LABORATORY AND FIELD STUDIES TO DETERMINE THE EFFECT OF A BIOCIDE (DELFIN) AND AN INSECT GROWTH REGULATOR (CONSULT) ON THE PINK BORER *SESAMIA CRETICA* LED. AND CERTAIN NATURAL ENEMIES IN MAIZE FIELDS IN EGYPT.

Hafez, A. A.[1], F.F. Shalaby[1], E. A. Kares[2], and G. H. Ebaid[2]

1 Plant Protection Department, Faculty of Agriculture, Moshtohor, Zagazig University, Egypt.

2 Plant Protection Research Institute, Agricultural Research Centre, Giza, Egypt.

(Manuscript received December 2002)

Abstract

The efficacy of Delfin (a commercial product of *Bacillus thuringiensis* and Consult (an insect growth regulator) on the 1^{st} instar larvae of *Sesamia cretica* was studied. The LC_{50} value after 48 hours from Delfin treatment was 5.2×10^4 S.U. this value was 72 p.p.m., 24 hours after treatment of Consult. A negative relationship was found between the applied concentration of Delfin, Consult and LT50 values where it shortened by increase of applied concentrations. A program was followed in the field on (16 experimental plots) of early maize cultivation of 1998 and 1999 maize season that received 3 treatments and control of 4 replicates each. The treatments were Delfin + 1% NaCl, Delfin (0.525 kg. / feddan) and Consult (200 ml / feddan). All treatments were applied 20 days after sowing. Such treatments induced % reductions in the numbers of perforated leaves due to *S. cretica* larval feeding by 66.51, 64.74 and 42.59 % in 1998 and by 38.84, 26.85 and 28.51 % in 1999 for the three treatments, respectively. In addition reduced the mean larval counts /10 infested plants and caused % reduction than control by 47.39, 40.62 and 21.88 % in 1998 and by 27.01, 20.11 and 13.79 % in 1999 for the three treatments, respectively. Spraying maize by Delfin or Delfin + 1% NaCl had no effect on parasitization of *Platytelenomus hylas* (an egg parasitoid) or on *Apanteles* sp., *Bracon brevicornis* and *Meteorus rubens* (three larval parasitoids). Consult treatment caused significant reduction in the percentages of parasitism by *P. hylas* and also no parasitized *S. cretica* larvae was detected in this treatment.

INTRODUCTION

In Egypt sugar can and maize plants are subjected to infestation with a variety of insect pests, of which the most destructive one is *Sesamia cretica*. Highest infestation to maize plants by this pest occurs during April followed by March and then May cultivations. The infestation in the cultivations of June to September was relatively very low (Abul-Nasr *et al.*, 1968; Ismail *et al.*, 1974; Isa and Awadallah, 1975; Simeada, 1985). Larvae of this pest feed inside maize seedling causing rottening of these plants. Therefore, this pest may be considered the most serious economic pest of maize as the loss in the final yield is normally proportional to the percentage of dead hearted plants.

Normally, the mentioned pest is controlled according to the 2002 recommendations of the Egyptian Ministry of Agriculture by spraying Lannate 90 % SP at a rate of 300 gm/ feddan. But, investigating other non-chemical control methods is necessary, to be used either alone or in IPM programs to reduce the well known harms due to environmental pollution by pesticides.

One alternative to synthetic insecticides is *Bacillus thuringiensis* a bacterium that produces δ-endo toxins specific to lepidopteran larvae. As a ubiquitous soil-borne bacterium, *B. thuringiensis* has few detrimental effects on non target organisms, such as fish or mammals (Saik *et al.*, 1990). Many authors reported the potential effects of using many commercial microbial insecticide of *B. thuringiensis* against the pest; such as Mc Guire *et al.*, (1994) David & William, (1995) and Ebaid, (2001).

For increasing the efficacy of *B. thuringiensis* by adding a feeding stimulant, several authors tested the additive effects of *B. thuringiensis* with chemical insecticides as (Abdallah, 1969 and 1982; Abdel-Megeed *et al.*, 1984; Salama *et al.*, 1984; Al-Zubadi *et al.*, 1988; Kares 1991). Also many authors studied the addition of some natural stimulants to the suspension of microbial insecticides as sugar or molasses were used by El-Husseini, (1975), Schmidt and Antonin (1977), El-Husseini and Afify, (1980 – 1981) and some inorganic salts, nitrogenous compounds, protein solubilizing agents and organic acids were used by El-Moursy *et al.* (1992).The addition of a 1 and 5 % glucose and 1 % pure NaCl to the *B. thuringiensis* (Delfin) to be tested against *Spodoptera littoralis* larvae were investigated by Makkar and El Mandarawy (1996). They indicated that, Delfin with low concentration of glucose was more effective than that with high concentration. But by adding NaCl to Delfin the combination gave better results than by adding glucose.

Other possible to synthetic insecticides is the insect growth regulators, which produce many effects against lepidopteran pests; i.e., *S. littoralis*, *Agrotis ipsilon* and *Ostrinia nubilalis* Ascher *et al.*, (1989), Mostafa *et al.*,(1991), Burgio *et al.*, (1993), Sokar (1995), Mansour (1997) and Trisyono & Chippendole (1997).

The present paper summarizes the results of spraying *B. thuringiensis* (Delfin) and insect growth regulator (Consult) for controlling *S. cretica* and to evaluate the effects of such treatments on the occurrence of natural parasitoids.

