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CURRENT STATUS OF CORN BORERS IN MAIZE FIELDS AND PILOT UTILIZATION OF *Sesamia cretica* Granulovirus *"SCGV"* AS A BIOCONTROL AGENT

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ABSTRACT

The population density of larvae of the three corn borers species: greater pink borer, *Sesamia cretica* Led., European corn borer, *Ostrinia nubilalis* (Hubner), and purple-lined borer, *Chilo agamemnon* Bles. was studied during 1994 and 1995 at Kafr El-Sheikh Governorate. Generally, the population varied greatly according to insecticide treatment, corn borer species, and plantation. In the early summer planting, population density of *S. cretica* was greater than the other two species, while in the late summer planting, *O. nubilalis* was the most dominant borer.

The recommended insecticides used against corn borers resulted in remarkable reductions in the infestation and, consequently, increase maize yield in the treated plots compared to those untreated.

There were no noticeable differences between the number of *S. cretica* larvae on insecticide or *Sesamia cretica* Granulosis Virus (*ScGV*) treated plots. Corrected yields in kg/ha were 6901, 5509 and 4391 for methomyl, *ScGV*, and control treatments in 1995 and 6351, 4362, 4055, and 3400 for methomyl, high dose of *ScGV*, low dose of *ScGV* and control treatments in 1996, respectively.

Key words : Biological control, *Chilo agamemnon*, Granulosis Virus, *Ostrinia nubilalis*, population density, *Sesamia cretica*.

INTRODUCTION

Maize (*Zea mays*, L.) is a major cereal crop in Egypt both in acreage and yield. Infestations with the three corn borers *Sesamia cretica* Led., (Lep., Noctuidae), *Ostrinia nubilalis* (Hubner), (Lep., Pyralidae), and *Chilo agamemnon* Bles., (Lep., Pyralidae), cause serious economic yield losses by boring both stem and ear. Studies on the use of entomopathogenic baculoviruses for the control of corn borers require comprehensive knowledge of their natural populations. As most of the population studies on corn borers in Egypt were carried out during the 60's and 70's (Ahmed & Kira 1960, Hanna & Atries 1968, Hosny & El-Saadany 1973, Isa & Awadallah 1975, Isa 1979 and Metwally 1979). It seems important to re-investigate the current status of the population fluctuations of the three afore-mentioned corn borers in late 90's in view of new agricultural technology and further practices as well as changed environmental conditions.

The aim of the present study was, therefore, to investigate the current population density of the corn borers and their effect on yield, and also conduct field screening at ecologically different regions to look for any virus(es) infecting *O. nubilalis* larvae. In addition, preliminary field trials to evaluate the efficacy of the recently isolated GV infecting *S. cretica* (*ScGV*) (Fediere *et al.*, 1993) were conducted. The final goal of such investigations was to identify new components for the integrated management of corn borers in maize fields through the promotion of entomoviruses as biocontrol agents.

MATERIAL AND METHODS

Population studies

Field trials were conducted during 1994 and 1995 at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt. All agricultural practices were carried out according to the recommended doses proposed by the Ministry of Agriculture (Anonymous, 1994). In 1994, the experimental area consisted of 2 main blocks of 20 plots each. One block was untreated and the other was treated with chemical insecticide. The 20 plots of each block included 10 plots for larval sampling and 10 plots for yield assessment. Sowing took place on June 26 (late summer planting). In 1995, the experimental design was similar to that of 1994 with the exception that the main blocks consisted of 10 plots; 5 plots for larval sampling and 5 for yield assessment. Sowing took place on April 23 (early summer planting). For both seasons, plot size was 6 x 7 m and consisted of 10 rows (6 meters long and 70 cm. between rows) and the in-row spacing was 30 and 25 cm for 1994 and 1995, respectively. Sampling started 3 weeks after sowing and continued thereafter at 2 week intervals until plant maturing. Sample size was 10 random plants/plot in 1994 (a total of 100 plants/sample) and 20 random plants/plot in 1995 (a total of 100 plants/sample also). Sampled plants were carefully dissected and the corn borer larvae occurring inside were counted. Methomyl (Lannate 90% S.P.) was applied to the insecticide treated plots at a rate of 750 g/h against *S. cretica* and monocrotophos (Nuvacron 40% S.L.) at a rate of 3.75 l/h against both *O. nubilalis* and *C. agamemnon*.

