, ($1.6X10^6$) 0.05, ($3.2X10^6$) 0.1, $16X10^6$) 0.5 and ($32X10^6$) 1.0 g, after 9 days, respectively.

1.2. Residual toxicity of Dipel-2x on:

Newly hatched larvae:

Data in Tables (3&4) show the potency of Dipel-2x against the newly hatched larvae of the cotton leafworm, *Spodoptera littoralis* after feeding on treated Castor bean leaves under laboratory conditions**.**

Results in Table (3) show the effect of Dipel-2x on mortality percentages of newly hatched larvae of *S. littoralis*. These results clear that % of mortality was increased with increasing the concentration of Dipel-2x compound. Whereas, these moralities were 4.12, 7.21, 15.46, 20.61 and 21.64% for the successive concentrations ($0.32X10^6$) 0.01, ($1.6X10^6$) 0.05, ($3.2X10^6$) 0.1, $16X10^6$) 0.5 and ($32X10^6$) 1.0 g, respectively. While, the previous concentrations gave 95.29, 97.64, 98.82, 100 and 100% mortality, respectively after 9 days. It means that % of mortality was increased gradually and reached its maximum after 9 days.

Table (3)

When compare between the effects of Dipel-2x on the newly hatched larvae after 5 and 7 days from treatment, it was found that LC_{50} values were 4001.86 and 85984.866, respectively (Table, 4). While, the LC_{90} values of Dipel-2x were 27219E+3 and 69799E+1, respectively (Table, 4).

On base of the slop values, Dipel-2x gave 0.334, and 1.409, respectively.

Table (4): LC values and slopes of Dipel-2x on the newly hatched larvae of *S. littoralis* after feeding on treated Castor bean leaves.

Parameters	Dipel-2x	
	5 days	7 days
LC_{50}	4001.86	85984.866
LC_{90}	27219E+3	69799E+1
Slope	0.334	1.409

The 2nd larval instar:

Data in Table (3) show the effect of Dipel-2x on mortality percentages of the 2nd larval instar of *S. littoralis*. Whereas , larval mortality began to appear after 3 days from treatment and reached its maximum after 9 days with different concentrations of Dipel-2x compound. But, after 1 day no mortality was recorded. While, after 9 days % of mortality were 18.36, 22.44, 26.53, 32.65 and 40.81% for the successive concentrations ($0.32X10^6$) 0.01, ($1.6X10^6$) 0.05, ($3.2X10^6$) 0.1, $16X10^6$) 0.5 and ($32X10^6$) 1.0 g, respectively.

Broza *et al.* (1984) mentioned that the microbial insecticide successfully controlled first and second instars of the Egyptian cotton leafworm, *S. littoralis.*

The 4th larval instar:

Data in Table (3) show the effect of Dipel-2x on mortality percentages of the 4th larval instar of *S. littoralis.* These % of mortality were increased with increasing the concentration on the other hand, with different concentrations of Dipel-2x compound, it did not appear any mortality after one day from treatment. But, mortality began to appear after 3 days and increased gradually until reached its maximum after 9 days, showing 10.20, 16.32, 20.40, 20.40, and 30.61 for the successive concentrations ($0.32X10^6$) 0.01, ($1.6X10^6$) 0.05, ($3.2X10^6$) 0.1, $16X10^6$) 0.5 and ($32X10^6$) 1.0 g, after 9 days, respectively.

Concerning, the slop values of Dipel-2x, these values was 0.325 after 9 days, respectively.

1.3. Residual toxicity of Ecotech bio on:

Newly hatched larvae:

Data in Tables (5&6) show the potency of Ecotech bio against the newly hatched larvae of the cotton leafworm, *Spodoptera littoralis* (Boisd.) after feeding on treated Castor bean leaves under laboratory conditions**.**

Data in Table (5) show the effect of Ecotech bio on mortality percentages of newly hatched larvae of *S. littoralis*, these percentages were increased gradually after 1 day from treatment till 9 days with different concentrations of Ecotech bio compound. These percentages were 1.04, 3.12, 3.12, 5.20, and 9.37% for the successive concentrations ($0.32X10^6$) 0.01, ($1.6X10^6$) 0.05, ($3.2X10^6$) 0.1, $16X10^6$) 0.5 and ($32X10^6$) 1.0 g

Table (5)

after 1 day, respectively. While the previous concentrations gave 82.95, 87.50, 95.45, 97.72 and 97.72% mortality after 9 days, respectively.

Amonker *et al.* (1985) tested the differences in pathogenicity of *B. thuringiensis* subspecies to the 1st instar larvae of *S. littoralis* in the laboratory. They found that the subspecies HD-1, 137, 228, 229, 224, and 283 and the indigenous subsp. *Aizawi* , *B.t.* subsp. *Kurstaki* and *B.t.* subsp. *Kengae* were effective at doses of 108 and 109 spores/ml.

The effects of Ecotech bio on the newly hatched larvae after 7 days it was noticed that the LC_{50} value of it was 30923E+1. While, the LC_{90} value of Ecotech bio was 25379E+4, after 7 days (Table, 6).

The slop values of, Ecotech bio gave 0.44 after 7 days (Table, 6).

Table (6): LC values and slopes of Ecotech bio on the newly hatched larvae of *S. littoralis* after feeding on Castor bean leaves.

Parameters	Ecotech bio
	7 days
LC_{50}	30923E+1
LC_{90}	25379E+4
Slope	0.44

The 2nd larval instar:

Data in Table (5) show the efficacy of Ecotech bio against the 2nd larval instar of *S. littoralis* after feeding on treated Castor bean leaves under laboratory conditions.

Results in Table (5) show that the highest concentration ($0.32X10^6$) of Ecotech bio gave mortality after 1 day from treatment and this % of mortality increased gradually and reached its maximum after 9 days (Table 10). While, the effect of the two lowest concentrations ($0.32X10^6$ and $1.6X10^6$) appear only after 7 days from treatment. But, the highest mortalities 8.16, 12.24, 12.24, 14.28 and 28.57% were obtained for the successive concentrations ($0.32X10^6$) 0.01, ($1.6X10^6$) 0.05, ($3.2X10^6$) 0.1, $16X10^6$) 0.5 and ($32X10^6$) 1.0 g, after 9 days, respectively.

The 4th larval instar:

Data in Table (5) show the effect of Ecotech bio on mortality percentages of the 4th larval instar of *S. littoralis.* From these data, it was observed that percentages of larval mortality took the same trend that in case of the 2nd larval instar, but were higher. Where, these percentages were 16.32, 18.36, 18.36, 22.44 and 38.77% for the successive concentrations ($0.32X10^6$) 0.01, ($1.6X10^6$) 0.05, ($3.2X10^6$) 0.1, $16X10^6$) 0.5 and ($32X10^6$) 1.0 g, after 9 days, respectively.

From the above mentioned results, it can be concluded that the 1st instar larvae of *S. littoralis* were the most susceptible to *B. thuringiensis var. kurstaki* followed by the 2nd and the 4th instar larvae.

Bekheit (1985) studied the acute and chronic effect of *Bacillus thuringiensis var. kurstaki* (Thuricide HP) by using leaf dipping technique, against cotton leafworm *S. Littoralis*. He found that 1st instar larvae was the most susceptible followed by the 2nd and the 3rd instars. Also, **Hamed (1985)** found that the 1st and the 2nd larval instars of *S. littoralis* were more susceptible to *B. thuringiensis var. kurstaki* than the old ones, prolonged the larval duration of larvae, seriously reduced both of the pupal weight and adult emergence , and increased their malformations.

When compared between the effects of the tested bacterial formulations, it can be decided that Protecto caused the highest larval mortality, followed by Diple-2X and Ecotec bio. Also, it can be stated that larval susceptibility to all the active formulations decreased with increasing larval age.