MATERIALS AND METHODS

1. Rearing of corn stalk borer S. cretica

Large numbers of *S. cretica* larvae were collected from the field and confined individually in glass vials about 10 x 5cm. each. Each vial was provided with a piece of about 3cm. long cut from the top of a fresh green maize plant as larval food. Also, a piece of cotton wool was added to each vial to serve as pupation site and the vial was covered on the top by muslin cloth. Vials were cleaned and plant pieces were renewed every couple of days and as the larvae grew older; they were fed on tender cuttings of maize stems of more than 40 days old. The vials were kept at an average temperature of 27 ± 2 °C and 65 ± 5 % R.H. The obtained pupae were sexed and every couple was placed in a plastic cup of 30 x 10 cm. covered on the top by muslin cloth kept in position by a rubber band for moths' emergence. Maize seedlings in one plastic pot were exposed to the emerged moths of *S. cretica* for oviposition. Egg that are about to hatch were collected and supplied with fresh succulent rolled leaves as suitable food supply for the hatching larvae.

2. Materials used

A. Bioinsecticide: Delfin, a selective bacterial insecticide containing 53 x 106 S.U. of Bacillus thuringiensis var. kurstaki / gram of product, applied at a rate of 0.525 kg. / Feddan. (4200 m2)

B. insect growth regulator (I. G. R.) Consult 10 % E.C.

Common name: Hexaflumuron and commercial name: Consult

N-{[(3, 5-Dichloro-4- (1, 1, 2, 2. Tetraflouroethoxy) phenyl amino] Carbonyl}-2, 6- diflurobenzamide were applied at rate of 200 cm^3. / feddan

Laboratory studies

a. Biocide treatments

Weights of 0.1887, 0.3774, 0.7547, 1.1320, 1.5094 and 1.8868 grams of Delfin were diluted, each in a constant volume of 500 ml. water to obtain the concentrations of 2 x 10^4, 4 x 10^4, 8 x 10^4, 12 x 10^4, 16 x 10^4 and 20 x 10^4 S.U (Spodoptera units)., respectively.

b. insect growth regulator treatments

A volume of 2ml.of Consult 10 % (E.C. equal 10 x 10^4 p.p.m.) was dissolved in water, (final volume 200 ml.) to obtain the concentration of 1000 p.p.m. as a stock solution. Six concentrations; 20, 40, 80, 160, 320 and 640 p.p.m. were prepared by adding 2, 4, 8, 16, 32 and 64 ml. of the stock solution, respectively to obtained constant volume of 100-ml. water.

The following procedures were followed

1. In the two experiments, fresh succulent rolled leaves, as suitable food supply for larvae, were dipped for about one minute in each concentration, and then left for about an hour to dry.

2. Three replicates each of 10 first instar *S. cretica* larvae of each replicate were placed in a cup of 6 x 7.5 cm, and allowed to feed on the treated food for a period of 48 hours in the case of Delfin and 24 hours for consult treatments. The mortality rates were recorded daily. Larvae that survived after treatment were transferred to new cups containing untreated food on which they fed until pupation.

3. Control tests were conducted using the same source of food, but dipped in water only.

4. Larvae were starved for 6 hours before exposure to treated food, in order to obtain rapid simultaneous ingestion.

5. The experiments were carried out under laboratory conditions of an average 25 ± 2 °C. and 65 ± 4 % R.H.

Statistical analysis

1. As larval mortality percentages in control treatments, ranged from zero up to 5 %, accordingly no correction on the obtained mortalities was followed.

2. The effectiveness of the different treatment was expressed in terms of LC_{50} and LT_{50} values at 95 fiducially limits. Slopes of regression lines were represented. Statistical analyses of the obtained data were made based on the analysis of variance and liner regression analysis (Finney, 1971 and slide write program). In addition, polynomial regression procedure in COSTAT program was done.

Field studies

This study was carried out at the Experimental Farm of the Faculty of Agriculture at Moshtohor, Qalubia Governorate.

An area of about one half of a feddan was divided into 16 experimental plots that received 3 treatments and control of 4 replicates each. Plots were distributed in a complete randomized block design. Maize variety (Giza 2) was sown at a rate of 2-seeds/ hill. In order to induce high borer infestation in the experimental field was sown during the last two weeks of April 1998 and1999 maize seasons. All plots received the normally recommended agricultural practices

Treatments:

1. Treatment (a): plots were left untreated as a control.

2. Treatment (b): plots received one application of Delfin (bacterial bioinsecticide).

3. Treatment (c): plots received one application of Delfin with 1% NaCl. (For increasing the efficacy of *B. thuringiensis*, a combination was made of commercial product of Delfin at rate 0.525 kg/feddan with pure NaCl.)

4. Treatment (d): plots received one application of insect growth regulator (Consult).

Insecticides were applied by means of 20L-knapsack sprayer using a total volume of 200 L. /feddan. All plots were sprayed after 20 days of sowing (on May 10th 1998 and May 18th 1999). Sampling started on May 16th 1998 and May 17th 1999, 8 samples were taken throughout the season.

*Rate of infestation caused by *S. cretica* in different treatments

Fifteen randomly seedlings from each plot (60 seedlings / treatment) were taken at random weekly. Examined number of plants with perforated leaves and those with dead hearts were counted.

*Degree of infestation caused by *S. cretica* in different treatments

The newly hatched *S. cretica* larvae first feeds on the egg shell, and then bore directly through the stem which, at that time, is composed of rolled leaves surrounding the growing point. Up to this stage infestation does not show to the outside, but few days latter, small holes can be seen on the leaf blades in the form of regular transverse rows (perforated leaf symptom).

The larvae may continue to feed up wards destroying in their way the growing point of the plant which withers and can be easily detached. This phenomenon is knows as (dead heart).

As shooting in maize is of no value, the phenomenon that cause the most damage and a complete loss in maize yield is the dead heart not perforated leaf.