Search for effective virus(es) infecting *O. nubilalis* larvae

O. nubilalis is known to occur at the end of maize growing season especially in areas with mild temperatures and high humidity. Search for effective virus(es) infecting *O. nubilalis* was undertaken during 1996 in Alexandria, Damietta, Kafr El-Sheikh, Dakahlia, Qaluobia and Giza Governorates. For every considered governorate, several late summer maize plantations were inspected for *O. nubilalis* infestation approximately ten weeks after sowing and not less than 500 plants/location were dissected. Existing larvae of *O. nubilalis* of any instar were collected and checked for virus infection by applying the standard viral diagnostic methods for detecting the presence of any viral DNA in them (Fediere *et al.*, 1993).

Evaluation of the efficacy of *Sesamia cretica* Granulosis Virus (*ScGV*)

A stock culture of *S. cretica* larvae collected from the afore-mentioned field experiments was maintained under laboratory conditions and infected with the wild-type granulosis virus isolated from Egypt and described by Fediere *et al* ., (1993). The virus suspension used was a highly purified preparation of *ScGV* at a concentration of 1.0 optical density, OD_{420}/ml (1.0 OD_{420} = 1.48×10^{10} capsule/ml and 1 ml at 1.0 OD_{420} = 0.125 mg capsule/ml (Chang and Tanada, 1978) mixed with distilled water.

The experimental area was selected in Kafr El-Sheikh Governorate and divided into 12 and 16 plots arranged in a complete randomized block design with 3 and 4 treatments and 4 replications in 1995 and 1996, respectively. In 1995, treatments were: control, methomyl, and standard dose of *ScGV* (1D). In 1996, they were control, methomyl, half and double standard doses (*ScGV*, 1/2D and 2D). Each plot consisted of 18 rows 6 m. long and 70 cm. wide (2 central rows for yield, 6 rows on each side for sampling, and 2 border rows on each side).Twenty plants per plot were sampled every week starting from the 1st day of application until the population of *S. cretica* decreased markedly. Sampled plants were dissected and the collected larvae were recorded.

Yield assessment

At harvest, ears from the plants of the yield rows from each plot were collected, counted, shelled and for each instar. Mean numbers of plants and ears, as well as mean weights of ears and seeds/plot were calculated. Yield data was presented as kg/ha and percentage of yield increase for each treatment.

RESULTS

Population density

The population density of the larvae of *S. cretica, O. nubilalis,* and *C. agamemnon* at Kafr El-Sheikh Governorate during 1994 and 1995 seasons is presented in Fig. 1. The larval population density of the three species changed noticeably according to sowing date and insecticidal treatment.

- *S. cretica* :

For 1994 late summer planting, larvae occurred on non-protected plants as of the first sampling date and larval population increased from one sample to another with a peak of 46 larvae/100 plants by late September. This peak was followed by a general decrease of larval count. In insecticide-treated plots, infestation was firstly recorded by late September and reached a maximum of 21 larvae/100 plants by the 2nd week of October, then decreased progressively (Fig. 1A).

In the early summer planting of 1995, infestation level was 20 larvae/100 plants by mid-May and increased to a peak of 210 larvae/100 plants in June, then decreased progressively until early August. In treated plots, the same trend of infestation occurred but the yield was considerably less (Fig. 1B).

Table 1: Mean number of maize plants, ears, yield in kg/ha and percentage yield increase assessed in treated and untreated plots at Kafr El-Sheikh region (1994-1996 seasons).