Jansen *et al.* (1984), the formulations known as Thuricide WP, Dipel WP and ABG6105 contained strains of *B thuringiensis* subsp. *kurstaki* (serotype 3 & 3b), while Bactospeine 1 contained a strain of B.t. subsp. *thuringiensis* (seriotype 1). They decided that ABG61050 caused the highest larval mortality followed by Dipel and Bactospeine 1, but Thuricide was ineffective, and larval susceptibility to all the active formulations decreased with increasing larval age.

It is also, observed that there was a positive correlation between larval mortalities and *Bacillus thuringiensis* concentration.

MC Connell and Richards (1959) indicated that the bacterium *B.t.* and related forms were considered as the most promising bacteria for the purpose of biological control of insect pests. The *B. Thuringiensis* was pathogenic to a number of insect

species and can be grown easily on artificial media without loss of virulence.

1.4. Residual toxicity of Viroset (NPV virus) on:

Data in Tables (7 to 11) show the potency of Viroset against the larvae of the cotton leafworm, *Spodoptera littoralis* (Boisd.) after feeding on treated Castor bean leaves under laboratory conditions by using leaf dipping technique**.**

Newly hatched larvae:

Data in Table (7) show the effect of Viroset on mortality percentages of newly hatched larvae of *S. littoralis*, whereas these mortality% were increased gradually after 1 day from treatment till 9 days with different concentrations of Viroset compound. It were 6.06, 7.07, 14.14, 15.15 and 21.21% for the successive concentrations ($1X10^4$) 0.01, ($1X10^5$) 0.05, ($1X10^6$) 0.1, ($1X10^7$) 0.5 and ($1X10^8$) 1.0 g, after 1 day respectively. While, the first three concentrations gave 100%, mortality after 7 days and the remain two concentrations gave 100% after 9 days.

The effects of Viroset on the newly hatched larvae after 5 days from treatment, it is clear that the LC_{50} value was 40610E+1. Concerning, the LC_{90} values, Viroset show the same trend, it gave 18186E+6 after 5 days, respectively (Table, 8).

On base of the slop values, Viroset gave 0.276 after 5 days (Table, 8).

Su-Gy (1992) found that the mortality of the 1^{st} instar larvae of the Noctuidae, *Spodoptera littoralis* with *S. litura* nuclear polyhedrosis virus (SINPV) at $2.8X10^6$, $1.4X10^6$, $9.0X10^5$ and $7.0X10^5$ PIB/ml was 100.0, 96.7, 100.0 and 96.7%, respectively.

Table (7)

Table (8): LC values and slopes of Viroset on the newly hatched larvae of *S. littoralis* after feeding on treated Castor bean leaves.

Parameters	Viroset
	5 days
LC_{50}	40610E+1
LC_{90}	18186E+6
Slope	0.276

Table (9): LC values and slopes of Viroset on the 2nd larval instar of *S. littoralis* after feeding on treated Castor bean leaves.

Parameters	Viroset	
	7 days	9 days
LC_{50}	19934E+3	15141E+2
LC_{90}	13241E+6	39513E+5
Slope	0.454	0.375

The 2nd larval instar:

Data in Table (7) show the effect of Viroset on mortality percentages of the 2nd larval instar of *S. littoralis*. These data revealed that mortalities were increased gradually by increasing the concentration of Viroset compound, being 0.00, 2.00, 4.00, 6.00 and 10.00% mortality for the successive concentrations ($1X10^4$) 0.01, ($1X10^5$) 0.05, ($1X10^6$) 0.1, ($1X10^7$) 0.5 and ($1X10^8$) 1.0 g, after 1 day from treatment, respectively.

El-Saadany *et al.* (1989) tested the transmission of nuclear polyhedrosis virus in laboratory colonies of the cotton leaf worm, *Spodoptera littoralis*. They found that the mortalities were 4.0% and 25% for $3.7X10^7$ and $3.7X10^6$ PIB/larva.

Also, the lowest mortality was obtained after 1 day. While the highest mortalities, 41.66, 50.00, 52.08, 64.58 and 70.83% for the previous concentrations were recorded, after 9 days, respectively.

Concerning, the LC values, it is appear the LC_{50} values were 19934E+3, and 15141E+2, but the LC_{90} values were 13241E+6 and 39513E+5 after 7 and 9 days, respectively (Table, 9).

On the other hand, the slop values of Viroset were 0.454 and 0.375 after 7 and 9 days, respectively (Table, 9).

The 4th larval instar:

Data in Table (7) show the effect of Viroset on mortality percentages of the 4th larval instar of *S. littoralis*. These data revealed that percentages of larval mortality were increased by increasing concentration and by increasing the time after treatment. Whereas, these mortalities were 4.00, 4.00, 8.00, 10.00 and 14.00% mortality for the successive concentrations

($1X10^4$) 0.01, ($1X10^5$) 0.05, ($1X10^6$) 0.1, ($1X10^7$) 0.5 and ($1X10^8$) 1.0 g, after 1 day, respectively. Also, it gave 38.29, 46.80, 51.06, 59.57 and 59.57% mortality for the previous concentrations after 9 days, respectively

From the previously mentioned data it can be concluded that the rate of mortality among larvae of the cotton leaf worm, *S. littoralis* increased with the increase in virus concentration of nuclear polyhedrosis virus (NPV). On the other hand, the susceptibility to virus was affected by the age of larvae, i.e. newly hatched larvae were more susceptible than the 4^{th} larval instar (Table, 11). These results agreement with **El-Nagar *et al.* (1983)** who reported that the rate of mortality among larvae of *Spodoptera littoralis* increased directly with the increase in virus dosage. However, susceptibility to virus was inversely affected by the age of larvae from the 2^{nd} to the 5^{th} instar.

When compare between the effects of Viroset against the 4^{th} larval instar after 7 and 9 days, it is reveal that the LC_{50} were 15839E+3 and 30930E+2, respectively (Table, 17). Also, Viroset show the same trend with LC_{90} being 88267E+7 and 10208E+7 after 7 and 9 days, respectively (Table, 10).

On base of the slop values, Viroset gave 0.238, 0.27 and 0.284 after 7 and 9 days, respectively (Table, 10).

Table (10): LC values and slopes of Viroset on the 4th larval instar of *S. littoralis* after feeding on treated Castor bean leaves.

Parameters	Viroset	
	7 days	9 days
LC_{50}	15839E+3	30930E+2
LC_{90}	88267E+7	10208E+7
Slope	0.27	0.284

Table (11): LC values and slopes of Viroset on the newly hatched larvae, 2nd instar and 4th instar larvae of *S. littoralis* after feeding on treated Castor bean leaves.

Parameters	LC values of Viroset on	
	2nd instar larvae (5 days)	4th instar larvae (5 days)
LC_{50}	14437E+4	87379E+4
LC_{90}	50577E+6	20710E+10
Slope	0.504	0.238

2. Latent effect of the tested compounds on percentages of larvae failed to pupate:

2.1. Effect on the 2nd larval instar:

Data in Table (12) and Figs (1, 2, 3 & 4) show the percentages of larvae which failed to pupate after treating the 2nd instar larvae of cotton leafworm with three *B.t.* compounds (Protecto, Dipel-2X and Ecotech-bio) and one Virus NPV (Viroset). Protecto with five concentrations ($0.22X10^6$) 0.01, ($1.6X10^6$) 0.05, ($3.2X10^6$) 0.1, ($16X10^6$) 0.5 and ($32X10^6$) 1.0 g caused 20, 24, 20, 22 and 20% of larvae which failed to pupate, respectively. While, Dipel-2X gave 20, 18, 10, 10 and 16% of larvae failed to pupate, respectively, at the same concentrations. On the other hand, Ecotech-bio gave 16, 22, 14, 16 and 12%, respectively, with the same concentrations. But, Viroset induced 0, 0, 8, 14, and 18% of larvae failed to pupate, at the five concentrations ($1X10^8$, $1X10^7$, $1X10^6$, $1X10^5$ and $1X10^4$), respectively.