Degree of infestation was estimated by dissecting a number of 10 infested plants chosen randomly from infested plants of each treatment weekly. Number of larvae was counted and recorded.

*Effect of different treatments on the rate of parasitism

a. Egg parasitoids: Samples of *S. cretica* egg masses were randomly collected weekly from the two summer plantations. Eggs of each mass were counted and placed in a 5 x 10cm. glass vial tightly closed on the top by muslin wrapped cotton plug and examined daily for emergence of any parasitoids.

b- Larval parasitoids: Larvae of *S. cretica* were collected weekly. Each larva was kept in a glass vial 5 x 10cm and provided daily throughout their developmental period with fresh green top shoots of maize plants. Vials were covered with muslin cloth and examined daily for emergence of any parasitoids.

$$\text{Percentages of parasitism} = \frac{\text{Total numbers of parasitized eggs or larvae}}{\text{Total numbers of collected eggs or larvae}} \times 100$$

RESULTS AND DISCUSSIONS

Laboratory studies

1- Effect of tested biocide; Delfin on *Sesamia cretica.*

Daily mortalities among treated first instar *S. cretica* larvae are shown in Table 1, the corrected mortality percentages after 48 hours of treatment increased by increasing Delfin concentration and ranged from 20 to 90 % at the concentrations of 2 to 20 x 10^4 S.U. As shown in Table 1 and Fig. 1, the LC50 value was 5.2 x 10^4 S.U.

The increased mortality percentages by increasing the concentration of Delfin agree with those previously reported by El-Hussieni (1980-1981) on *O. nubilalis* larvae treated with the two bioinsecticide Bactospeine and Entobakterin-3; Kares *et al.*, (1992) on larvae of the cabbage worm *Artogeia rapae* when testing Bactospeine; Badawy (2000) when he tested Dipel 2x, Ecotech bio and MVP_{11} against *S. littoralis* and the potato tuber moth *Phthorimaea operculella*; where also Ecotech bio and MVP_{11} were more effective than Dipel 2x against the second and fourth larval instars of *S. littoralis*; El- Khawas (2000) on the olive leaf moth *Palpita unionalis* larvae by using the bioinsecticide Xentari; Atalla *et al.* (2001) on the three insect pests, *S. littoralis*, the black cutworm *Agrotis ipsilon* and the corn stalk borer *Sesamia cretica* when evaluating the effect of Agerin bioinsecticide.

Data of LT_{50} values indicated a negative relationship between the applied concentrations of Delfin and LT_{50} values. These values were 80, 50 and 32 hours by using the concentrations of 2, 4 and 8 x 10^4 S.U., respectively. These results are in agreement with those of Moawad *et al.* (1982/1983) who tested Bactospine and Diple powders on larvae of *Earias insulana*; Kares *et al.* (1992) who studied the efficacy of Bactospine on *Artogeia rapae* larvae and Kares *et al.* (2002) who tested the bioinsecticide Delfin against larvae of *Ostrinia nubilalis.*

2. Effect of insect growth regulator (Consult) on Sesamia cretica

The first instar larvae were fed on fresh succulent rolled leaves of maize seedlings treated with different concentrations of Consult. The larval daily mortality of *S. cretica* are shown in Table 2, the corrected mortality percentages after 24 hours increased by increasing Consult concentration and ranged from 16.67 to 100 % at the concentrations of 20 to 640 p.p.m. Whereas, as shown in Fig. 2, the LC_{50} value was 72 p.p.m. for *S. cretica* after 24 hours.

The acute and delayed toxicity of Diflubenzuron (an inhibitor of chitin synthesis) on *S.littoralis* larvae was studied under laboratory condition by Kares (1990). The author found that the corrected mortality percentages increased as the concentration increased. Mansour (1997) evaluated the effectiveness of some I.G.R. compounds (IKlbb 145, Consult 100 EC and Consult 100 SC). These substances were applied on cotton plants to be assayed against the 2^{nd} and 4^{th} instar larvae of *S. littoralis* which were fed for 24 hrs on cotton treated leaves after different periods from field application. The toxicological and biological activity of these compounds indicated that, Consult 100 EC caused the highest mortality among the treated larvae. According to the latent toxicity of I.G.R. compound, it caused reductions in the weight of resultant pupae, pupation, emergence and eggs reproductive. These effects were dependent on the period after the I.G.R. application to treatment and also on the assayed compound.

Data of LT_{50} values indicated a negative relationship between the applied concentrations of Consult and LT_{50} values. These values were 50, 37.5 and 23.5 hours by using the concentrations of 20, 40 and 80 p.p.m., respectively. These results agree with Kares (1990) and Mansour (2001) on *S. littoralis* treated with Diflubenxuron and Mimic.

Table 1. Corrected mortality percentages for first instar of *S. cretica* larvae fed on Delfin treated fresh succulent rolled leaves of maize plants.

Con. (SU)	Cumulative morality % after hours of treatment						
	24	48	72	96	120	144	168
0.00	0.00	0.00	3.33	3.33	3.33	3.33	3.33
2×10^4	10.00	20.00	43.33	70.00	86.67	96.67	100.00
4×10^4	23.33	40.00	60.00	83.33	93.33	100.00	
8×10^4	40.00	63.33	73.33	90.00	100.00		
12×10^4	53.33	76.67	86.67	96.67	100.00		
16×10^4	66.67	86.67	93.33	100.00			
20×10^4	80.00	90.00	100.00				

Table 2. Corrected mortality percentages among first instar of *S. cretica* larvae fed on Consult treated fresh succulent rolled leaves of maize plants.