Season and planting	Treatment	Mean no. of plants	Mean no. of ears	Mean weight of ears Kg/ha	Mean weight of seeds Kg/ha	% water content of seeds	Corrected yield at 15% water content	% yield increase
1994	Insecticide-treated	36430 a*	36000 a	10312 a	8196 a	17.55	7949.2	24.54
late	untreated	39430 a	39000 a	8283 b	6531 b	16.93	6382.7	--
1995	Insecticide-treated	52710 a	52310 a	8505 a	6993 a	16.12	6900.9	57.17
early	*ScGV*(1D) @	47140 b	42900 b	6610 b	5581 b	16.10	5508.8	25.47
	untreated	42120 c	34430 c	5455 c	4426 c	15.68	4390.6	--
1996	Insecticide-treated	44760 a	47760 a	7698 a	6578 a	17.93	6351.3	86.78
early	*ScGV*(2D)	37000 b	39710 b	5300 b	4457 b	16.82	4361.6	28.27
	ScGV(1/2D)	34810 b	35710 c	4795 c	4086 c	15.65	4054.8	19.24
	untreated	29000 c	27240 d	4162 d	3402 d	15.04	3400.4	--

*** Means within columns for the same season followed by the same letter(s) are not significantly different (L.S.D, $P<0.05$).**

@ 1D : Standard dose (Fediere *et al.*, 1997).

2 D : Double standard dose.

1/2 D: Half standard dose.

- *O. nubilalis:*

In the late summer planting of 1994, infestation by *O.nubilalis* in untreated plots started by late August at a rate of 9 larvae/100 plants. By mid September, the population increased to 196 larvae/100 plants then to a peak of 349 larvae/100 plants by the end of the same month. Larval population density decreased slowly thereafter until the average of 341 and 330 larvae/100 plants were recorded by mid and late October, respectively. Insecticide application reduced the infestation rate to 11 larvae/100 plants reaching a peak of 52 larvae/100 plants by mid October. Larval population decreased slowly until harvest time when a mean of 45 larvae/100 plants was recorded by the end of October (Fig. 1A).

In the early summer planting of 1995, untreated plots had few larvae during the second half of July whereas no larvae were occurred in the insecticide-treated plots (Fig. 1B).

- *C. agamemnon:*

In the late summer planting of 1994, the larval population densities of *C. agamemnon* were noticeably low between late July and mid September then increased to a small peak of 24 larvae/100 plants by late September. A gradual population decline took place thereafter until a minimum of 5 larvae/100 plants was recorded by late October. In insecticide treated plots, infestation was very low and never exceeded 1 larva/100 plants until October (Fig. 1A). The early summer planting of 1995 was absolutely free of any *C. agamemnon* larvae (Fig. 1B).

Effect of infestation on yield

Table (1) shows the yield/ha and the percentage of yield increase due to treatment with insecticides and *ScGV* in 1994, 1995 and 1996 seasons.

For the late summer plantation, there were no significant differences between the treated and untreated plots with respect to the number of plants or number of ears/ ha, while a significant difference occurred in the cases of mean weight of ears and seeds. As a result of such significant difference, the percentage of yield increase due to absence of corn borers was 24.54%.

For the early summer planting (1995 and 1996), differences between the treated and untreated plots were significant for all tested yield parameters. Yield increases of 57.17 and 86.78% in both seasons were obtained due to the chemical control of the corn borers. Such considerable increase in yield loss on the early summer plantation emphasises the fact that the damage caused by *S. cretica* appears to be rather serious and more important than that inflicted with *O. nubilalis.*

Search for effective virus(es) infecting *O. nubilalis* larvae

The numbers of *O. nubilalis* larvae collected during 1996 from Alexandria, Damietta, Kafr El-Sheikh, Dakahlia, Qaluobia and Giza Governorates were 507, 96, 3403, 315, 1572, and 2820, respectively. Unfortunately, viral diagnostic tests on all of these larvae (8713) were negative and none of them showed any symptoms of viral infections.

