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Possibility of Replacing the Conventional Insecticides with Safety Environmental Compounds for Controlling the Two Corn Borers *Sesamia Cretica* Led. And *Ostrinia nubilalis* Hun.

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Abstract: The present research was carried out to study the possibility of replacing the conventional insecticides (Malathion as organophosphorus insecticide and carbaryl as carbamate insecticide) with safety environmental compounds (spinosad as bioinsecticide and chlorfluazuron as IGR compound) to control the two corn borers *Sesamia cretica* Led. and European corn borer *Ostrinia nubilalis* Hun. The results obtained revealed that all treatments were significantly reduced the infestation of *S. cretica*. In the early season carbaryl showed the highest general mean of reduction recording 79.43% reduction in *S. cretica* infestation followed by chlorfluazuron (70.97%), spinosad (60.65%) and malathion (29.41%), while in the late summer season chlorfluazuron recorded the highest general mean of reduction gave 57.15% followed by spinosad and carbaryl they were recorded 50.31 and 45.45%, whereas malathion gave the lowest effect 27.59% reduction. All treatments significantly reduced *O. nubilalis* infestation damage as compared with control in the early and the late summer seasons. The efficiency of the tested insecticides against *O. nubilalis* can be arranged according to the mean of reduction percentage during both seasons in a descending order as follows : Spinosad, chlorfluazuron, carbaryl and malathion they were 73.11, 71.78, 65.32 and 38.03%, respectively. The general mean of change with increase in grain yield of the tested insecticides during both seasons were arranged in a descending order as follows: spinosad, chlorfluazuron, carbaryl and malathion giving 98.94, 84.20, 70.23 and 40.40%, respectively. So it can be replacing malathion and carbaryl as conventional insecticides with spinosad and chlorfluazuron as safety environmental compounds for controlling the two corn borers *S. cretica* Led. and *O. nubilalis* Hun. in pest management strategies.

Key words: Insecticides, spinosad, chlorfluazuron, *Sesamia cretica*, *Ostrinia nubilalis*

INTRODUCTION

The environmental hazards of conventional insecticides are necessitates entrance other new mode of action of insecticides that are effective, safer for human and negligible effects on ecosystem. Maize is the most important economic crops that are subjected to attack by many insects that can cause severe losses to the producer such as the two corn borers *Sesamia cretica* Led. and *Ostrinia nubilalis* Hub (Abd El-Gawad *et al*., 2002; Musser and Shelton, 2003). *O. nubilalis* cause direct losses by boring into plant stems or ears in addition to direct losses by facilitating the infection by microorganisms (Sabra *et al*., 2005). The use of chemical insecticides is still a common practice for combating corn pests in Egypt (Abdel-Aziz, 2003). The benzoylphenyl ureas constitute a class of Insect Growth Regulators (IGRs) that interfere with insect growth and development by inhibiting

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chitin synthesis in insect (Post and Vincent, 1973). Insects treated with Chitin Synthesis Inhibitors (CSIs) become unable to synthesize new cuticle and therefore unable to successfully molt into the next stage (Hoffman and Lorenz, 1998). CSIs such as Chlorfluazuron inhibit the production of chitin, a major component of the insect exoskeleton. IGRs are biorational insecticides with novel modes of action that the less harmful to non target organisms than are conventional insecticides (Croft, 1990). Spinosad is an extract of the fermentation broth of soil actinomycete bacterium, *Saccharopolyspora spinosa* Martz and Yao, containing a naturally occurring mixture of two macrocyclic lactones, spinosyn A and spinosyn D. It shows exceptional activity against Lepidoptera, Thysanoptera, Diptera and Coleoptera, whilst at the same time showing low toxicity to mammals and beneficial insects and nonphytotoxicity (Liu *et al*., 1999; Dutton *et al*., 2003). It is commercially registered on 250 crops in over 50 countries (Subramanyam *et al*., 2004).

So the present study was conducted to study the possibility of replacing malathion (organophosphorus) and carbaryl (carbamate) as conventional insecticides with spinosad (bioinsecticide) and chlorfluazuron (IGRs) as safety environmental compounds for controlling the two corn borers *S. cretica* Led. and *O. nubilalis* Hub. In addition assessment the effect of tested insecticides on corn grain yield.