Con. (p.p.m.)	Cumulative morality % after hours of treatment					
	24	48	72	96	120	144
0.00	0.00	0.00	3.33	3.33	3.33	3.33
20	16.67	36.67	60.00	83.33	96.67	100.0
40	30.00	53.33	76.67	93.33	100.0	
80	50.00	76.67	96.67	100.0		
160	76.67	96.33	100.0			
320	90.00	100.0				
640	100.0					

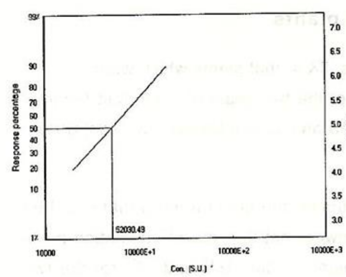

Fig. 1. Log concentration probit lines showing response of first instar larvae of *S. cretica* to Delfin (computed from 48 hours mortality data)

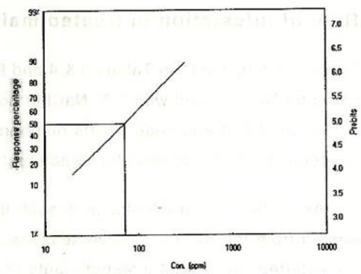

Fig. 2. Log concentration probit lines showing response of first instar larvae of *S. cretica* to Consult (computed from 24 hours mortality data)

Field studies

I.Rate of infestation caused by *S. cretica* in different treatments

In the two years of study, Delfin, Delfin + 1% NaCl and an insect growth regulator (Consult) were sprayed 19 days after sowing during 1998 and 1999 plantations.

a.Rate of infestation in the untreated maize plants

In 1998 plantation, damage on the untreated maize seedlings (perforated leaves and those with dead hearts) began to appear 25 days after sowing. The number of damaged seedlings increased gradually to reach noticeable damage (45 infested / 60 plants) and rate of infestation 75 %, Table 3 and Fig. 3. These data indicated that, the untreated maize plants had significantly the highest number of perforated leaves and dead hearts by *S. cretica* larvae.

In 1999 plantation, it could be observed from Table 4 and Fig.4 that infestation to maize plants by *S. cretica* was generally less than in 1998. The rate of infestation increased slightly until the sample of June, 26th by 1.67 %. The infestation reached 41.66 % when 25 infested plants / total of 60 plants were observed. The whole seasonal mean of the rate of infestation in the untreated maize plants of the two seasons of study (37.88 and 20.38, respectively) were found, statistically, significantly higher than the mean numbers of perforated leaves and dead hearts of all treatments, Table 3 & 4.

b.Rate of infestation in treated maize plants

It could be deduced from Tables 3 & 4 and Figs. 3& 4, that plants which were sprayed by Delfin mixed with 1 % NaCl in both of the two years of study had the lowest perforated leaf and dead hearts numbers (13 and 12.5 infested / 60 plants) than those recorded from the two other treatments.

As for the rate of infestation in such treatment, the general trend that could be observed from the two successive seasons, showed that the rate of infestation by *S. cretica* started very low (4 infested plants / 60 plants in May 16^{th} and 17^{th} for the two years of study, respectively). This number of infested plants represented 6.66 % rate of infestation in both of the two seasons and indicating the highest % reduction than control by 75 and 60 % respectively. Rate of infestation increased successively in the subsequent samples throughout the season until reached a highest percentage of infestation (26.66 % on June 20th 1998 and on July, 5^{th} 1999, Tables, 3 & 4 and Figs., 3 &4. As for the average numbers of infested plants (13 plants in 1998) this average was insignificantly lower than those recorded from maize plants treated by Delfin, while in 1999 it showed significant reduction than average 15.25 recorded for the Delfin.

On the contrary, the highest mean count of perforated leaves and dead hearts due to *S. cretica* larval feeding was associated with plants treated by Consult in both of the two years of study. The 1998 seasonal mean (21.5 perforated leaves and dead hearts / 60 plants) was significantly higher than those recorded from the two remaining treatments. While in 1999, the average number (14.63 perforated leaves and dead hearts / 60 plants) was insignificantly lower with those of plants received Delfin, but significantly higher than in case of Delfin + 1 % NaCl (12.75 / 60 plants).

Regarding the percentages of reduction in perforated leaf and dead hearts numbers due to Delfin + 1 % NaCl treatments compared to control, it could be observed that this treatment was the most effective in this season of study as it caused 66.51 % reduction than control. The remaining treatments may be arranged, descendingly, according to their efficacy in reducing the rate of perforated leaves and dead hearts as Delfin and Consult (64.74 and 42.59 % respectively), Table 3. In 1999, treatments by Delfin, Delfin + 1 % NaCl and Consult caused reductions in perforated leaves and dead heart plants than control by 26.85, 38.84 and 28.51% respectively, Table, 4.

2. Rates of infestation by S. cretica larvae in maize plants after application of Delfin, Delfin + 1 % NaCl and Consult.

As shown in Table 5, in both season of study, the untreated maize plants received the highest infestation rates with *S. cretica* larvae (32 and 29 larvae / 10 infested plants in 1998 and 1999 season, respectively) than the other three treatments.

The two Delfin treatments showed similar trend of efficacy in the two seasons of study, as Delfin + 1% NaCl was the most effective. Maize plants treated with this mixture harbored 16.8 and 21.17 larvae / 10 infested plants, respectively. These larval counts were significantly lower than those recorded from maize plants treated by I.G.R. (Consult) in 1998 (25 larvae / 10 infested plants) and varied insignificantly in 1999 from those recorded from maize treated with Consult (25 larvae / 10 infested plants) or Delfin only (23.17 larvae / 10 infested plants).

