EFFICACY OF A NONSTEROIDAL ECDYSONE AGONIST, CERTAIN CONVENTIONAL INSECTICIDES AND ONE BIOCIDE FOR CONTROLLING THE TWO CORN BORERS, *SESAMIA CRETICA* (LED.) AND *OSTRINIA NUBILALIS* (HÜB.)

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INTRODUCTION

Maize is an important economic crop which is subjected to attack by many insects such as the two corn borers *Sesamia cretica* Led. and *Ostrinia nubilalis* (Hüb.) (Abd El-Gawad *et al.*, 2002). These two pest species are regarded among the major factors affecting the productivity of growing maize plants and causing great damage and yield loss. Corn ears may cause damage by caterpillar infestation that begins before or during the silk stage. *O. nubilalis* may begin development in the whorl or tassel, or larval may hatch during silking and move directly into ears from oviposition site on flag leaves to the ear or on silk. Larvae enter ears through the silk channel, or by tunneling through the husk from the side or base (Ferro and Weber, 1988; Adams and Clark, 1995). Alternative to insecticidal control of *O. nubilalis* are being used with varying degrees of success, chemical control still plays a key role in managing this pest (Rinkleff *et al.*, 1995). Foliar applications with *Bacillus thuringiensis* Berliner subsp. *Kurstaki* can reduce European corn borer damage compared with untreated corn (Linduska, 1990; Hutchinson and Bartels, 1991; Hutchinson *et al.*, 1992; Bartels and Hutchinson, 1993, 1995 and Bartels *et al.*, 1995). Hazzard *et al.* (1997) found, nearly, equivalent levels of European corn borer control using *B. thuringiensis* products compared with conventional insecticides. Insect growth regulators (IGRs) are biorational insecticides with novel modes of action, being less harmful to non target organisms than other conventional insecticides (Croft 1990). Methoxyfenozide is a compound bind to ecdysteroid receptors and induces larvae to inter a premature and lethal molting cycle (Wing *et al.*, 1988; Hsu 1991).

So the present study was conducted to compare the efficacy of methoxyfenozide (IGR) with certain conventional pesticides (Methomyl and Pirimiphos methyl) and *B. thuringiensis* (Biocide) for controlling the two corn borers *S. cretica* and *O. nubilalis*, in addition to assess the effect of tested agents on corn grain yield.

MATERIALS AND METHODS

Two experiments were conducted at Mansoura University Experimental Station, Dakahlia Governorate during early and late summer seasons 2005. Each was cultivated with Single hybrid (S.C.224) maize variety on April 16, for the early season and on June 15, for late season plantation. Five treatments were used including four different groups of insecticides:

1- Pirimiphos methyl (Actellic® 50% E.C), as an organophosphate, at the rate of 1000 ml / feddan (1feddan = 4200m^2).

2- Methomyl (Lannate® 90% SP), as a carbamate, at the rate of 300 gm/ feddan.

3- Methoxyfenozide (Runner® 24%SC), as insect growth regulator, at the rate of 200 ml / feddan.

4- *Bacillus thuringiensis* Berliner (Agerin® 6.5 % WP Contain 32000 IU/mg) as biocide, at the rate of 250 gm / feddan.

5- The control (check).

Maize fields were subjected to normal agricultural practices such as planting, thinning, irrigation and hoeing. A randomized complete block design with 5 treatments and 3 replicates (42m^2/plot) was used for each experiment. A knapsack sprayer provided with one nozzle (delivering 200 liters water/fed.) has proved to be sufficient to give good coverage on the tested maize plants. The tested insecticides were applied with recommended concentrates at two times; 15 days after sowing to control *S. cretica* and the second after 45 days from planting to control *O. nubilalis* . The stem borer *S. cretica* infestation was recorded in 30 randomly selected plants from the inner rows of each plot at 24h. before the first spray and post treatment intervals of 3 days and 1,2 ,3 ,4 weeks (Ahmed *et al.*, 2002) . Degree of the leaf eating and dead heart due to the infestation with *S. cretica*, were rated as follows : 0 = no feeding sign 1 = slight leaf eating ; 2 = medium leaf eating ; 3 = high leaf eating ; 4 = fully damaged leaves and 5 = dead heart . Percent of reduction in infestation was estimated using Henderson and Tilton, (1955) equation to determine the effect of the tested insecticides.