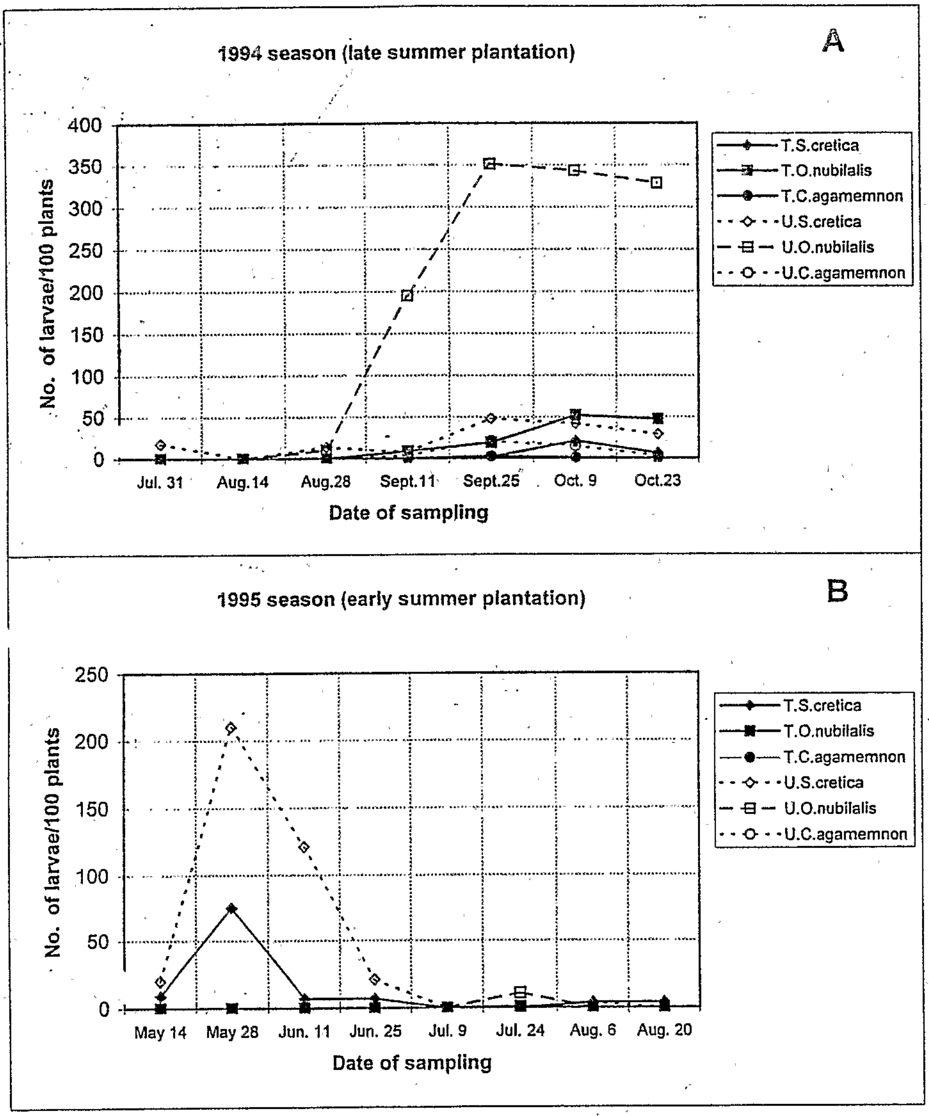

Fig. 1: Population fluctuation of larval count of three corn borers in maize field at Kafr El-Sheikh governorate.

U= Untreated plots
T= Treated plots (Insecticides)