Regarding the reduction percentages in *S. cretica* larval counts due to different treatments than control, it is clear from Table 5 that in both years, all the treatments caused reductions in the rates of infestation by *S. cretica* larvae than control.

The reduction percentages ranged from 21.88 % by using Consult to 47.39 % in the case of Delfin + 1 % NaCl in 1998 season. Treatment by Delfin only in the same season caused a reduction percentage by 40.62 %. In 1999, treatments by Delfin, Delfin + 1 % NaCl and Consult caused reductions in *S. cretica* larval infestation by 20.11, 27.01 and 13.79 %, respectively than control.

3. Effect of different treatments on percentages of parasitism

A. Egg parasitoids: Rates of parasitism by *P. hylas* in *S. cretica* eggs were estimated on maize plants treated in the two-summer plantations during 1998 and 1999 seasons.

Data presented in Table 6 clearly indicated that, percentages of parasitism by *P. hylas* in *S. cretica* eggs started very low at the beginning of the season, while it increased towards the end of the season. Regarding to the overall percentages of parasitism during 1998 plantation, it could be arranged, descending, according to their values as Delfin (8.73), control (8.04), Delfin mixed with 1 % NaCl (7.34) and Consult (4.08).These data indicated insignificant differences between control and both treatments of Delfin. On the other hand, treatment by Consult caused significant reduction in the percentages of parasitism than control.

In 1999, early plantation, the same trend of effectiveness was observed where the highest overall percentage of parasitism was recorded in the Delfin treatment (5.53) followed by that of Delfin mixed treatment (4.48) and control (3.69), while the lowest percentage (0.71%) was recorded in Consult treatment. The statistical analysis of these data indicated insignificant differences between the overall percentages of parasitism of the two Delfin treatments while significant reduction was detected by using I.G.R. compared to the remaining treatments.

From all the aforementioned data it could be concluded that:

1. Parasitism by *P. hylas* starting low during May at the beginning of maize season, while it increased towards the end of the season.

2. The natural role of parasitism by *P. hylas* was not affected when maize plants were sprayed with Delfin or Delfin mixed with 1 % NaCl.

3. Spraying maize plants by Consult (I.G.R.) caused significant reduction in the overall percentages of parasitism.

B. Larval parasitoids: In this part of study three hymenopterous parasitoids were secured from larvae of *S. cretica*; namely *Apanteles* sp., *Bracon brevicornis* and *Meteorus rubens*.

Data obtained from the two seasons, Table 7 clearly indicated that, the overall percentages of parasitism were affected by spraying different treatment. According to (L.S.D.) values these percentages could be arranged descendingly as follows; control, Delfin, Delfin mixed and finally consult. Such total percentages of parasitism were 4.95, 3.3, 2.8 and zero, respectively in 1998 and 5, 2.2, 1.6 and zero

In respect in 1999 season. Such data indicated significant difference between the control and other three treatments. On the other hand, data insignificantly varied between the overall percentages of parasitism of the two Delfin treatments.

Data also indicated that no parasitized *S. cretica* larvae were obtained in the Consult treatment. Most of the larvae collected from this treatment specially the three subsequent samples followed spraying failed to survive due to the effect of the anti-moulten insecticide. The highest percentages of parasitism were found in both years of study in the control treatment. However, the lower numbers of *S. cretica* larvae were recorded from the two Delfin treatments of the two years. The three braconid species could be detected in varying percentages of parasitism. These obtained data indicated that the two Delfin treatments have no effect on the occurrence of the above mentioned parasitoids.

Table 3. Cumulative rates of perforated leaves and dead hearts / 60 maize seedlings due to *S. cretica* infestation during 1998 plantation.

Date of inspection	No. of infested plants % infestation and % reduction than control										
	Control		Delfin			Delfin + 1% NaCl			Consult		
	No.	% infestation	No.	% infestation	% reduction	No.	% infestation	% reduction	No.	% infestation	% reduction
16/5/1998	16	26.67	4	6.66	75	4	6.66	75	10	16.66	37.5
23/5	32	53.33	11	18.33	65.62	10	16.66	68.75	20	33.33	37.5
30/5	39	65.00	13	21.67	66.66	13	21.67	66.66	22	36.33	43.59
6/6	39	65.00	16	26.66	58.97	14	23.33	64.10	22	36.33	43.59
12/6	42	70.00	17	28.33	71.66	15	25.00	64.28	23	38.33	45.24
20/6	45	75.00	18	30.00	60.00	16	26.00	64.44	25	41.66	44.44
26/6	45	75.00	18	30.00	60.00	16	26.66	64.44	25	41.66	44.44
3/7	45	75.00	18	30.00	60.00	16	26.66	64.44	25	41.66	44.44
Mean	37.88	63.13	14.38	23.96	64.74	13	21.66	66.51	21.5	35.75	42.59
L.S.D.	2.33										

Table 4. Cumulative rates of perforated leaves and dead hearts / 60 maize seedlings due to *S. cretica* infestation during 1999 plantation.