2.2. Effect on the 4th larval instar:

Data in Table (13) and Fig (5, 6, 7 & 8) show percentages of larvae which failed to pupate after treating the 4th larval instar with the three *B.t.* compounds, (Protecto, Dipel-2X and Ecotech-bio) compared with NPV virus (Viroset). Protecto with five concentrations ($0.32X10^6$) 0.01, ($1.6X10^6$) 0.05, ($3.2X10^6$) 0.1, ($16X10^6$) 0.5 and ($32X10^6$) 1.0 g gave 30, 40, 30, 22 and 22% of larvae which failed to pupate, while, Dipel-2X gave 18, 22, 20, 24 and 18%, while Ecotech bio gave 22, 20, 22, 14 and 18%, respectively.

Table (12)

Fig (1)

Figs (2)

Figs (3)

Figs (4)

Table (13)

Figs (5)

Figs (6)

Figs (7)

Figs (8)

with the same concentrations. On the other hand, Viroset with the previous concentrations induced 2, 6, 14, 22 and 30% of larvae which failed to pupate, respectively.

Concerning, the larval mortality, results gave the highest larval mortality compared with the others *B.t.* compounds (Dipel-2X and Ecotech-bio) at the same five concentrations. While, the NPV (Viroset) caused higher larval mortality than Protecto. Whereas. For example these mortalities were 62, 60, 53, 49 and 43% with the five concentrations of Viroset, but were 72, 62, 60, 54 and 46% with the 4 tested compounds of Protecto (Table, 20). Also, with decreased by decreasing concentration, this is attributed by decrease the number of *B.t.* spores or particles of NPV with the decreasing concentration.

By using a leaf dip bioassay, it can be conclude that the second and fourth instar larvae of *S. littoralis* are the most and the least sensitive to *B. t.* and Viroset compounds, respectively. Treated 2nd and 4th instar resulted in less pupal weight and adult emergence. In this respect, **Li *et al.*, (1995)** found that all larval instars were susceptible to *B.t.* and fourth and fifth instars were the most and least sensitive pupal, while weight and adult emergence were not affected. Also, **Hou and Chou (1993)** reported that *B.t.* compounds decreased the pupation rate, pupal weight and adult emergence.

Also, from the previous results, the 2nd larval instar was most affected with the three *B.t.* compounds than the 4th larval instars i.e. the 4th larval instar was more tolerance to *B.t.* compounds than the 2nd larval instar.

3. Latent effect of the tested compounds on some biological aspects of cotton leafworm:

3.a. Effect on percentages of pupation, emergence and malformation of moths:

Data in Tables (14 and 15) and Figs (9, 10, 11 and 12) show the latent effect of the tested compounds on percentage of pupation, mean weights of pupa%, adult emergence as well as percentages of malformed moths.

At the highest concentration (1.0 g) percentage of pupae obtained from larvae treated with Protecto, Dipel-2x and Ecotech -bio were 28.6, 54.5 and 65.2%, respectively. While, with the $1X10^8$ and $1X10^7$ concentrations of Viroset did not pupation results from treated larvae. On the other hand, control treatment gave percentages of pupation ranged between 93.6 and 97.9%. But at the lowest concentration [0.01 g] Ecotech-bio had the least latent effect (82.9% pupation) followed by Dipel-2x (77.8% pupation) and Protecto (63.0% pupation). On The other hand, Viroset gave 50.00% at lowest concentration.

Regarding the pupation records in case of treating the 4^{th} instar larvae, data in Tables (16 and 17) and Figs (13, 14, 15 and 16) it could be noted that results took the same trend with the three formulations. Percentages of pupation at the concentrations of [1.0 g] and [0.01 g] were 25.0-70.3, 70.0-78.6 and 59.3–76.9% for Protecto, Dipel-2x and Ecotech-bio, respectively. Also, ranged between 5.55-55.55 for the highest and lowest concentration of Viroset, respectively.

Concerning, the influence of tested compounds on weight of pupae, data revealed no clear differences between the used compounds, where all the produced pupae weighed between

Table (14)

Figs (9)

Figs (10)

Figs (11)

Table (15): Effect of treating the 2nd instar larvae of *S. littoralis* with different concentrations of Viroset on its some biological aspects.

Conc. g/ 100 ml D.W.	Viroset			
	Mean weight of pupae/gm	% Pupation	% Emergence	% Malformation
1.0 g ($1X10^8$)	0.25	0	0	0
0.5 g ($1X10^7$)	0.23	0	0	0
0.1 g ($1X10^6$)	0.20	30.76	0	100
0.05 g ($1X10^5$)	0.23	43.75	2	71.72
0.01 g ($1X10^4$)	0.21	50.00	4	55.55
Control	0.41	93.61	38	13.63

Figs (12)

0.20–0.29 g and 0.24–0.32 g for the treated 2^{nd} and 4^{th} instar larvae, respectively. The normal pupae in the control treatment gave an average weight 0.42 g. It is means that these compounds caused lower weight of pupae than control.

Treatment the 2^{nd} and 4^{th} instar larvae with the used bactericides affected also moths emergence comparing with untreated insects. The percentages of moths emergence with different concentrations were very low. Protecto was more sever on emergency of moths resulted from treated 2^{nd} instar larvae, where 2,4,5,8 and 12% emergence occurred at ($32X10^6$) 1.0, ($16X10^6$) 0.5, ($3.2X10^6$) 0.1, ($1.6X10^6$) 0.05 and ($0.32X10^6$) 0.01 g concentrations of Protecto, respectively. The corresponding rates were 8,10,18,32 and 40%, respectively in case of Diple-2X at the same concentrations. While, Ecotech-bio gave 6, 10, 18, 20 and 22%, also, at the same concentrations, respectively. On the other hand, the non–treated larvae gave percentage of emergence ranged between 78–84%. While, the lowest emergency was obtained with NPV (Viroset)

By using a leaf dip bioassay, it can be conclude that the second and fourth instar larvae of *S. littoralis* are the most and the least sensitive to *B.t.* and Viroset compounds, respectively. Treated 2^{nd} and 4^{th} instar resulted in less pupal weight and adult emergence. In this respect, **Li *et al.*, (1995)** found that all larval instars were susceptible to *B.t.* and fourth and sixth instars were the most and least sensitive, respectively. They also, recorded that pupal weight and adult emergence were not affected. Also, **Hou and Chou (1993)** reported that *B.t.* compounds decreased the pupation rate, pupal weight and adult emergence.

Table (16)

Figs (13)

Figs (14)

Figs (15)

Table (17): Effect of treating the 4th instar larvae of *S. littoralis* with different concentrations of Viroset on some biological aspects.

Conc. g/100 ml D.W.	Viroset			
	Mean weight of pupae/gm	% Pupation	% Emergence	% Malformation
(1X10^8) 1.0 g	0.32	5.55	0	100
(1X10^7) 0.5 g	0.30	15.78	0	100
(1X10^6) 0.1 g	0.29	31.82	28.57	71.42
(1X10^5) 0.05 g	0.25	45.83	36.36	63.63
(1X10^4) 0.01 g	0.26	55.55	46.66	53.33
Control	0.47	87.23	87.81	12.19

Fig. (16)

Concerning the residual effect after treating the 4th instar larvae, it is obvious that Protecto caused drastic effect with its high concentration, where all the produced pupae failed to transfer to moths followed by 4% moths emergence at ($0.32X10^6$) 0.5 concentration. The least concentration of ($1.6X10^6$) 0.01 g recorded 36% emergency. Noteworthy, 16% of the emerged moths were malformed. As for Dipel–2x and Ecotech bio treatment, percentages of moths emergence ranged 16-48 and 12-44% at the tested concentrations.

From the previously mentioned data it can be concluded that the tested compound were (in descending order of latent effects) Viroset and Protecto. Also, it was found that Protecto was generally the most efficient on pupation and emergency of cotton leafworm compared with the other tested commercial products of *B.t.* While, Diple-2X and Ecotech-bio were equally effective.