MATERIALS AND METHODS

Tested Insecticides

- Malathion (Malathion® 57% EC) at the rate of 1000 cm/feddan (1 feddan = 4200 m^2), as organophosphorus insecticide.
- Carbaryl (Sevin® 85% WP) at the rate of 1.5 kg/feddan, as carbamate insecticide.
- Chlorfluazuron (Atabron® 5% EC) at the rate of 400 cm/feddan, as insect growth regulator.
- Spinosad (Tracer ® 24% SC) at the rate of 160 cm/feddan, as bioinsecticide.
- The control (check).

Experimental Design

Experiments were conducted at Mansoura University Experimental Station, Dakahlia Governorate. The field was cultivated with single hybrid maize (SC 224) during the early and the late summer seasons, 2005. Maize was seeded on April 16, 2005 for the early season plantation and on June 15, 2005 for the late season. Maize fields were subjected to normal agriculture practices such as planting, thinning, irrigation and hoeing. A randomized complete block design with 5 treatments and 3 replicates (42 m^2/plot) was used for both experiments. A knapsack sprayer provided with one nozzle delivering (200 L 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; the first when the plants reached 15 days to control *S. cretica* and the second when it becomes 45 days old to control *O. nubilalis*.

Procedures of Evaluating the Treatments

The stem borer *S. cretica* infestation was recorded in 30 randomly selected plants from the inner rows of each plot at 24 h. before first spray and post treatment interval of 3 days and 1, 2, 3, 4 weeks. Degree of the leaf eating and dead heart due to the infestation with *S. cretica*, were estimated as follows 0 = healthy plant ; 1 = slight leaf eating; 2 = medium leaf eating; 3 = high leaf eating; 4 = damage plant and 5 = dead heart. Percent reduction in infestation was estimated using Henderson and Tilton (1955) equation to determine the effect of the tested insecticides.

At harvest time thirty ears were picked at random from each treatment plot. Each ear was husked, inspected for presence of European corn borer *O. nubilalis* 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 means of ears infestation were calculated and subjected to statistical analysis by ANOVA (Costat, 1990).

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

RESULTS

Efficiency of Tested Insecticides Against *Sesamia cretica*

Data in Table 1 showed that the initial and residual effect of tested insecticides against *S. cretica* infestation during the early season. Concerning the initial effect (after three days of spraying), carbaryl was the most effective toxicant giving 68.61% reduction in infestation. The other insecticides arranged descendingly according to their initial effect as follows: Chlorfluazuron (66.13%), spinosad (50.97%) and malathion (29.34%). On the other hand carbaryl showed the longest mean residual effect (during the next four weeks post treatments) recording 90.24% reduction in *S. cretica* infestation. The descending order of the mean of residual effect of the rest toxicant was chlorfluazuron (75.82%), spinosad (70.33%) and malathion (29.48%).

Regarding the effect against *S. cretica* in the late summer season data in Table 2 showed that the Spinosad recorded the highest initial reduction (40.37%) and no differences were showed between carbaryl and chlorfluazuron they were recorded the same value (30.52%), malathion gave the lowest effect (21.98%) reduction. Meanwhile chlorfluazuron was recorded the highest mean residual effect (83.78%) followed by descendingly carbaryl (60.38%), spinosad (60.26%) and malathion (33.19%) reduction.

Efficiency of Tested Insecticides Against *Ostrinia nubilalis*

Results in Table 3 showed that all treatments reduced *O. nubilalis* infestation damage compared with untreated plots in the early and the late summer seasons. Concerning the early season spinosad gave the best effect (76.50% reduction) followed by descendingly chlorfluazuron (66.50%), carbaryl (60.00%) and malathion was recorded the lowest effect in reduction 10.00%. On the other hand in the late summer season chlorfluazuron gave the best effect, it recorded 77.06% in reduction followed by spinosad (69.72%), carbaryl (70.64%) and malathion (66.06%) reduction.