Date of inspection	No. of infested plants % infestation and % reduction than control										
	Control		Delfin			Delfin + 1% NaCl			Consult		
	No.	% infestation	No.	% infestation	% reduction	No.	% infestation	% reduction	No.	% infestation	% reduction
17/5/1999	10	16.66	5	8.33	50	4	6.66	60	4	6.66	60.00
24/5	11	18.33	9	15.00	18.18	9	15.00	18.18	10	16.68	9.09
31/5	21	35.00	12	20.00	42.85	13	21.67	38.09	15	25.00	28.57
7/6	23	38.33	16	26.66	30.43	13	21.67	43.48	16	26.66	30.43
14/6	24	40.00	20	33.33	16.66	15	25.00	37.5	18	30.00	25.00
21/6	24	40.00	20	33.33	16.66	15	25.00	37.5	18	30.00	25.00
28/6	25	41.66	20	33.33	20.00	15	25.00	40.00	18	30.00	25.00
5/7	25	41.66	20	33.33	20.00	16	26.66	36.00	18	30.00	25.00
Mean	20.38	33.96	15.25	25.41	26.85	12.75	20.83	38.84	14.63	24.37	28.51
L.S.D.	1.27										

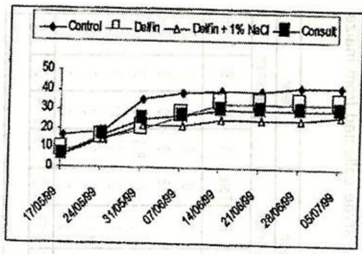

Fig. 3

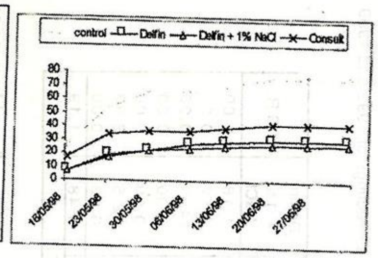

Fig. 4

Cumulative rates of infestation of perforated leaves and dead hearts / 60 maize plants in different treatments of 1998 and 1999 summer plantation.

Table 5. Number of *S. cretica* larvae per 10 infested seedlings in different treatments throughout 1998 and 1999.

Sampling date	Control	Delfin	Delfin + NaCl	I.G.R.	Sampling date	Control	Delfin	Delfin + NaCl	I.G.R.
16/5/98	84	68	57	85	17/5/1999	80	77	87	82
23/5	53	25	17	35	24/5	39	31	11	32
30/5	28	5	4	14	31/5	21	12	12	15
6/6	20	12	3	10	7/6	13	5	9	10
13/6	6	2	0.00	4	14/6	15	9	5	5
20/6	1	2	2	2	21/6	6	5	3	6
26/6	0.00	0.00	0.00	0.00	28/6	0.00	0.00	0.00	0.00
3/7	0.00	0.00	0.00	0.00	5/7	0.00	0.00	0.00	0.00
Over all	192	114	101	150		174	139	127	150
Mean	32	19	16.8	25		29	23.17	21.17	25
Reduction than control		40.62	47.39	21.88			20.11	27.01	13.79
L. S. D.	6.93					5.53			

Table 6. Percentages of parasitism by *P. hylas* in *S. cretica* egg collected from treated and untreated maize seedlings of 1998 and 1999 seasons.

Sampling date	Control	Delfin	Delfin + 1% NaCl	I.G.R.	Sampling date	Control	Delfin	Delfin + 1% NaCl	I.G.R.
9/5/1998	2.14	1.78	1.84	0.00	17/5/1999	2.63	1.23	1.18	0.00
16/5	6.81	5.92	5.36	0.74	24/5	7.77	7.32	8.57	0.00
23/5	14.83	15.15	20.83	4.00	31/5	6.25	13.33	14.28	0.00
6/6	0.00	0.00	0.00	0.00	7/6	0.00	0.00	0.00	0.00
13/6	0.00	0.00	0.00	0.00	14/6	0.00	0.00	0.00	0.00
20/6	31.16	31.43	23.81	20.29	21/6	0.00	11.11	12.5	8.33
26/6	26.66	33.33	37.5	33.33	28/6	28.51	0.00	0.00	0.00
Mean	8.04	8.73	7.34	3.7		3.69	5.53	4.48	1.19
L. S. D.	4.33					2.03			

Table 7. Percentages of parasitism by *Apanteles* sp., *Meteorus rubens* and *Bracon brevicornis* on *S. cretica* larvae collected from maize plants treated during 1998 season.

Sampling date	Control % parasitism				Sampling % parasitism				I.G.R. % parasitism				Sampling date	I.G.R. % parasitism				Delfin % parasitism				Delfin % parasitism			
	A	M	B	Total	A	M	B	Total	A	M	B	Total		A	M	B	Total	A	M	B	Total	A	M	B	Total
9/5/1998	1.06	0.00	1.06	1.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17/5/99	0.0	1.3	0.0	1.3	0	0	0	0	0	0	0	0
16/5	3.7	0.00	5.6	5.6	4	0.00	4	8	5.9	0.00	0.00	5.9	24/5	5.1	0.0	0.0	5.1	3.2	3.2	0	6.8	0	0	0	0
23/5	3.6	3.6	10.7	10.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31/5	4.8	4.8	7.7	9.5	0	0	0	0	8.3	0	0	8.3
30/5	5	5	15	15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7/6	0.0	0.0	6.7	7.7	0	0	0	0	0	11	0	11.1
6/6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14/6	6.7	0.0	0.0	13.3	0	0	11.1	0	0	0	0	0
13/6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21/6	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0
overall	2.5	1.5	0.99	4.95	1.6	0.00	1.6	3.3	2.8	0.00	0.00	2.8		2.3	1.1	2.3	5	0.72	0.72	0.72	2.2	0.79	0.79	0	1.6
L. S. D.	0.75												0.61												

REFERENCES

1. Abdallah, M. D. 1969. The joint action of microbial and chemical insecticides in the cotton leafworm *Spodoptera littoralis* (Boisd) (Lepidoptera: Noctuidae). Bull. ent. Egypt, Econ. Ser., 11: 209-217.