3.b. Influence of different tested bio-compounds on fecundity of *S. littoralis* females and hatchability of eggs:

The biological effects of the commercial preparation of the tested were assessed on fecundity of *S. littoralis*. Reduction in eggs production of the moths and fertility of the eggs were observed together with significant reduction in pupal weight and appearance of deformities in both pupae and moths population.

3.b.1. Fecundity of females resulting from treated 2nd instar larvae:

Data in Table (18) show the influence of Protecto on fecundity of females resulted from treated 2nd and 4th larval instars of *S. littoralis* and the hatchability of eggs. It was found that the total no. of eggs/female averaged between 180-245 eggs/female with the three concentrations of Protecto (0.1, 0.05 and 0.01 g/100 ml D.W.), while with the concentration (0.5 g) no eggs were deposited. It also means that the high concentrations of Protecto caused sterilization for *S. littoralis* females. On the other hand, it was found that the average no. of hatched eggs/female, when treated with Protecto averaged between 116-165 eggs/female in case of the three concentrations (0.1, 0.05 and 0.01 g/100 ml water).

In the same table, the previous three concentrations of Protecto gave reduction in hatchability ranged between 32.65-35.55.

Also, data in Table (19A) show the influence of Ecotech-bio on fecundity of females resulted from treated 2nd larval instar of *S. littoralis* and the hatchability of their eggs. It was found that the average no. of eggs/female ranged between 230-336 eggs/female in all concentration of Ecotech-bio. In the same trend, it was, also, found that the mean no. of hatched eggs/female ranged between 145-156 eggs/female with all concentrations. All concentrations of Ecotech-bio gave reduction in hatchability ranged between 36.90-53.50%.

Table (18): Influence of Protecto infection to the 2nd and 4th instar larvae of *S. littoralis* on fecundity of resulted females and hatchability of their eggs.

(A) The 2nd instar larvae:

Conc. g/100 ml D.W.	No. of couples	Average No. of eggs/female		% of reduction in hatchability
		Deposited	Hatched	
1.0g ($32X10^6$)	0	0	0	0
0.5g ($16X10^6$)	1	0	0	0
0.1g ($3.2X10^6$)	1	180	116	35.55
0.05g ($1.6X10^6$)	1	215	135	37.20
0.01g ($0.32X10^6$)	2	245	165	32.65
Control	10	487.5	395	18.00

(B) The 4th instar larvae:

Conc. g/100 ml D.W.	No. of couples	Average No. of eggs/female		% of reduction in hatchability
		Deposited	Hatched	
1.0g ($32X10^6$)	0	0	0	0
0.5g ($16X10^6$)	1	0	0	0
0.1g ($3.2X10^6$)	3	260	150	42.30
0.05g ($1.6X10^6$)	6	270	180	33.35
0.01g ($0.32X10^6$)	6	285	210	26.30
Control	13	324	248	23.40

Table (19): Influence of Ecotech bio infection to the 2nd and 4th instar larvae of *S. littoralis* on fecundity of resulted females and hatchability of their eggs.

(A) The 2nd instar larvae:

Conc. g/100 ml D.W.	No. of couples	Average No. of eggs/female		% of reduction in hatchability
		Deposited	Hatched	
1.0g ($32X10^6$)	1	230	145	63.0
0.5g ($16X10^6$)	2	396	146	36.9
0.1g ($3.2X10^6$)	4	276	127	46.0
0.05g ($1.6X10^6$)	4	352	144	41.0
0.01g ($0.32X10^6$)	5	336	156	46.0
Control	10	487.5	395	81.0

(B) The 4th instar larvae:

Conc. g/100 ml D.W.	No. of couples	Average No. of eggs/female		% of reduction in hatchability
		Deposited	Hatched	
1.0g ($32X10^6$)	3	458	167	36.50
0.5g ($16X10^6$)	4	435	180	41.37
0.1g ($3.2X10^6$)	6	293	172	58.70
0.05g ($1.6X10^6$)	7	270	133	49.30
0.01g ($0.32X10^6$)	9	224	114	50.90
Control	13	324	248	77.00

Fig. (17)

Data in Table (20A) show the effect of treated the 2nd larval instar of *S. littoralis* by Diple-2X on fecundity of resulted females and the hatchability of their eggs. It is clear that the average no. of eggs/female reached its maximum 425 eggs/female in case of 0.5 g concentration. While, with the concentration (1 g) no eggs were deposited. On the other hand, it was found the total no. of hatched eggs/female, when treated larvae with Dipel-2X, ranged between 104-223 eggs/female in case of the four concentrations (0.5, 0.1, 0.05 and 0.01) of Dipel-2X, respectively. In the same table, the previous four concentrations of Dipel-2X gave % of reduction in hatchability ranged between 30.60-47.50%.

Results in Table (21A) clear the influence of treated the 2nd larval instar of *S. littoralis* by NPV, Viroset on fecundity of resulted females and the hatchability of their eggs. It was found that no deposited eggs were obtained with the two last concentrations of Viroset. While, the number of deposited eggs in control was 487.50/female. This meant that the two lower concentrations of (0.05 and 0.01 g) caused sterility to the females.

3.b.2.Fecundity of females resulting from treated 4th instar larvae:

Data in Table (18B) show the fecundity of females resulted from treated the 4th larval instar of *S. littoralis* with Protecto and the hatchability of their eggs. These data indicated that the average no. of eggs/female ranged between 260-285 eggs with the three concentrations (0.1, 0.05 and 0.01/g) of Protecto. While, with the other, two concentrations (0.5 and 1/g) no emerged adults and no eggs, were deposited respectively.

Table (20): Influence of Diple-2X infection to the 2nd and 4th instar larvae of *S. littoralis* on fecundity of resulted females and hatchability of their eggs.

(A) The 2nd instar larvae:

Conc. g/100 ml D.W.	No. of couples	Average No. of eggs/female		% of reduction in hatchability
		Deposited	Hatched	
1.0g ($32X10^6$)	2	0	0	0
0.5g ($16X10^6$)	2	425	223	47.50
0.1g ($3.2X10^6$)	4	231	138	40.25
0.05g ($1.6X10^6$)	7	150	104	30.65
0.01g ($0.32X10^6$)	8	163	113	30.60
Control	10	487.5	395	18.00

(B) The 4th instar larvae:

Conc. g/100 ml D.W.	No. of couples	Average No. of eggs/female		% of reduction in hatchability
		Deposited	Hatched	
1.0g ($32X10^6$)	3	400	119	70.20
0.5g ($16X10^6$)	4	502	260	48.20
0.1g ($3.2X10^6$)	6	360	145	59.70
0.05g ($1.6X10^6$)	7	317	159	49.80
0.01g ($0.32X10^6$)	9	289	160	44.60
Control	13	324	248	33.40

Table (21): Influence of Viroset infection to the 2nd and 4th instar larvae of *S. littoralis* on fecundity of resulted females and hatchability of their eggs.

(A) The 2nd instar larvae:

Conc. g/100 ml D.W.	No. of couples	Average No. of eggs/female		% of reduction in hatchability
		Deposited	Hatched	
1.0g ($32X10^6$)	0	0	0	0
0.5g ($16X10^6$)	0	0	0	0
0.1g ($3.2X10^6$)	0	0	0	0
0.05g ($1.6X10^6$)	1	0	0	0
0.01g ($0.32X10^6$)	2	0	0	0
Control	10	487.50	395	82.00

(B) The 4th instar larvae:

Conc. g/100 ml D.W.	No. of couples	Average No. of eggs/female		% of reduction in hatchability
		Deposited	Hatched	
1.0g ($32X10^6$)	0	0	0	0
0.5g ($16X10^6$)	0	0	0	0
0.1g ($3.2X10^6$)	1	0	0	0
0.05g ($1.6X10^6$)	2	0	0	0
0.01g ($0.32X10^6$)	3	250	135	40.00
Control	13	324	248	23.40

Fig. (18)

On the other hand, it was found that the no. of hatched eggs/female reached its maximum (210 eggs/female) with 0.01/g of Protecto. From the same table, the previous three concentrations of Protecto induced reduction in hatchability ranged between 26.30-42.30 % while in control was23.40 % reduction in hatchability.

