

SUMMARY

Laboratory studies were conducted to find out the efficacy of Delfin (a bioinsecticide derived from *Bacillus thuringiensis* var. *kurstaki*) on the first instar larvae of *Sesamia cretica* and the second instar larvae of *Ostrinia nubilalis*, and also the inspect of Consult (an I.G.R.) on the first instar larvae of *S. cretica*. Laboratory studies were also oriented to *Conomorium* sp., which was first recorded in Egypt as pupal endoparasitoid on *S. cretica*. On the other hand, field included survey of parasitoids on immature stage of *S. cretica* and *O. nubilalis* and the percentages of parasitism on pests infesting summer and Nili plantations in addition to assaying different control methods against the two mentioned pests. The obtained results may be summarized as follows:

Laboratory studies:

I-1- Effect of bioinsecticide (Delfin) on *Ostrinia nubilalis* and *Sesamia cretica*.

The efficacy of Delfin (a commercial product of *Bacillus thuringiensis*) on the 2nd instar larvae of *O. nubilalis* and 1st instar larvae of *S. cretica* were studied. After 48 hours from treatment, the LC₅₀ values were 10×10^4 S.U. on *O. nubilalis* and 5.2×10^4 S.U. on *S. cretica*. A negative relationship was determined between the applied concentration of Delfin and LT₅₀ value i.e., the LT₅₀ was shortened by the increase of Delfin concentration in both of *O. nubilalis* and *S. cretica*. In addition, these values were shorter in case of 1st instar larvae of *S. cretica* than those of the 2nd instar larvae of *O. nubilalis* at the same concentration of Delfin.

I-2- Effect of I.G.R. (Consult) on *S. cretica*

The 1st instar larvae *S. cretica* were fed on fresh succulent rolled leaves of maize plants dipped in different concentrations of Consult. The LC₅₀ value was 72 p.p.m., 24 hours after treatment. The LT₅₀ was shortened by increase in Consult concentration.

I-3- Morphological studies on *Conomorium* sp.

This study included the first record of *Conomorium* sp. on *S. cretica* pupae. This parasitoid was identified by Dr. Hannes Baur, staff member Natural History Museum (Bern, Switzerland).

I-3-a-The different immature stages of *Conomorium* sp. (egg, 4 larval instars, prepupa and pupa) were briefly described.

Egg of hymenopterous type, on deposition it measures 0.7-mm. long and 0.28 mm. at its widest part. The size of egg increased as development proceeds to reach 1.31-mm in length and 0.437 mm in width, just before hatching. The larva could be easily discerned through the transparent chorion. The larva molts three times during its development, i.e. it develops through four larval instars.

The 1st instar larva is 1.4 mm long and 0.525 mm wide, the body 13 segmented. The head capsule measured 0.210-mm length and its width 0.210-mm. Each of the mandibles of 0.14 mm length and 0.070 mm width. The 2nd instar measures 2.625-mm in length and 0.7 mm in width. Head length and width measured 0.245 and 0.42 mm. Mandibles are 0.175-mm long and 0.105-mm width. The 3rd instar measures 4.2-mm long and 0.875-mm wide. The head capsule is 0.21 mm long and 0.315 mm wide. The mandibles are larger in size and

more pigmented than in the preceding stage. Each mandible has broad rounded base and tapers to a sharp end. It measures 0.21mm in length and 0.14mm at its base. The 4th larval instar measures 3.325mm long and 0.857 mm wide. The head capsule is 0.179 mm in length and 0.208 mm at its widest part.

Prepupal stage is formed inside the host pupa and measured 2.9-mm in length and 1.0 mm width. The posterior parts of prepupa lacks segmentation. Prepupa transfers to a free type pupa, which is about 3-mm long and 2.2-mm wide. At the beginning of this stage, the pupa is creamy in colour, the compound eyes and ocelli appear red. As development proceeds, the body darkens gradually starting with the head and thorax, which become black. Legs appear brown with yellow in some parts.

I-3-b- The average duration's of the egg, the four larval instars, the prepupa and pupa occupied 1.75 ± 0.25 , 2.25 ± 0.25 , 3.5 ± 0.09 , 3.75 ± 0.20 , 4 ± 0.18 , 1.13 ± 0.12 and 8.5 ± 0.23 days, respectively at 25°C and $65 \pm 5\%$ R.H. The total larval period occupied 13.5 ± 0.72 days and the total developmental period was 24.88 ± 1.32 days.