The efficiency of the tested insecticides against *O. nubilalis* can be arranged according to the mean of reduction percentage during both seasons in a descending order as follows: Spinosad, chlorfluazuron, carbaryl and malathion they were 73.11, 71.78, 65.32 and 38.03%, respectively.

Effect of Tested Insecticides on Grain Yield

Data presented in Table 4 showed that all tested insecticides caused increase the grain yield of maize in the early and the late summer seasons. In the early season, Spinosad gave the highest grain yield 15.71 ardab/feddan (1 ardab = 180 kg of maize grain yield) with an increase of 89.05% comparing with control, no differences could be detected between chlorfluazuron and carbaryl they gave nearly the same grain yield 14.16 and 14.05 ardab/feddan, the corresponding increase were 70.40 and 69.07% increase in grain yield as compared with the control. While malathion gave the lowest grain yield 10.13 ardab/feddan with an increase of 21.90% as compared with the control. Concerning the late season, Spinosad gave the highest grain yield 12.55 ardab/feddan with an increase of 108.82%, followed by descendingly Chlorfluazuron 11.90, Carbaryl 10.30 and Malathion 9.55 ardab/feddan with an increase of 98.00, 71.38 and 58.90% as compared with the control, respectively.

The general means of change with an increase in grain yield of the tested insecticides during both seasons were arranged in a descending order as follows: Spinosad, chlorfluazuron, carbaryl and malathion giving 98.94, 84.20, 70.23 and 40.40%, respectively.

Table 1: Initial and residual effect of tested insecticides against *Sesamia cretica* infesting maize during the early season 2005

Treatments	Degree of infestation before 24 h of treatment	Initial effect after 3 days of treatment		Residual effect after treatment (week) 1		2		3		4		Mean of residual effect (%)	General mean of reduction (%)
		I	R (%)	I	R (%)	I	R (%)	I	R (%)	I	R (%)		
Malathion	21	23	29.34	35	24.24	55	26.22	60	39.85	76	27.62	29.48	29.41
Carbaryl	37	18	68.61	11	86.49	11	91.63	14	92.03	17	90.81	90.24	79.43
Chlorfluazuron	40	21	66.13	17	80.68	38	73.24	44	76.84	55	72.50	75.82	70.97
Spinosad	25	19	50.97	14	74.55	26	70.70	36	69.68	42	66.40	70.33	60.65
Control	20	31		44		71		95		100			

I = Degree of infestation in 30 plants, R (%) = Percent of Reduction

Table 2: Initial and residual effect of tested insecticides against *Sesamia cretica* infesting maize during the late season 2005

Treatments	Degree of infestation before 24 h of treatment	Initial effect after 3 days of treatment		Residual effect after treatment (week) 1		2		3		4		Mean of residual effect (%)	General mean of reduction (%)
		I	R (%)	I	R (%)	I	R (%)	I	R (%)	I	R (%)		
Malathion	19	12	21.98	14	35.53	13	24.38	12	21.98	4	50.88	33.19	27.59
Carbaryl	16	9	30.52	9	50.78	7	51.65	6	53.68	1	85.42	60.38	45.45
Chlorfluazuron	16	9	30.52	4	78.13	3	79.28	1	92.28	1	85.42	83.78	57.15
Spinosad	29	14	40.37	14	57.76	12	54.27	11	53.14	3	75.86	60.26	50.31
Control	21	17		24		19		17		9			

I = Degree of infestation in 30 plants, R (%) = Percent of reduction

Table 3: Mean of ears infested damage by *Ostrinia nubilalis* as affected by tested insecticides during the early and the late summer seasons 2005

Treatments	Early season: General mean of ears infestation	Reduction of infestation (%)	Late season: General mean of ears infestation	Reduction of infestation (%)	Mean of reduction during both seasons (%)
Malathion	1.80b	10.00	0.74b	66.06	38.03
Carbaryl	0.80c	60.00	0.64c	70.64	65.32
Chlorfluazuron	0.67d	66.50	0.50d	77.06	71.78
Spinosad	0.47e	76.50	0.66c	69.72	73.11
Control	2.00a		2.18a		

Means followed by the same letters are not significantly different, Reduction of infestation (%)= (Test - Control)/Controlx100