At harvest time (August10 and October, 13 for early and late season plantation respectively), thirty ears were picked at random from each treatment (10 ears/plot). Each ear was husked, inspected for presence of *O. nubilalis* larvae and rated for feeding damage as follows: 0 = no damage; 1= damage to silks only; 2 = damage to unfilled tip only; 3 = damage to kernels < 3.8 cm from tip and 4 =

damage to kernels > 3.8 cm from tip (Hazzard *et al.*, 2003). The mean level of infestation of ears were calculated and subjected to statistical analysis by ANOVA (Costat, 1990).

To calculate the grain yield, all ears (infested and uninfested) from one randomly selected row/plot were separately, collected, dried and shelled. The grain yield was exposed to sun shine for two months to remove moisture content (Metwally and Barakat, 2003). The grain yield was weighed and subjected to statistical analysis by ANOVA (Costat, 1990).

RESULTS AND DISCUSSION

The results presented in Tables (1&2) revealed that all treatments reduced the infestation of *S. cretica* in both seasons. Concerning the early season Tables (1) the initial effect (three days after spraying), Methomyl and Pirimiphos methyl exhibited the higher effect showing 51.61 and 49.31% reductions in the infestation level then control, respectively. The other insecticides may be arranged descendingly as; *B. thuringiensis* (35.48%) and Methoxyfenozide (31.32%). On the other hand , 4 weeks after spraying Methoxyfenozide treatment showed the highest reduction (76.58%) in *S. cretica* infestation than control, followed, descendingly, by Methomyl (72.00%), *B. thuringiensis* (60,00%) and Pirimiphos methyl (46.57%).

During the late summer season, Methomyl also had the highest initial efficacy against *S. cretica* (74.74%) reduction in infestation level than control, followed by *B. thuringiensis* (53.85%), Pirimiphos methyl (45.46%) and Methoxyfenozide(28.00%) . Meanwhile 4 weeks after treatment, Methoxyfenozide, *B. thuringiensis* and Methomyl treatments led, nearly, to the same reduction percentage (56.00 %) in damage than control, compared with 18.62% reduction recorded from Pirimiphos methyl treatment (Table 2).

Results in Table (3) showed that all treatments reduced *O. nubilalis* damage compared with untreated plots in early and late summer seasons. Concerning the early season, Methoxyfenozide gave the best effect (80.00% reduction) followed by *B. thuringiensis* (36.50%). On the other hand, no difference was observed between Methomyl and Pirimiphos methyl, both caused the same level of reduction (23.50%). In the late summer season, a similar trend was detected. Methoxyfenozide recorded the highest efficacy of reduction (76.15%), followed by *B. thuringiensis* (71.56%), Methomyl (48.17%) and Pirimiphos methyl (45.47%).

TABLE (II)

Initial and latent effect of tested insecticides against *Sesamia cretica* infesting maize during early season 2005.

Treatment	Degree of infestation 24h.before treatment	Initial effect after 3 days of treatment		Effect after treatment (week)								%R residual Mean	%R General mean
				1		2		3		4			
		I	%R	I	%R	I	%R	I	%R	I	%R		
Pirimiphos methyl	21	15	49.31	27	38.51	42	38.03	45	49.31	51	46.57	43.10	44.34
Methomyl	22	15	51.61	16	65.22	21	70.42	23	75.27	28	72.00	70.73	66.90
Methoxyfenozide	31	30	31.32	19	70.69	21	79.01	26	80.16	33	76.58	76.61	67.55
B. thuringiensis	22	20	35.48	18	60.87	30	57.75	31	66.66	40	60.00	61.32	56.15
Control	22	31		46		71		93		100			

TABLE (II)

Initial and latent effect of tested insecticides against *Sesamia cretica* infesting maize during late season 2005.