I-3-c- Emergence of parasitoid adults occurs from one or two holes of a circular shape and 1- 1.5-mm diameter. Emergencies is finished within few hours.

I-3-d- Sexes could be easily differentiated by the close examination of antenna and genitalia. The antenna is of geniculate type and consists of long scape, a shorter pedicel and a 7-segmented flagellum in both sexes. The flagella are longer in male (1.22mm) than female (1.05mm). Male has also a pale yellow ring on the ventral side of abdomen, which is not present in female.

I-3-e- Mating occurs immediately just after emergence. Males were able to mate at any time during their whole life and the mating be repeated several times within a day. Females accepted to mate more than once.

I-3-f- Oviposition processes is described.

I-3-g- Host range: under laboratory conditions, *Conomorium* sp. was successfully reared on *A. ipsilon*; *S. cretica* and *S. littoralis* but it failed complete parasitism on *Ostrinia nubilalis*; *Chilo agamemnon*; *Earias insulana*; *Pectinophora gossypiella* and *Anagasta kuehniella*.

I-3-h- Effects of different temperature conditions (15, 25 and 35 °C) on oviposition period, longevity of adult female, total developmental period, number of adults in progeny per female and sex ratio were determined. Data indicated that, 25 °C was the most favorable for the egg laying activity of *Conomorium* sp. At this temperature, the female lived for a mean period of 27 days. The total developmental periods were 25.9 (24-30) days. An adult female produced (72- 375) adults with a sex ratio of 1male: 12.95 females.

I-3-i- Effect of copulation on sex-ratio, ovipositional activities, rate of oviposition and life-span in *Conomorium* sp.

Data indicated that copulation is not the factor that stimulates oviposition. Unmated females deposit eggs as well as mated ones, but the progeny obtained in the former case are males. The number of produced adults was nearly the same in both cases. It was also found that mating did not affect the ovipositional activities, life-span of adult female and the number of eggs deposited female during its life-span.

I-3-j- Effect of rearing the parasitoid on different host species on the number of progeny, sex-ratio and life-cycle:

In association with pupae of two host species, *S. cretica* and *A. ipsilon*, and rearing the parasitoid at $30 \pm 2^{\circ}\text{C}$ & $70 \pm 5\%$ R.H., the life-cycle average (16.81 ± 0.14 and 17.44 ± 0.22) days, respectively, indicating shorter life-cycle by rearing on *S. cretica*. Insignificant differences were found between rearing on both species in the numbers of adults in progeny and the numbers of female resulted. Sex-ratio was in favor to rearing of the parasitoid on *S. cretica* (1: 7.9) opposed to 1: 4.67 in case of rearing the parasitoid on *A. ipsilon*.

I-3-k- Number of generations of *Conomorium* sp. per year in the laboratory:

It was found that the parasitoids have 13 generation per year under laboratory condition.

I-3-l- Effect of supplementary food on the longevity of *Conomorium* adults:

Longevities of adult male and female parasitoids were considerably short under the state of starvation and when water only was supplied. In the case of male feeding on bee honey with 20 %-dried yeast resulted the longest life-span. In case of females, the longest life-span (12.7 ± 0.77 days) was observed when fed on 50 % sucrose solution.

I-4- Storage of *Conomorium* sp. adults

In four laboratories experiments carried out at 10°C , the effect of low temperature storage on adults of *Conomorium* sp. adults was measured.

I-4-a-Effect of storage on mortality rates among *Conomorium* adults:

A number of 50 females and that of 50 males were stored at 10 °C for different periods (20, 30, 40, 50, 60, 70, 80, 90 and 100 days). After such periods the mortalities among females were 10, 26, 46, 60, 62, 68, 74, 78 and 82%, respectively. While in case of males, those were 8, 28, 52, 68, 72, 78, 86, 90 and 92 %, respectively. These data indicated that females more tolerant to cold storage than males.

I-4-b- Effect of storage at 10 °C for different periods on mated females of *Conomorium* sp.:

The experimented mated females lived for 36, 38, 36.1 and 25.2 days, respectively. The mean number of adults resulted per female during life- span after such periods of storage were 101.3, 83, 75.1 and 72.2, respectively. Number of adult females resulted per female were 91.6, 74.5, 67.1 and 36.7 respectively, while those of males in progeny were 9.7, 8.5, 8 and 8.5, respectively. It could be concluded that, the storage of the adults mated female for a maximum of 90 days is the favorable one. By storage for 90 days, the longevity of adults females was not affected significantly from those recorded for storage for 30 or 60 days.