Table 4: Means of grain yield (ardab/feddan) as affected by tested insecticides on the early and the late summer seasons 2005

Treatment	Early season: Grain yield (ardab/feddan)	Change of control (%)	Late season: Grain yield (ardab/feddan)	Change of control (%)	Mean of percentage change in grain yield during both seasons
Malathion	10.13c	21.90	9.55d	58.90	40.40
Carbaryl	14.05b	69.07	10.30c	71.38	70.23
Chlorfluazuron	14.16b	70.40	11.90b	98.00	84.20
Spinosad	15.71a	89.05	12.55a	108.82	98.94
Control	8.31d		6.01e		

Means followed by the same letters are not significantly different, Change of control (%) = (Test - Control)/Control×100 Ardab = 180 kg of grain yield - (1feddan = 4200 m^2).

DISCUSSION

Present results reported successful the spinosad and chlorfluazuron as safety environmental compounds more than the malathion and carbaryl as conventional insecticides for controlling the two corn borers *S. cretica* and *O. nubilalis*. Muresan *et al*. (2001) assessment the efficacy of chemical and biological products for the diminution of European corn borer and found that, the efficacy of chemical control ranged from 25 to 71% and the biological products 45 to 75%. Musser and Shelton (2003) found that Spinosad was able to provide control of *O. nubilalis*. Ahmed *et al*. (2002) studied the field efficacy of some bioinsecticides (spinosad one of them) against jower stem borer *Chilo partellus* (Pyralidae: Lepidoptera) and found that in Spinosad treated plots, the infestation was reduced from

10.72% before spray to 3.05% after seven days of first spray and to 0.74% on the seventh day of second spray, which was done one week after first spray. Ascher *et al.* (1987) found that more than 90% mortality in eggs and larvae of *O. nubilalis* when sprayed infested maize seedlings by 5 insect growth regulators (chlorfluazuron one of them).

Two corn borers *S. cretica* Led. and *O. nubilalis* Hub. which are regarded among the major factors affecting the productively of growing maize plants and causing great damage and yield loss. Corn ears may be damaged by caterpillar infestation that begin before or during silk stage. Many researchers have attempted to quantify the relationship between infestation level and corn yield reduction. Guthrie *et al.* (1975) reported that 11.4 to 34.8% grain yield reduction for some maize single crosses corresponding to different levels of larval survival. Sobek and Mun Kvold (1999) reported that *O. nubilalis* larvae act as vectors of fusarium, causing kernel rot. 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* larvae per plant. Also, Szoke *et al.* (2002) found that, losses caused by *O. nubilalis* ranged 250-1000 kg ha^{-1} depending on the degree of infestation year and yield averages. Metwally and Baracat (2003) cited that, the yield losses caused by *O. nubilalis* larval depended mainly on larval survival, extent of activity, timing of tunneling and their within plant distribution. Sabra *et al.* (2005) found that the act losses of grain yield caused by *O. nubilalis* was 0.38 and 0.31 kg/100 plants. Muresan *et al.* (2000) found that, the biological products and chitin inhibitors significantly reduced the attack frequency and number of *O. nubilalis* larvae and increased the yield of maize by up to 10.2%.

Becerra *et al.* (1999) cited that spinosad this a new pesticide is convenient in order to protect the beneficial entomofauna and to reduce the risk of contamination of human food. Musser and Shelton (2003) found that in field trials, Spinosad is less toxic to the must abundant predators in sweet corn (*Coleomegilla maculata*, *Harmonia axyridis*, *Orius insidiosus*). Subramanyam *et al.* (2003) mentioned that, the activity against a variety of stored product insects, persistence in farm-stored grain and low mammalian toxicity make spinosad a viable alternative to currently registered organophosphate grain protectants, such as malathion, chlorpyrifos-methyl and pirimiphos-methyl. So it is concluded that it can be replacing the conventional organophosphorus insecticides like Malathion and carbamate insecticides like carbaryl with biological products like spinosad and chitin synthesis inhibitors like chlorfluazuron as safety environmental compounds for controlling the two corn borers *S. cretica* and *O. nubilalis* in pest management strategies.

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