EFFECT OF SOME CHEMICAL AND BIOLOGICAL PESTICIDES ON *TRICHOGRAMMA EVANESCENS* WESTWOOD (HYMENOPTERA: TRICHOGRAMMATIDAE) AND ITS HOST *OSTRINIA NUBILALIS* HN. (LEPIDOPTERA: PYRALIDAE)

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INTRODUCTION

In Egypt, maize (*Zea mays* L.) is considered as one of the most important economic crops that is subject to attack by many insect pests. The European corn borer *Ostrinia nubilalis* Hb. (Lepidoptera: Pyralidae) is one of the most important and harmful insect pest attacking maize plants (El-Hussieni; 1980-1981). Larvae of *O. nubilalis* excavate tunnels in stems, tassels and ears, causing a reduction in yield estimated by 33.60% for maize plants grown during late July (Sherif and Lutfallah, 1991-1992).

The egg masses of *O. nubilalis* are naturally parasitized by the egg – parasitoid *Trichogramma evanescens*. This parasitoid plays an important natural role in suppressing its population density. The percentages of natural parasitism increase markedly and steadily during the season and reach their peaks in September and October (Selem, 1984; El-Wekeel, 1997 and Ebaid, 1997 & 2001).

The use of chemical insecticides is now under control and they are only used when necessary; i.e., only at the presence of severe damage caused by insect pests. Many authors reported the potential effects of using many commercial microbial insecticides of *Bacillus thuringiensis* against this pest (Mc Guire *et al.*, 1994; David &

William, 1995 and Ebaid, 2001).In addition, the efficiency of using many commercial Insect Growth Regulators as other possible control alternatives against O. *nubilalis* was studied (Ascher *et al.*, 1989; Burgio *et al.*, 1993 and Trisyono & Chippendale, 1997).

Limited information is available on the relative toxicity of insecticides to insect pests and their natural enemies, and this makes the selection of insecticides suitable for Integrated Pest Management (I.P.M.) difficult (Stevenson & Walters, 1983). Besides, it is of great importance to know the effects of various insecticides on useful insects (Varama and Singh, 1987).

The present study was conducted under laboratory conditions to evaluate the toxic effects of *B. t.* endotoxin (microbial insecticide, MVP_{11}), the Insect Growth Regulator (Cascade) and the chemical insecticide (Dursban) on eggs of *O. nubilalis* (unparasitized or parasitized). The three products were also bioassayed against third instar larvae of *O. nubilalis* and adult parasitoids of *T. evanescens.* This information is needed if *T. evanescens* is used as a biological control agent together with other available chemical control methods in planning I.P.M. programs against *O. nubilalis.*

MATERIAL AND METHODS

Egg masses of *O. nubilalis* were collected from several fields cultivated with maize plants in Qalubia Governorate. Rearing of the pest was carried according to the technique described by Guthrie (1982), and under laboratory conditions of 25± 2°C and 65± 5% R.H.

Adult parasitoids were obtained from field parasitized eggs of *O. nubilalis* which were reared at 25 ± 2 °C and 65 ± 5 % R.H., using the technique described by Abbas *et al.*, (1989).

Tested materials:

1- MVP_{11} 20 % flowable, a bioinsecticide containing 20% delta endotoxin of *Bacillus thuringiensis* var. *Kurstaki* encapsulated in killed *Pseudomonas fluorescens.* Two ml. of the bioinsecticide (20%) were suspended in water to obtain a total constant volume of 200 ml. to give the stock suspension of 2000 p.p.m. Five. Concentrations of 6.3, 12.5, 25, 50 and 100 p.p.m. were prepared by diluting with water 0.31, 0.63, 1.25, 2.50 and 5.00ml. of the stock suspension (2000 p.p.m.), respectively, to obtain a total constant volume of 100 ml. from each concentration

2- Flufenoxuron (Cascade 10% DC), an insect growth regulator. A volume of 2 ml. of Cascade 10 % was diluted in water to obtain constant total volume of 200 ml. to give the stock solution of 1000 p.p.m. Five concentrations of 5, 15, 25, 35 and 45 p.p.m., were prepared by diluting with water 0.50, 1.50, 2.50, 3.50 and 4.50ml. of the stock solution (1000 p.p.m.), respectively, to obtain a total constant volume of 100ml.

3- Chlorpyrifos (Dursban 48% E.C).Two ml. of this chemical insecticide were diluted with water to obtain a total constant volume of 200 ml., giving a stock solution of 4800 p.p.m. Five concentrations of 5, 10, 15, 20 and 25 p.p.m. were prepared by diluting with water 0.10, 0.21, 0.31, 0.42 and 0.52 ml. of the stock solution (4800 p.p.m.) respectively, to obtain a total constant volume of 100 ml.

Insecticidal effects on parasitized and unparasitized *O. nubilalis* eggs

Large number of *O. nubilalis* egg masses (less than 24 hours old) was exposed to adult parasitoids for 24 hours. Groups of 90 eggs, (of thirty eggs in each group), were prepared. Each group was immersed for 10 seconds in each concentration of the three tested compounds. The same number and age of unparasitized *O. nubilalis* eggs were also treated. Eggs of each replicate were placed in a glass test tube (10 × 2.5 cm.) covered with muslin set in position by a rubber band. The treated eggs (parasitized and unparasitized) were left until emergence of either adult parasitoids or pest larvae. Untreated control of both parasitized and unparasitized eggs was conducted by dipped only in water. Replicates were checked daily and the percentages of dead eggs (that failed to give either adult parasitoids or pest larvae) were calculated.