I-4-c- Effect of storage for different periods on *Conomorium* sp. virgin females:

The experimented virgin females' left to mate with freshly emerged males before introduction to parasites. Females lived for 38.1, 42.4, 37.3 and 27 days. The mean number of adults resulted per female during life-span after such storage periods were 102.5, 86, 80 and 69.7,

respectively. Number, of adults female resulted per female was 94.2, 78.4, 73 and 63.5 respectively. The average numbers of male among the progeny were 8.3, 7.9, 7.1 and 6.2 in association with the aforementioned periods of storage.

1-4-d- Effect of storage of males for different periods on the fertility:

Storage of males at 10C° for 25, 35 or 45 days induced adverse effects upon males. The maximum suitable period for storage adult males of *Conomorium* sp. was 25 days. At such period of storage, males were able to give after mating a progeny of males and females with sex ratio of 1male: 7.3 females.

II-Field studies

The present study was carried out during maize summer and Nili plantations at Moshtohor during 1998 and 1999. Summer plantation was sown on April 20th 1998 and April 28th 1999. While, the Nili plantation was sown on July 10th of each year. The study aimed to find out the following:

II-1-Survey of the parasitoids and percentages of parasitism:

II-1-1-Egg parasitoids

A-Platytenomus hylas Nixon (Hymenoptera: Scelionidae)

This parasitoid emerged from *S. cretica* eggs collected throughout both summer and Nili plantation of the two years, the parasitoid showed two periods of activity that coincidence with the period of presence of *S. cretica* eggs in the field. During summer plantation, the first period of activity extended from the second week of May to the

end of this month (2.17- 15 %) while the second period was detected from the third week of June to the beginning of July (31.16- 41.66 % parasitism).

In the two Nili plantations, the first period occurred from the first to the third week of, August (25- 54.28 % parasitism). While, the second period was from the second to the 4th week of September showing highest rate of parasitism (88.88 – 100 %) on *S. cretica* eggs.

B- *Trichogramma evanescens* West. (Hymenoptera: Trichogrammatidae)

The percentages of parasitism by *T. evanescens* were estimated in *O. nubilalis* eggs infesting maize plants of Nili plantations of the two years of study. These percentages started low and increased as the season advanced. The highest percentages of parasitism were (60 % on September 19th 1998 and 61.22 % on September 24th 1999.

II-1-2-Larval parasitoids:

A-*Apanteles* sp. (Hymenoptera: Braconidae)

It is a gregarious endoparasitoid on *S. cretica* larvae detected during summer plantation of the two years. In 1998, the percentages of parasitism ranged from 1.14 % on May 30th to 9.09 % on June 20th. In the subsequent year, those ranged from 1.11 % on May, 31st to 8 % on June 21st.

B- *Bracon brevicornis* Wesm. (Hymenoptera: Braconidae)

1- On *S. cretica* larvae

This gregarious ectoparasitoid was detected late in the summer plantation and Nili seasons. In summer plantation, percentages of parasitism ranged from 3.13 % on June 6th to 3.84 % on June 13th in 1998, and from 1.85 % on June 7th to 4.41 % on June 13th in 1999. In Nili season, the percentages of parasitism ranged from 2.44 % on

September 24th to 3.70 % on October 7th 1998, and 2.56 % on September 13th to 5 % on September 27th 1999.

2- On *O. nubilalis* larvae

The parasitoid was detected in the Nili plantation parasitising *O. nubilalis* larvae. In 1998, the percentages of parasitism ranged from 1.77 % October 1st to 3.33 % on September 24th. In 1999 Nili plantation, percentages of parasitism ranged from 2.47 % on October 1st to 2.54 % on October 8th.

C- *Meteorus rubens* Nees (Hymenoptera: Braconidae)

M. rubens is a gregarious endoparasitoid, which was secured from larvae of *S. cretica* infesting maize plants of the summer plantation. The percentages of parasitism ranged from 2.08 on June 6th to 3.84 % on June 13th 1998 and from 1.11 % on May 31st to 3.7 % on June 13th 1999.

D- *Tachina larvarum* (L.) (Diptera: Tachinidae)

This dipterous parasitoid parasitised *S. cretica* larvae. In Nili plantation of 1998, the rate of parasitism ranged from 2 % on September 10th to 2.44 % on September 24th. In the subsequent Nili plantation 1999, percentages of parasitism ranged from 1.33 % on August 23rd to 2.22 % on August 16th.