Treatment	Degree of infestation 24h.before treatment	Initial effect after 3 days of treatment		Effect after treatment (week)								%R residual Mean	%R General mean
				1		2		3		4			
		I	%R	I	%R	I	%R	I	%R	I	%R		
Pirimiphos methyl	22	15	45.46	22	38.46	31	24.85	39	21.21	47	18.62	25.78	29.72
Methomyl	19	6	74.74	9	70.85	13	63.51	17	60.23	22	55.89	62.62	65.04
Methoxyfenozide	20	18	28.00	8	75.39	11	70.67	17	62.22	23	56.19	66.12	58.49
B. thuringiensis	26	15	53.85	13	69.23	22	45.87	25	57.27	30	56.04	59.35	58.25
Control	24	30		39		45		54		63			

I= Degree of infestation in 30 plants. %R=Percent of Reduction

TABLE (III)

Mean of damage to maize ears by *Ostrinia nubilalis* in different treatments during 2005 early and late summer seasons

Treatment	Early season		Late season		Mean of reduction
	General mean of ears infestation	% Reduction	General mean of ears infestation	% Reduction	
Pirimiphos methyl	1.53 b	23.50	1.18 b	45.87	34.69
Methomyl	1.53 b	23.50	1.13 c	48.17	35.84
Methoxyfenozide	0.40 d	80.00	0.52 e	76.15	78.08
B. thuringiensis	1.27 c	36.50	0.62 d	71.56	54.03
Control	2.00 a		2.18 a		

* Means followed by the same letter are not significantly different.

Data presented in Table (4) showed that all tested treatments increased the grain yield of maize in the early and the late plantations. In the early season, Methoxyfenozide treatment gave the highest grain yield (14.76 ardab / feddan ; 1 ardab = 180 kg of maize grain yield) indicating an increase of 77.62% than control , followed by Methomyl and *B. thuringiensis* which occupied the second and third rank (12.88 and 11.76 ardab / feddan ; *i.e.*, 54.48 and 41.51% increases in grain yield, respectively . Meanwhile, Pirimiphos methyl treatment resulted the lowest grain yield (10.43 ardab/feddan) showing 25.51% increase than control . Concerning the late season, the obtained grain yield weights from Methomyl , *B. thuringiensis* and Methoxyfenozid (12.37, 12.37 and 12.02 ardab/feddan, respectively) were insignificantly different and showed 105.82, 105.82 and 100.00% increase than control, respectively. Pirimiphos methyl treatment, also resulted the lowest grain yield (7.07 ardab / feddan; 17.64% increase).

This study provides new comparative information about the effect of the nonsteroidal ecdysone agonist, Methoxyfenozide, compared with two conventional insecticides and a biocide compound to control the corn borers, *S. cretica* and *O. nubilalis*.

The present results confirm and extend previous reports which showed that, IGR and biocide were more effective than conventional insecticides. Wing *et al.* (1988) reported that, RH-5849 (Methoxyfenozide) is the prototype of nunsteroidal ecdysone agonists (diacylhydrazines) that have potential for the control of lepidopterous pests. Georghiou and Legunes (1991) stated that *B. thuringiensis* is the ideal means for controlling lepidopterous pests in agriculture. Trisyono and Chippendale, (1997) reported that Methoxyfenozide have potential for controlling *O. nubilalis*. They added that the relative toxicity of Methoxyfenozide compared

with Carbaryl varies depending on the time of assessment and appears to be related to differences in there mode of action. Smagghe and Degheele, (1992) found that , the fourth instar larvae of *O. nubilalis* treated with Methoxyfenozide ceased feeding, 8h after ingestion indicating that larvae had prematurely entered a molting cycle. This effect is important for the control potential of Methoxyfenozide because larval feeding damage to maize would be limited, feeding cessation and malformation of the mouth parts may cause starvation, which eventually leads to death. Muresan *et al.* (2001) assessed the efficacy of chemical and biological products (*B. thuringiensis*) for the diminution of European corn borer. They found that, the efficacy of chemical control ranged from 25 to 71%, while in the biological products it ranged between 45 to 75%. Metwally (2003) found that *B. thuringiensis* treatment led to reduction in *O. nubilalis* infestation by 16.3 and 59.2% and he added that, using *B. thuringiensis* products as microbial insecticides is much effective and safe.

TABLE (IV)

Mean weights of maize grain yield (ardab/feddan) gained from the different treatments in early and late summer season 2005.