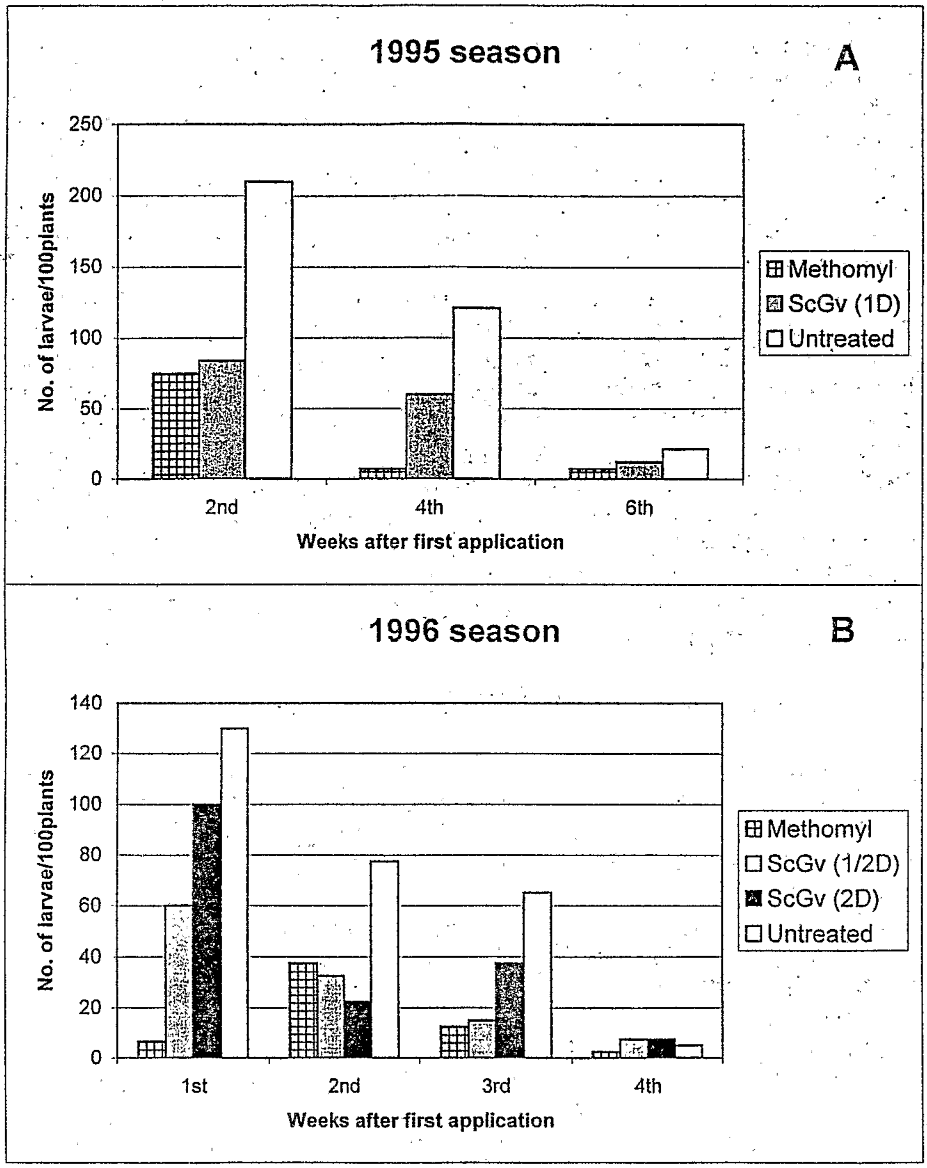

Fig. 2: Numbers of *S. cretica* larvae/100 plants in the different treatments in 1995 and 1996.

1D : Standard dose (Fediere *et al.* 1997)
2D : Double standard dose
1/2D: Half standard dose

Evaluation of the efficacy of *ScGV*

In 1995 experiment, we evaluated a *ScGV* newly isolated from *S. cretica* against the same pest and concluded that *ScGV* noticeably reduced the population of this pest (Fig 2A). As an extension to this work, the 1996 experiment evaluates 2 doses of *ScGV*: half and double the doses previously used in comparison with the recommended chemical insecticide (Methomyl 90% SP). Data in Fig. 2B show that all tested doses reflected reduction of larval population almost similar to that induced by the chemical insecticide. Viral effect was delayed but became quite evident 2 weeks after application. Delay of appearance of viral effect of *ScGV* may have been due to the one week incubation period required for the Granulosis Virus to become capable of inducing evident infection.

As seen in Table 1 and Fig. 1, infestation with *S. cretica* on early summer plantations influenced plant stand in the field. The mean number of plants/ha in 1995 was 42120 in untreated plots compared to 47140 in *ScGV* treated plots. Such mean was 29000 in untreated plots compared to 34810 and 37000 in *ScGV* tested doses and 44760 in insecticide treated plots in 1996. Similarly, the respective number of ears/ha were 34430 and 42900 in 1995 and 27240, 35710, 39710 and 47760 in 1996 for the aforementioned treatments. *S. cretica* infestation affected the weight of both ears and seeds. Corrected yield in kg/ha in 1995 was 4391, 5509, and 6901 in untreated, *ScGV*, insecticide treated plots, respectively and it was 6351 for insecticide treated plots, 4362 for double dose of *ScGV*, 4055 for 1/2 dose of *ScGV* plots and 3400 for untreated plots.