Also, data in Table (19B) reveal the effect of Ecotech-bio on fecundity of *S. littoralis* females and the hatchability of their eggs. It was found that the average no. of eggs/female ranged between 224- 458 eggs/female with all concentrations of Ecotech-bio. In the same trend it was observed that the no. of hatched eggs/female reached its maximum (180 eggs/female) with 0.5 g concentrations. All concentrations of Ecotech-bio caused reduction ranged between 63.50-49.10% of hatched eggs.

Data in Table (20B) show the effect of treating the 4th larval instar of *S. littoralis* by Dipel-2x on fecundity of resulted females and the hatchability of their eggs. It was found that the average no. of eggs/female ranged between 400-289 eggs/female with all concentrations (1, 0.5, 0.1, 0.05 and 0.01 g), of Dipel-2X. On the other hand, it was noticed that the highest no. of hatched eggs/female ranged 260 eggs/female was obtained with 0.50 concentration of Dipel-2X. In the same table, the previous five concentrations of Dipel-2X caused reduction in hatching ranged between 70.20-44.60%.

Also, data in Table (21B) show the effect of treated 4th larval instar of *S. littoralis* with Viroset. It was found that resulted females did not deposit eggs with two concentrations (0.1 and 0.05 g) of Viroset. While, with the concentration (0.01 g) it deposited 250 eggs/female. But, with 1.0 g and 0.5 g

concentrations of Viroset, no females emerged. In the previous 0.01 concentration of Viroset gave 40% reduction, while in control the reduction in hatchability was 23.40%.

From the above results in Tables (18, 19 & 20) it can be noticed that the tested biological compounds varied greatly in latent effectiveness against *S. littoralis* according to the commercial product of bioinsecticides. So, the tested microbial insecticides could be ordered as follows, Viroset was proven have highly latent efficient followed by Protecto and finally Diple-2X and Ecotceh-bio showed very weak latent action.

Concerning, the latent effect of bio-tested compounds, it is clear that the lowest number of emerged adults were obtained with the Viroset compound, while the highest number was obtained with bacterial compound, Diple-2X, it means that the more active bio-compound that can be used for controlling *S. littoralis* is the NPV (Viroset) followed by the *B.t.* product, Protecto.

Also, from the above mentioned results, it can be concluded that latent adverse effects of *B.t.* compounds and NPV were detected on adult emergence, fecundity (reduction in eggs deposition as compared with control) and egg viability. Whereas, treated 2^{nd} and 4^{th} instar larvae of *S. littoralis* with sub-lethal concentrations of *B.t. var. kurstaki* and NPV lead to reduction in adults emergence and fertility of the eggs. Also, remarkable latent adverse effects were recorded for egg deposition as well as for egg hatchability (Tables, 18, 19, 20 & 21). Similar results were obtained by **Salama *et al.*, (1980), Abd El-Haleim (1993)** and **Mohamed *et al.*, (2000),** who concluded that treated larvae

of *S. littoralis* had latent adverse effects on adults' emergence, number of deposited eggs and fertility of eggs.

Also, data indicated that the polyhedrolysis virus induced highly adverse effects on adult's emergence. In addition, the number of eggs/female was 250 at 0.01 g (Table 19b), while with the highest concentrations (Table 21 A&B), the emerged females did not deposit any eggs. In this respect, **Li*et al.*, (1995)** reported that fecundity of *S. littoralis* females was reduced when treated with NPV.

3.C. Latent effect of tested bio-compounds on number of emerged adults and sex ratio after treatment:

Treatment the 2nd and 4th instar larvae of *S. littoralis* by some microbial insecticides affected on the number of adult emergence, this is will appear in the following recorded data.

Data in Tables (22) and Figs (19, 20 and 21) show the effect of treatment 2nd instar larvae by bacterial compounds, Protecto, Ecotech-bio and Diple-2X on number of obtained pupae, emerged adults of *S. littoralis*. The results indicate that the total number of adult emergence reached 1, 3, 5, 8 and 11 with different concentrations of Protecto (1, 0.5, 0.1, 0.05 and 0.01). But, the total no. of adult emergence in control reached 42 adults.

Data in the same (Table, 22) and Fig. (19) indicate that the total number of adults emerged from treated 4th instar larvae reached 0,2,6,13and 18 adults with different concentrations of Protecto.

Data in Table (23) and Fig. (20A) clear that the number of adults emergence was 7, 9, 16, 20 and 23 which resulted from 47, 6.12 and 17 obtained pupae with different concentrations of

Ecotech-bio 1, 0.5, 0.1, 0.05 and 0.01, respectively. But, the no. of adults emergence was 47 adults in control.

Also, data in the same table (23 and Fig. (20 B) clear that the total number of adults emerged from treated 4th instar larvae reached 6, 10, 14, 21 and 22 adults with different concentrations of Ecotech-bio (1, 0.5, 0.1, 0.05 and 0.01).

The data in Table (24) and Fig. (21A) show the effect of Diple-2x on number of obtained pupae and emerged adults of *S. littoralis*. The data clear that the total no. of adults emergence reached 4, 5, 9, 16 and 20 adults, respectively, which resulted from 12, 15, 21 and 24 and 28 obtained pupae with different concentrations of Diple-2x (1, 0.5, 0.1, 0.05 and 0.01), respectively, while, the number of emerged adults in control (42 adults).

Data in the same table (24) and Fig. (21 B) clear that the total number of adults emerged reached 8, 9, 14, 17 and 24 after treated with different concentrations of Diple-2x (1, 0.5, 0.1, 0.05 and 0.01).

On the other hand, data in Table (25) and Fig. (22A) show the effect of NPV, Viroset on no. of obtained pupae & emerged adults of *S. littoralis*. The results indicated that the no. of emerged adults was 0, 0, 0, 0, 2 and 4 resulting from 0.0, 4, 7 and 9 pupae after treated the 2nd larval instar of cotton leafworm with different concentrations of Viroset (1, 0.5, 0.1, 0.05 and 0.01), respectively.

Also, data in the same table (25) and Fig. (22 B) indicate that the total no. of emerged adults, after treated the 4th larval instar reached 0, 0, 2, 4 and 7 adults with different concentrations of Viroset (1, 0.5, 0.1, 0.05 and 0.01).

Table (22)

Table (23)