Treatment	early season		late season		General means of grain yield (ardab/feddan)
	grain yield (ardab/feddan)	% increase	grain yield (ardab/feddan)	% increase	
Pirimiphos methyl	10.43 d	25.51	7.07 b	17.64	8.75
Methomyl	12.88 b	54.48	12.37 a	105.82	12.63
Methoxyfenozide	14.76 a	77.62	12.02 a	100.00	13.39
B. thuringiensis	11.76 c	41.51	12.37 a	105.82	12.07
Control	8.31 e		6.01 c		7.16

* Ardab=180 kg of maize grain yield

** Means followed by the same letter are not significantly different.

Many researchers have attempted to quantify the relationship between infestation level and corn yield reduction. Guthrie *et al.* (1975) evaluated 11.4 to 34.8% grain yield reduction for some maize single crosses corresponding to different levels of larval survival. In Egypt, Ismail *et al.* (1974) found negative relationship between maize yield and percentages of infestation with *O. nubilalis* . Semeada (1998) attributed the 13-18% reduction in yield of maize to *O. nubilalis* infestation. Also, Sherif and Lutfallah (1991) sated that yield reduction ranged between 15.7 to 73.3% for different infestation rates by *O. nubilalis* in maize ears. In Germany, the yield losses due to *O. nubilalis* in tested cross hybrids amounted to 40% (Kreps *et al.*, 1998). Bohn *et al.*(1999) found that *O. nubilalis* infestation reduced average maize grain yield by 0.28% for each 1% of damaged plants and by

6.05% for each *O. nubilalis* larva per plant . Also, Szoke *et al.* (2002) found that losses caused by *O. nubilalis* ranged between 250-1000 kg/ha depending on the degree of infestation, year and yield averages. Metwally and Barakat (2003) cited that the yield losses caused by *O. nubilalis* larvae depended mainly on larval survival, extent of activity, timing of tunneling and their within plant distribution. Sabra *et al.* (2005) found that, the actual losses of grain yield caused by *O. nubilalis* were 0.38 and 0.31 kg/100 plants.

Muresan *et al.* (2000) found that, using the biological products and chitin inhibitors to control *O. nubilalis* caused increase in the yield of maize by up to 10.2%. Brown (1994) cited that Methoxyfenozide has low toxicity to non-target insects. So, applying Methoxyfenozide may be recommended to control the two corn borers *S. cretica* and *O. nubilalis*.

SUMMARY

The objective of the present work was to compare the efficacy of one of the nonsteroidal ecdysone agonist, Methoxyfenozide with two conventional insecticides (Pirimiphos methyl as organophosphorus insecticide and Methomyl as carbamate insecticide) and *Bacillus thuringiensis* as biocide compound (Agerin) to control the two corn borers *Sesamia cretica* Led. and *Ostrinia nubilalis* (Hub.) infesting maize plants. Field experiments were conducted at Mansoura during 2005 early and late summer seasons. The insecticides were applied 15 days after sowing to control *S. cretica* and when reached 45 days old to control *O. nubilalis*. The results obtained revealed that all treatments significantly reduced the infestation of *S. cretica* in early season plantation. Highest reduction in damage caused by *S. cretica* after 4 weeks post treatments recording (76.58%) resulted from Methoxyfenozide treatment followed by Methomyl (72.00%), *B. thuringiensis* (60,00%) and Pirimiphos methyl (46.57%). Meanwhile, in the late summer season Methoxyfenozide also recorded the highest reduction of *S. cretica* damage (56.19%) after 4 weeks from sowing followed *B. thuringiensis* (56.04%) and Methomyl (55.89%). All treatments significantly reduced damage caused by *O. nubilalis* compared with untreated plots in both early and late summer seasons. Results showed that Methoxyfenozide gave the best effect followed by *B. thuringiensis*, on the other hand no significant differences were detected between Methomyl and Pirimiphos methyl which gave, nearly, the same values of reduction. Data showed that all tested treatments significantly influenced the maize grain yield in both early and late seasons. So,

applying Methoxyfenozide may be recommended to control the two corn borers *S. cretica* and *O. nubilalis*.

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