2. Abdallah, S. A. 1982 / 1983. Efficacy of certain synthetic pyrethrodis, *Bacillus thuringiensis* and their combination on the Egyptian cotton leafworm, *Spodoptera littoralis* (Boisd.). Bull. ent. Soc. Egypt, Ser., 13: 145-155.

3. Abul-Nasr, S. E.; A. K. M. El-Nahal and S. K. Shahoudah. 1968. Some biological aspects of the corn stem borer, *Sesamia cretica* (Led.) Bull. Soc. Ent. Egypte, 52: 429-444

4. Al-Zubadi, A. N. O., A. S. A. Ali and T. A. Aldergazali. 1988. Compatibility of the microbial insecticide (Bactospeine) with some chemical insecticides for control three lepidopterous pests in protected agriculture. J. of Agric. And Water Res., Plant Production. 7 (2): 277-291.

5. Ascher, K. R, M. V. Nelamed, N.E. Nemny and S. Tarn. 1989. The effect of benzaylphenyl urea molting inhibitors on larvae and eggs of the European corn borer, *Ostrinia nubilalis* Hbn. (Lepidoptera: Pyralidae). Acta. Phytopa-thologica Entomologica Hungarica. 24(1-2):25 30.

6. Atalla, F. A., A.A. El–Zoghby and M.A. Eweis. 2001. Susceptibility of the three lepidopterous pests, *Sesamia cretica* (Led.), *Spodoptera littoralis* (Boisd.) and *Agrotis ipsilon* (Hufn.) to the bacterial biocide "Agerin". Egypt. J. Biol. Pest Cont. 11 (1): 45-49.

7. Badawy, H. M. A. 2000. Efficacy and cytotoxic effect of bacterial insecticides on *Spodoptera littoralis* (Boisd.) and *Phthorimaea operculella* (Zeller). Bull. ent. Soc. Egypt, Econ. Ser., 27: 41-53.

8. Burgio, G., S. Maini, L. Manfredini and C. Maini. 1993. Comparison of microbiological and chemical control against *Ostrinia nubilalis* (Hb.) on maize. Informatore. Fitopatholoica. 43 (7-8) 45-48.

9. David, W. B. and D. H. William. 1995. On-farm efficacy of aerially applied *Bacillus thuringiensis* for European corn borer (Lepidoptera: Pyralidae) and corn earworm (Lepidoptera: Noctuidae) control in sweet corn. J. Econ. Entomol. 88 (2): 380-386.

10. Ebaid, G.H. 2001. Studies on some corn borers parasitoids. Ph. D. Thesis, Fac. of Agric., Moshtohor, Benha Branch, Zagazig Univ., Egypt, 205 pp.

11. El-Husseini, M. M. 1975. Zur Emsatz moglichkent von *Bacillus thuringiensis* bei der Bekampfung von fruchtschalenwicklern, insbesondere *Pandemis heparana* Den. Schiff-in pfelintensivanlagen. Ph. D. Thesis, Humboldi- University, Berlin.

12. El-Husseini, M. M. 1980-1981. Effect of two *Bacillus thuringiensis* Berl. Preparation on early larval instar of the European corn borer *Ostrinia nubilalis*. Bull. Soc. ent Egypte 63: 175-179.

13. El- Khawas, M. A. M. 2000 Integrated Control of Insect Pests on Olive Trees in Egypt with Emphasis on Biological Control. Ph. D. Thesis. Fac. of Sci., Cairo Univ., Egypt, 247 pp.

14. El-Moursy, A, R. Aboul-El, H. S. Salama and A. Abdel-Razek. 1992 Chemical additives that affect the potency of endotoxin of *Bacillus thuringiensis* against *Plodia interpunctella*. Insect Sci. Applic. 13(6): 775-779.

15. Finney, D. J. 1971 Probit analysis 3rd edition. Cambridge Univ., pp 333 Isa, A. L. and W. H. Awadallah (1975): Biological studies on corn borer in Egypt., 1-seasonal distribution. Agric. Res. Rev. Egypt, 53 (1): 53-64.

16. Ismail, I. I., M. T. Kira and M. A. Hassanein. 1974. Corn yields response to borer infestation and planting dates in Giza region. Bull. Fac. Of Agric., XXXV (1): 77-85.

17. Kares, E. A. 1990. Impact of diflubenzuron in *Spodoptera littoralis* (Boised.) larvae parasitized by *Zele nigricornis* (Walk.). Zagazig J. Agric. Res., 17 (3b): 953-958.

18. Kares, E. A. 1991. Effect of mixtures of *Bacillus thuringiensis* Berliner and chemical insecticides against larvae of pink bollworm *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae). Egypt. J. Biol. Pest Control. 1(2): 15-23.

19. Kares, E. A., A. A. El-Morusy, M. A. Amina and M. R. El-Mandarawy. 1992. Efficacy of a bioinsecticide (Bactospeine) on larvae of *Artogeia rapae* (L.) (Lepidoptera: Piridae). Egypt J. Biol. Pest Control 2 (2): 123-130.

20. Kares, E. A., A. A. Hafez, F.F. Shalaby and G. H. Ebaid. 2002. Evaluation of *Trichogramma evanescens* (Westwood) and *Bacillus thuringiensis* as control management tools of *Ostrinia nubilalis* (Lepidoptera: Pyralidae) in corn field at Qalubia Governorate. Egyptian Journal of Biological Pest Control, 12 (2), 71 – 77.

21. Makkar, A. W. and M. B. R. El Mandarawy. 1996. Laboratory studies for increasing the efficacy of a bioinsecticide (Delfin) against *Spodoptera littoralis* (Boisd.) larvae. Annals of Agric., Sc., Moshtohor 34 (4): 1925-1934

22. Mansour, E. S. 1997. Using methods to substitute insecticides for controlling the Egyptian cotton leaf worm in Qualubia Governorate. M. Sc. Thesis, Fac., of Agric. Moshtohor Zagazig Univ.