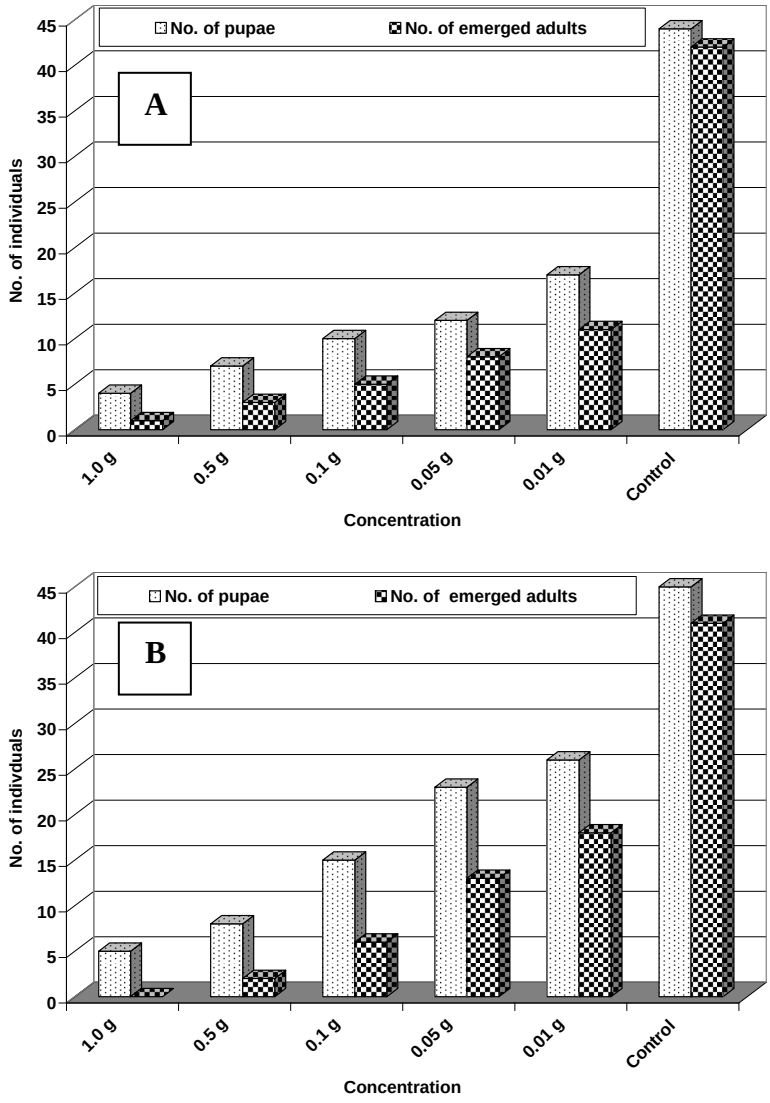

Fig. (19): Effect of treatment the 2nd (A) and 4th (B) larval instar of *S. littoralis* by Protecto on no. of pupae and emerged adults.

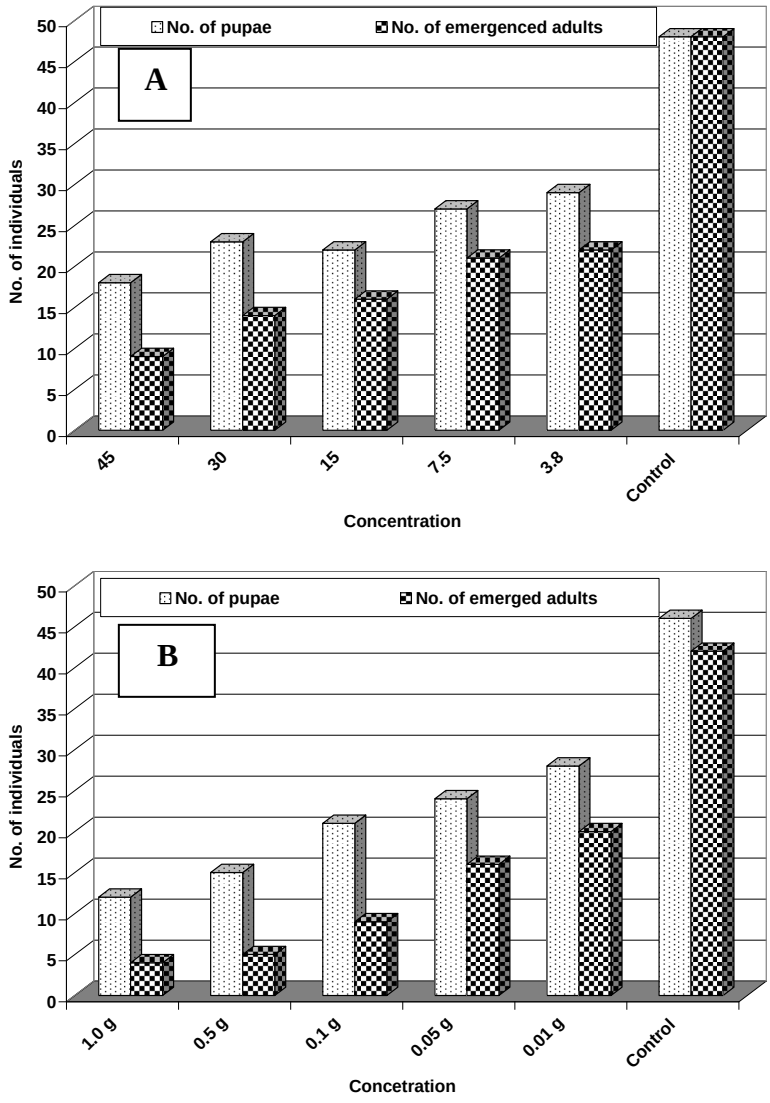

Fig. (20): Effect of treatment the 2nd (A) and 4th (B) larval instar of *S. littoralis* by Ecotech-bio on no. of pupae and emerged adults.

Table (24)

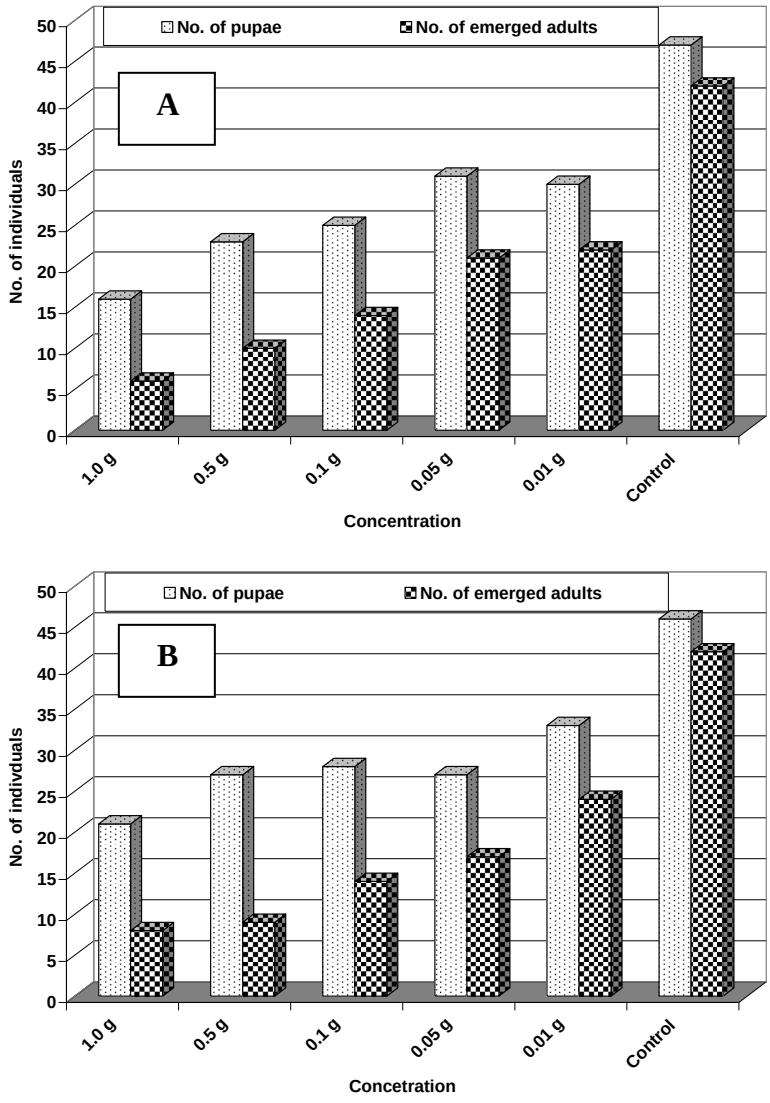

Fig. (21): Effect of treatment the 2nd (A) and 4th (B) larval instar of *S. littoralis* by Diple-2X on no. of pupae and emerged adults.