II-1-3- Pupal parasitoid

Conomorium sp. (Hymenoptera: Pteromalidae) is a parasitic wasp, newly recorded as endoparasitoid on the pupae of *S. cretica* during summer plantation of the two years. In 1998 season summer plantation the percentages of parasitism ranged from 10 % on July 4th to 16.67 %

on June 20th. In 1999, the percentages of parasitism were 7.69 % on June 21st to 20 % on July 5th.

II-2-1-Method for *S. cretica* control:

A bacterial bioinsecticide (Delfin), Delfin + 1 % NaCl, and an insect growth regulator (Consult) were assayed for the efficacy in controlling *S. cretica* infesting maize plants cultivated in an area of about half a feddan divided into 16 equal plots. Every 4 plots received a treatment and the remaining 4 plots were left as control. All plots were distributed in randomized block design. According to the obtained data, the applied materials could be divided as follows:

- 1- Highly efficient, including Delfin + 1 % NaCl which caused 66.51 and 38.84 % reductions in the numbers of perforated leaves due to *S. cretica* larval feeding opposed to 37.88 and 20.38 leaves in the control plants of the 1998 and 1999, respectively. This treatment reduced the mean larval counts / 10 infested plants and caused % reduction than control by 47.39 and 27.01 % in 1998 and 1999, respectively.
- 2- Intermediately efficient, including Delfin treatment, as this preparation caused 64.74 and 26.85 % reduction in the perforated leaf number than control plants, respectively. As to % reduction than control for the larval counts per / 10 infested plants, those were 40.62 and 20.11 % in the two years, respectively.
- 3- Least efficient, represented by the Consult treatment which caused 42.59 and 28.51 % reductions, respectively, in the number of leaves perforated by *S. cretica* larvae than control. The reduction percentages in larval counts 10 infested plants were 21.88 in 1998 and 13.79 % in 1999.

II-2-2-Effect of different treatments on the percentages of parasitism:

a- Egg parasitoid:

The natural role of parasitism by *P. hylas* in eggs of *S. cretica* was not affected when maize plants were sprayed with Delfin or Delfin + 1% NaCl. Spraying maize plants by Consult caused significant reduction in the overall percentages of parasitism.

b- Larval parasitoids:

The collected larvae of *S. cretica* were found to be parasitised by *Apanteles* sp., *Bracon brevicornis* and *Meteorus rubens*. The obtained data indicated that the spraying of maize by Delfin or Delfin + 1 % NaCl did not affect on the occurrence of the three larval parasitoids. On the contrary, no parasitised *S. cretica* larva was detected in the Consult treatment.

II-3- Evaluation of *Trichogramma evanescens* and *Bacillus thuringiensis* in control management of *O. nubilalis*.

A biological control program was planned for controlling the European corn borer, *O. nubilalis* using *Trichogramma evanescens* and *Bacillus thuringiensis*. An area of half a feddan was divided to 16 equal plots, which received 3 treatments and control in maize plants cultivated in 1998 and 1999. Releases were carried out twice at 7 days intervals at a release level of about 33,000 wasps for each one. One *B. thuringiensis* spray was applied against host larvae that escaped *T. evanescence* parasitism. Data indicated the following:

1-In 1998, infestation to maize plants by E.C.B. egg masses of began on August 15th and reached to the peak on September 5th. In the

subsequent year first detection of egg masses occurred on August 19th and the peak was on September 10th.

2- The release rate of 66,000 wasps / feddan induced rate of parasitism in *Trichogramma* and *Trichogramma* + *B. thuringiensis* plots by 69.87 and 70.69 % in 1998 and by 75.12 and 73.76 %, respectively in 1999.

3- It could be stated that the combined treatment (*Trichogramma* + *B. thuringiensis*) is the best treatment. In such treatment, the percentages of reduction in the mean number larvae *O. nubilalis* at harvest were 20 and 13.33 % in 1998 and 1999, respectively and induced a reduction in the infestation to ears than control by 66.67 and 73.33 %, respectively in the two years of study.

4- One *B. thuringiensis* treatment is not sufficient to prevent the larval attack to maize plants. This treatment caused 30.29 % and 34.09 % reduction in the mean numbers of larvae per 10 plants than control in the two years of study. This treatment resulted 53.33 % and 46.67 % infestations to ears, thus indicated lowest reduction in the infestation rate than control by 11.11 in 1998 and 6.67 % in 1999.