23. Mansour, E. S. 2001. New approaches for controlling the cotton leafworm and boll-worms in relation to abundance of parasitoids and predators. Ph. D. Thesis, Fac. Agric., Moshtohor Zagazig Univ.

24. Mc Guire, M. R., B. S. Shasha, L. C. Lewis and T. C. Nelsen. 1994. Residual activity of granular starch encapsulated *Bacillus thuringiensis.* J. Econ. Entomol. 87 (3): 681-687.

25. Moawad, G. M., F. F. Shalaby, A. G. Metwally and M. M. El-Gemeiy. 1982-1983. Laboratory pathagenecity tests with two commercial preparations of B*acillus thuringiensis* (Berliner) on the first instar larvae of the spiny bollworm. Bull. Soc. ent. Egypte, 64: 137 – 141.

26. Mostafa, S. A., F. A. F. Aly, M. G. Abbass and M. Abdel-Azeem. 1991. Effect of some insect growth regulators on the greasy cutworm, *Agrotis ipsilon* (Hufin.). J. Agric. Res., 69 (1), Egypt.

27. Saik, J. E., L. A. Lacey and C. M. Lacey. 1990. Safety of microbial insecticides to vertebrates-domestic animals and wild life, pp. 155 – 132.

28. Simeada, A. M. 1985. Relative susceptibility of certain maize gerplasm to infestation with the greater sugarcane borer, *Sesamia cretica* Led. (Lepidoptera: Noctuidae). M. Sc. Thesis, Fac. of Agric., Cairo Univ.

29. Sokar, A. L. 1995. Possible alternatives to classical insecticides in Management program of *Spodoptera littoralis* (Boisd.). Ph. D. Thesis, Fac. Of Agric., Moshtohor Zagazig Univ.

30. Trisyono, A. and G.M. Chippendale. 1997. Effect of nonsteroidal ecdysone against, Methoxy fenozide and Tebufemozide, on the European corn borer (Lepidoptera: Pyralidae). J. Econ. Entomol. 90 (6): 1486-1492.

دراسات معملية وحقلية حول تأثير المبيد الجيوى (دلفن) ومنظم النمو الحشرى (كونسلت) على دودة القصب الكبيرة وعلى بعض الاعداء الحيوية الطبيعية بحقول الذرة في مصر

عادل عبد الحميد حافظ[1] ، فوزى فائق شلبى[1]،
عصمت عبد الملك كارس[2]، جورج حلمى عبيد[2]

١ *كلية الزراعة بمشتهر - جامعة الزقازيق فرع بنها*
٢ معهد *بحوث وقاية النباتات- مركز البحوث الزراعية - الدقى - الجيزة* - مصر.

درس تأثير المبيد الحيوى (دلفن) ومنظم النمو الحشرى (كونسلت) على يرقات العمر الاول لدودة القصب الكبيرة- اوضحت الدراسة ان قيم التركيز القاتل ل ٥٠ ٪ من اليرقات كانت ٢,٥ × ١٠ ٤ وحدة دولية بعد ٤٨ ساعة من معاملة الدلفن بينما كانت ٧٢ جزء فى المليون بعد ٢٤ ساعة من معاملة الكونسلت. اوضحت الدراسة وجود علاقة سالبة بين التركيزات المستخدمة وقيم الوقت اللازم لقتل ٥٠ ٪ من اليرقات حيث قلت هذة القيم بزيادة التركيز المستخدم. اختبر برنامج مكافحة حقلية لدودة القصب الكبيرة على الذرة الصيفية المنزرعة فى عامى ٩٨ و ١٩٩٩ واشتملت ثلاث معاملات وكنترول. المعاملة الاولى باستخدام المبيد الحيوى دلفن والثانية الدلفن المضاف الية ١ ٪ كلوريد صوديوم (كمنشط للبكتيريا) والثالثة بمنظم النمو الحشرى كونسلت حيث تم رش النباتات فى المعاملات الثلاثة بعد ٢٠ يوم من الزراعة. ادت المعاملات الثلاثة الى خفض نسبة الاصابة مقارنة بالكنترول بنسبة ٦٤,٧٤, ٦٦,٥١, ٤٢,٥٩٪ فى عام ١٩٩٨ بينما كانت نسنة الخفض ٢٦,٨٥ ، ٣٨,٨٤ ، ٢٦,٥١ ٪ فى عام ١٩٩٩ للمعاملات الثلاثة على الترتيب. ايضا ادت هذة المعاملات الى خفض متوسط عدد اليرقات / ١٠ نباتات مصابة عن الكنترول بمقدار ٤٠,٦٢ ، ٤٧,٣٩ ، ٢١,٨٨ ٪ فى عام ١٩٩٨ بينما كانت تلك القيم ٢٠,١١, ٢٧,٠١, ١٣,٧٩ ٪ فى عام ١٩٩٩ للمعاملات الثلاثة على الترتيب.

اوضحت الدراسة ايضا ان معاملة نباتات الذرة باى من الدلفن او الدلفن المضاف الية كلوريد الصوديوم لم يؤثر على تواجد طفيل البيض *P. hylas* او اى من الطفيليات اليرقية *Meteurous rubens- Bracon brevicornis- Apanteles sp.* بينما ادت معاملة الذرة بمنظم النمو الحشرى كونسلت الى خفض معنوى فى نسبة التطفل بطفيل البيض *P. hylas*- كما لم يتم حصر اى من الطفيليات اليرقية فى هذة المعاملة.