Table (25)

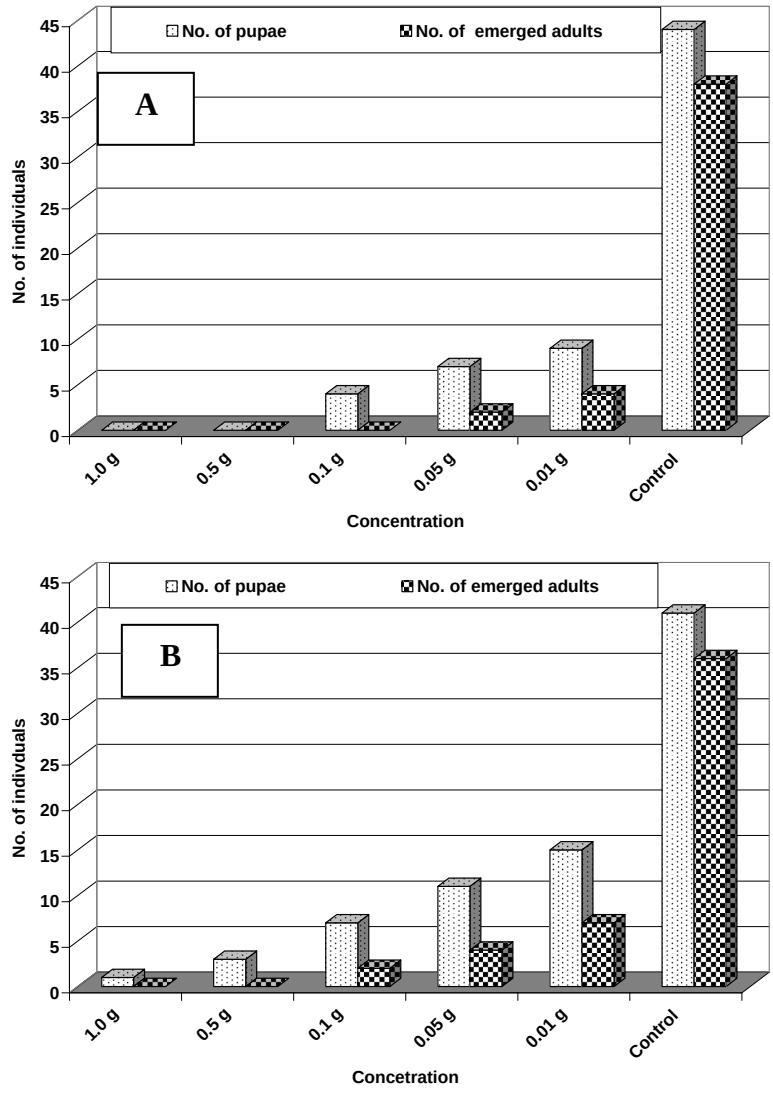

Fig. (22): Effect of treatment the 2nd (A) and 4th (B) larval instar of *S. littoralis* by Viroset on no. of pupae and emerged adults.

From the data in Tables (22, 23, 24 and 25) it was observed that among the emerged moth (after treatments the 2nd instar larvae of *S. littoralis* with different concentrations of tested bio-compounds) numbers of malformed adults were greater than control. Also, from the above mentioned data, it can be concluded that the biological effects of different concentrations of different bio-insecticides under study were reduction in numbers of pupae and moths and appearance of deformation in moths.

In this respect, **Salama *et al.* (1980)** evaluated development of some lepidopterous cotton pests as affected by exposure to sub-lethal levels of endotoxins of *B.t.* for different periods. They assessed the biological effects of *B.t.* during and after removal of toxin from the diet. The authors found that *B.t.* caused reduction in eggs production, pupal weight and appearance of deformities in both pupae and moths population.

II. Field studies:

The commercial preparations were sprayed during two successive seasons 2000 and 2001. To study the effect of different concentrations of the three tested compounds of *B.t.* (Protecto, Ecotech bio and Diple-2x) and compared with one of NPV virus (Viroset) against different instars of the cotton leafworm, *Spodoptera littoralis* larvae under filed conditions.

II.1. First season (2000):

Data in Table (26) show that the pre-spraying counts of larvae ranged between (274.5 and 378.75 larvae).

Protecto, with (0.01g/100 ml *B.t.*) concentration gave 59.50% reduction in number of different instars of larvae infesting cotton plants after 7 days. While, the second concentration (0.1 g/100 ml) gave 82.90% reduction. On the

other hand, the third concentration (1.0 g/100 ml) gave 90.50% reduction percentage in leafworm larvae infesting cotton plants (Table, 26) and Fig. (23).

Ecotech bio, with (0.01 g) concentration gave 63.00% reduction percentage in larvae infesting cotton plants after 7 days. While, the second concentration (0.1 g/100 ml) gave 68.60% reduction. On the other hand, the third concentration (1.0 g/100 ml) gave 71.30% reduction in leafworm larvae infesting cotton plants (Table, 26) and Fig. (23).

Diple-2x, with (0.01 g) concentration gave 65.30% reduction in number of larvae infesting cotton plants after 7 days. While, the second concentration (0.1 g) gave 76.70% reduction. On the other hand, the third concentration (1.0 g) gave 82.90% reduction in leafworm larvae infesting cotton plants (Table, 26) and Fig. (23).

Viroset, with (0.01 g) concentration gave 74.90% reduction in larvae infesting cotton plants after 7 days. While, the second concentration (0.1 g) gave 87.20% reduction. On the other hand, the third concentration (1.0 g) gave 92.00% reduction in leafworm larvae infesting cotton plants (Table, 26) and Fig. (23).

Statistical analysis of data in (Table, 26) for the first year 2000, show highly significant differences between the different concentrations of tested compounds (Protect, Ecotech bio, Diple-2x and Viroset) against different larval instars of the cotton leafworm, *Spodoptera littoralis* under filed conditions (F= 46.7, L.S.D.0.05 = 3.04).

Table (26): Effect of different tested compounds on mortality percentage of larvae of *S. littoralis* under field conditions during 2000 season.

Bio-compound	Conc.	Mean no. of alive larvae					% mortality of larvae
		Pre-spraying count	Post-spraying count				
			1 day	3 days	5 days	7 days	
Protecto (B.t.)	1.0 g ($32X10^6$)	274.50	210.00	174.25	91.12	26.00	**90.53**
	0.1 g ($3.2X10^6$)	313.12	245.12	180.00	136.87	42.25	**86.51**
	0.01 g ($0.32X10^6$)	316.25	262.12	180.37	158.37	56.00	**82.30**
Ecotech bio (B.t.)	1.0 g ($32X10^6$)	355.62	271.50	207.12	137.00	44.65	**87.45**
	0.1 g ($3.2X10^6$)	364.12	299.12	238.12	142.27	50.00	**86.25**
	0.01 g ($0.32X10^6$)	352.62	305.12	228.12	137.87	57.00	**83.83**
Diple-2x (B.t.)	1.0 g ($32X10^6$)	386.25	309.12	216.00	124.00	29.00	**92.50**
	0.1 g ($3.2X10^6$)	387.75	330.00	210.00	100.00	39.50	**89.82**
	0.01 g ($0.32X10^6$)	378.62	320.00	225.50	131.50	57.50	**84.82**
Viroset (NPV)	1.0 g ($1X10^8$)	380.50	280.00	200.00	114.12	15.60	**95.90**
	0.1 g ($1X10^6$)	375.00	328.62	226.50	127.75	21.82	**94.20**
	0.01 g ($1X10^4$)	378.75	327.12	222.50	128.50	41.62	**89.00**
Control	-	365.75	360.00	290.12	270.75	160.11	**56.00**

Table (27): Percent of reduction in numbers of larvae of *S. littoralis* caused by different bio-compounds under field conditions during 2000 season.