DISCUSSION

Data in Fig. 1 show that the larval population densities of the three considered corn borers varied according to insecticide treatment, insect species, and sowing date. In spite of the fact that previous studies (Ahmed & Kira 1960, Hosny & El-Saadany 1973, Isa & Awadallah 1975, Isa 1979 and Metwally 1979) stated the economic importance of these borers in maize fields it seems that their current situation is quite different from what it was during the 60's to 80's. The characteristic features of the current situation appear to be as follows.

- *S. cretica:*

S. cretica populations are getting higher than the other borers and tend to be the most economically important of them as it attacks maize plants during the early stage of their growth and often causes dead hearts to infested plants (zero yield) on the early summer plantation.

- *O. nubilalis*

O. nubilalis is still relatively economically important and shows high larval populations on the late summer planting. Fortunately, however, these plantations are limited now as the agricultural package recommended for maize growers advises early summer planting thus minimizing the damage caused by this species.

- *C. agamemnon*

C. agamemnon is gradually reduced in population density each year and the insect is no longer an important pest on maize.

Application of recommended insecticides against the three corn borers gave a remarkable reduction of their population (Ahmed & Kira, 1960 and Ismail, 1968). Difference in plant stand and numbers of ears may be attributed to the fact that, in most cases, *S. cretica* larvae kill the plants at the early stage of growth (Semeada, 1988).

Results revealed no marked differences in the number of *S. cretica* larvae in insecticides or *ScGV* treated plots. This observation is in line with the findings of Caballero *et al.* (1991) against *Agrotis segetum* in maize, Glen and Payne (1984) and Jaques *et al.* (1994) against *Cydia pomonella* in orchards. In spite of similarity in larval population, seed yield was comparatively higher in the insecticide treated plots possibly because chemical insecticides are general poisons that combat several other pests, whereas *ScGV* is a highly specific biocontrol agent that acts on *S. cretica* larvae alone.

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الوضع الحالى لثاقبات الذرة فى حقول الذرة الشامية والاستفادة من فيروس الجيرانيولوسيز ScGV كأحد عناصر المكافحة البيولوجية

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درست كثافة تعداد اليرقات لكل من ثاقبات الذرة الثلاثة؛ دودة القصب الكبيرة، ودودة القصب الصغيرة، ودودة الذرة الأوربية خلال موسمي ١٩٩٤، و١٩٩٥ فى محافظة كفر الشيخ. وقد بينت الدراسة اختلاف التعداد تبعًا للمعاملة بالمبيد والنوع الحشرى المدروس وميعاد الزراعة. كان تعداد يرقات دودة القصب الكبيرة فى العروة الصيفية المبكرة أعلى من تعداد بقية الأنواع، بينما ساد تعداد يرقات دودة الذرة الأوربية فى العروة الصيفية المتأخرة.

وقد سبب استخدام المبيدات الموصى بها لمكافحة الحشرات انخفاضا واضحا فى تعداد اليرقات وبالتالى زيادة محصول الحبوب فى القطع المعاملة بالمقارنة بالقطع غير المعاملة.

كما لم تظهر فروق واضحة بين أعداد يرقات دودة القصب الكبيرة فى القطع المعاملة بالمبيد والقطع المعاملة بالفيروس. وكان محصول الحبوب ٦٩٠١، و٥٥٠٩، و٤٣٩١ كجم/هكتار فى القطع المعاملة بالمبيد، والقطع المعاملة بالفيروس، وقطع المقارنة على التوالى فى موسم ١٩٩٥. بينما كان ٦٣٥١، و٤٣٦٢، و٤٠٥٥، و٣٤٠٠ كجم/هكتار عند المعاملة بالمبيد، والجرعة العالية من الفيروس، والجرعة المنخفضة منه، والمقارنة على التوالى فى موسم ١٩٩٦.

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