Bio-compound	Conc.	Mean no. of alive larvae % of reduction after			
		1 day	3 days	5 days	7 days
Protecto (B.t.)	1.0 g ($32X10^6$)	22.60	35.80	66.50	90.50
	0.1 g ($3.2X10^6$)	20.80	27.00	44.50	82.90
	0.01 g ($0.32X10^6$)	17.00	27.60	32.40	59.50
Ecotech bio (B.t.)	1.0 g ($32X10^6$)	22.80	26.10	48.00	71.30
	0.1 g ($3.2X10^6$)	16.90	17.60	47.30	68.60
	0.01 g ($0.32X10^6$)	12.50	17.90	47.00	63.00
Diple-2x (B.t.)	1.0 g ($32X10^6$)	19.10	29.00	56.70	82.90
	0.1 g ($3.2X10^6$)	13.90	31.30	65.20	76.70
	0.01 g ($0.32X10^6$)	14.50	24.40	53.20	65.30
Viroset (NPV)	1.0 g ($1X10^8$)	25.60	32.30	59.60	92.00
	0.1 g ($1X10^6$)	11.40	20.30	54.10	87.20
	0.01 g ($1X10^4$)	12.60	25.40	54.20	74.90
F= LSD .05 =					46.07*** 3.04

Fig. (23)

From these data it can be conclude that applied bio-compounds against *S. littoralis* in an area cultivated with cotton caused percentage of reduction in the population of *S. littoralis* larvae ranged between 63.00-90.50%. It is means that more than 63% reduction was obtained in the population of cotton leafworm larvae in addition; these compounds are harmless against the beneficial insects. Also, Viroset was more effective in cotton fields than *B.t.* compounds. In this respect, **El-Husseini (1980)** used *B.t.* compounds to control the cotton leafworm in clover fields. He reported that *B.t. var thuringiensis* at a rate of 1 Kg/feddan gave about 50% mortality of larvae and pupae of *S. littoralis* and was harmless against the beneficial insects.

II.2. Second season (2001):

Data in Table (28) show that the pre-spraying counts of larvae ranged between (334.62 and 389.75 larvae/plot). 10 plants

Protecto, with (0.01 g) concentration gave 72.90% reduction in larvae infesting cotton plants after 7 days. While, the second concentration (0.1 g) gave 76.50% reduction.

On the other hand, the third concentration (1.0 g) gave 81.50% reduction in leafworm larvae infesting cotton plants (Table, 29) and Fig. (24).

Ecotech bio, with (0.01 g) concentration gave 51.30% reduction in larvae infesting cotton plants after 7 days. While, the second concentration (0.1 g) gave 60.00% reduction. On the other hand, the third concentration (1.0 g) gave 78.30% reduction in leafworm larvae infesting cotton plants (Table, 27) and Fig. (24).

Table (28): Effect of different tested bio-compounds on mortality percentage of different larval instars of *S. littoralis* under field conditions during 2001 season.

Bio-compound	Conc.	Pre-spraying count	Mean no. of alive larva				% mortality
			Post-spraying count				
			1 day	3 days	5 days	7 days	
Protecto (B.t.)	1.0 g ($32X10^6$)	354.37	281.62	213.87	114.00	29.00	**91.80**
	0.1 g ($3.2X10^6$)	345.25	250.12	200.00	120.00	35.75	**89.65**
	0.01 g ($0.32X10^6$)	334.62	282.75	181.50	91.87	40.00	**88.00**
Ecotech bio (B.t.)	1.0 g ($32X10^6$)	359.62	287.75	203.12	95.12	35.00	**90.25**
	0.1 g ($3.2X10^6$)	358.12	295.37	229.37	139.50	63.12	**82.38**
	0.01 g ($0.32X10^6$)	354.00	292.12	220.00	104.87	76.00	**78.50**
Diple-2x (B.t.)	1.0 g ($32X10^6$)	340.50	265.75	196.15	145.70	60.15	**82.30**
	0.1 g ($3.2X10^6$)	384.25	291.22	200.62	130.00	62.25	**83.80**
	0.01 g ($0.32X10^6$)	381.75	300.75	232.20	144.90	76.12	**80.80**
Viroset (NPV)	1.0 g ($1X10^8$)	385.25	290.10	217.35	120.67	27.02	**93.00**
	0.1 g ($1X10^6$)	378.50	280.62	200.12	139.45	43.97	**88.35**
	0.01 g ($1X10^4$)	375.37	270.87	180.32	110.52	25.50	**93.20**
Control	-	345.87	313.75	256.75	195.25	152.12	**56.20**

Table (29): Percent of reduction in numbers of larvae of *S. littoralis* caused by different bio-compounds under field conditions during 2001 season.

Bio-compound	Conc.	Mean no. of alive larvae % reduction after			
		1 day	3 days	5 days	7 days
Protecto (B.t.)	1.0 g ($32X10^6$)	12.60	33.70	43.10	81.50
	0.1 g ($3.2X10^6$)	10.80	22.40	38.50	76.50
	0.01 g ($0.32X10^6$)	7.10	27.40	51.50	72.90
Ecotech bio (B.t.)	1.0 g ($32X10^6$)	12.00	24.40	53.20	78.30
	0.1 g ($3.2X10^6$)	9.30	14.20	31.10	60.00
	0.01 g ($0.32X10^6$)	9.30	16.80	47.60	51.30
Diple-2x (B.t.)	1.0 g ($32X10^6$)	14.20	22.90	24.30	60.00
	0.1 g ($3.2X10^6$)	11.70	30.10	40.20	63.30
	0.01 g ($0.32X10^6$)	13.40	18.50	32.90	54.80
Viroset (NPV)	1.0 g ($1X10^8$)	17.20	24.50	44.60	84.10
	0.1 g ($1X10^6$)	18.60	29.20	39.40	76.00
	0.01 g ($1X10^4$)	20.70	33.90	48.10	84.90
F=					37.91***
LSD .05 =					3.42

Diple-2x, with (0.01 g) concentration gave 54.0 / 80% reduction in larvae infesting cotton plants after 7 days. While, the second concentration (0.1 g) gave 63.30% reduction. On the other hand, the third concentration (1.0 g) gave 60.00% reduction in leafworm larvae infesting cotton plants (Table, 27) and Fig. (24).

Viroset, with (0.01 g) concentration gave 84.90% reduction in larvae infesting cotton plants after 7 days. While, the second concentration (0.1 g) gave 76.00% reduction. On the other hand, the third concentration (1.0 g) gave 84.10% reduction in leafworm larvae infesting cotton plants (Table 34) and Fig. (24).

Statistical analysis in (Table 29) for year 2001 show highly significant differences between the different concentrations of bio-compounds (Protecto, Ecotech bio, Diple-2x and Viroset) against different larval instars of the cotton leafworm, *Spodoptera littoralis* under filed conditions (F= 37.91, L.S.D.0.05 = 3.42).

In general, the percent reduction by different compounds increased with increases the concentration and also the percent reduction increasing with increase days.

Caballero *et al.* (1992) found that a nuclear polyhedrosis virus (NPV) causing epizootics in natural populations of *Spodoptera exigua* in the south of Spain. The incidence of this NPV has been determined from samples of larvae collected from sunflower fields. The NPV was the only disease agent identified at both sites.

Also, results of tested compounds showed that these compounds could be classified according to their effect into two groups: the 1st group with high reduction percentage such as

NPV (Viroset) and *B.t.* (Protecto), the 2nd group with moderate reduction such as *B.t.* (Ecotech-bio and Dipel-2X). from these data it can be concluded that the efficiency of tested *B.t.* compounds compared with the biocide NPV in reducing cotton leafworm infestation in treated cotton leafworm infestation were achieved with NPV (Viroset) and *B.t.* (Protecto). In this respect, **El-Sheakh (1998)** studied the effect of spraying Diepel-2X against the cotton leafworm in the field. He found that the initial mortalities recorded after 2 days of application were 34.02 and 37.50% for the residual effect whereas, the highest accumulative mortality percent reached 53.67% after 3days of spraying then decreased gradually after 5 and 7 days recording 36.67 and 20.00% , respectively as compared with 13.33 % in the control.

Fig. (24)