Insecticidal effects on third instar *O. nubilalis* larvae

Stem pieces of maize plants (40 day old) each of about 5 cm. long were dipped for one minute in each concentration of the three tested compounds and then left for about one hour to dry. For each concentration, three replicates each of ten 3rd instar *O. nubilalis* larvae were placed in a 15 × 7.5 cm. cup. Larvae were allowed to feed on the treated food for 48 hours in case of MVP_{II} and for 24 hours in case of Cascade and Dursban. Larvae were starved for 6 hours before their exposure to treated food. Treatments with bioinsecticide MVP_{11} were carried with concentrations of 20, 40, 80, 160, 320 and 640 p.p.m. In treatments with the Insect Growth Regulator Cascade, concentrations of 40, 80, 120, 160, 200 and 240 p.p.m., were used. Treatment with Dursban was done with 10, 20, 30, 40, 50 and 60 p.p.m. concentration.

Mortality percentages among *O. nubilalis* larvae were daily recorded. Survived larvae after treatments were transferred to other cups containing untreated

food until pupation and adult emergence. Test of the untreated control were conducted using the same source of food, but dipped only in water.

Insecticidal effects on adult parasitoids of *T. evanescens*

Three replicates, each of 50 newly emerged adult parasitoids kept in glass tubes (7.5 x 2cm.), were used for each concentration of the three tested compounds.

Ten droplets of 12% sugar solution containing the desired concentration were offered to adult parasitoids on *Nerium oleander* leaves by using a fine pin. Parasitoids of the untreated control were offered *N. oleander* leaves with droplets of sugar solution only. Mortality percentages among adult parasitoids were recorded daily. Concentrations of 20, 40, 80, 160 and 320 p.p.m. bioinsecticide MVP_{II} were tested. While the tested concentrations of the Insect Growth Regulator Cascade were 10, 20, 30, 40 and 50 p.p.m. Treatment with the chemical insecticide Dursban was tested with concentrations of 5, 10, 15, 20 and 25 p.p.m.

All experiments were carried under laboratory conditions of 25 ± 2°C and 65±5% R.H.

Statistical analysis

The obtained data were corrected according to the formula given by Abbott (1925). The effectiveness of different treatments were expressed in terms of LC_{50} and LT_{50} values at 95 fiducially limit. If the mortality percentages ranged between 16 to 84 %, the values of LC_{50} or LT_{50} were estimated. Slopes of regression lines were represented. Statistical analyses of the obtained data were based on the analysis of variance and linear regression analysis (Finney, 1971 and slide write program). In addition, polynomial regression procedure in COSTAT program was down.

RESULTS AND DISCUSSION

Insecticidal effects on parasitized and unparasitized *O. nubilalis* eggs
Treatment with the bioinsecticide MVP_{II}:

The corrected mortality percentages after 2 days for parasitized *O.nubilalis* eggs treated with MVP_{II} were 3.33, 10.00, 16.67, 23.33 and 33.33 %; while, those of unparasitized eggs were 6.67, 13.33, 20.00, 26.67 and 36.67 % for the concentrations of 6.3, 12.5, 25, 50 and 100 p.p.m., respectively (Table, 1). Despite of using high concentrations of the tested bioinsecticide on *O. nubilalis* eggs either parasitized or unparasitized, the obtained mortality percentages for both were not equivalent to these

concentrations. Mortality which occurred to the treated eggs (parasitized and unparasitized) may be due to the effect of delta endotoxin of *B. thuringiensis* or to additive materials used in the commercial bioinsecticide MVP_{II}. Ali and Watson (1982) stated that, the biomicrobial insecticide Dipel had no effect on eclosion when applied directly to eggs of the tobacco budworm *Heliothis viresecens.* Salama (1985) indicated that, the egg masses of the cotton leafworm S*podoptera littoralis* sprayed with Dipel hatched normally. Also, Abd El – Hafez *et al.*, (1994) revealed that, the bioinsecticide Delfin had no significant effect on the viability of treated eggs of the pink bollworm *Pectinophora gossypiella*, where normal hatch occurred at all concentrations used (that ranged from 0.63 to 10.00 mg./ml. of the tested bioinsecticide).

Treatment with the Insect Growth Regulator Cascade:

After 2 days of treatment, mortality percentages ranged from 16.67 to 76.67 % for the parasitized eggs. While in case of unparasitized ones, they ranged from 23.33 to 83.33 % by using the concentrations ranging from 5 to 45 p.p.m., respectively. However, as shown in Table (4) and Fig. (1), the LC_{50} values after 48 hours from treatment were 23.37 and 17.92 p.p.m., for parasitized and unparasitized eggs , respectively. Data presented in Table (1) revealed that, the mortality percentages increased by increasing the tested concentrations of Cascade. Results confirm those of Radwan *et al.*, (1984-1985) who used the two Insect Growth Regulators Diflubenzuron and Trifluron (BAY SIR-8514) against the unparasitized egg masses of *S. littoralis.* Also, Trisyono and Chippendale (1997) studied the effects of two Insect Growth Regulators Methoxy fenozide and Tebufenzoide against eggs of *O. nubilalis.* More than 90% of eggs died when egg masses were dipped in a solution of 100 p.p.m. of any of the two tested Insect Growth Regulators in acetone distilled water (1:1). Although some eggs that were treated with 10 p.p.m. hatched and the survival rate was low.

Treatment with the chemical insecticide Dursban:

After 2 days of treatment, the mortality percentages among parasitized *O. nubilalis* eggs treated with Dursban were 33.33, 53.33, 66.67, 76.67 and 86.67 %. The opposed values of unparasitized eggs were 36.67, 56.67, 73.33, 83.33 and 90.00% at concentrations of 5, 10, 15, 20 and 25 p.p.m., respectively (Table, 1). The LC_{50} values after 2 days from treatment for parasitized and unparasitized *O. nubilalis* eggs were 9.05 and 7.97 p.p.m., respectively (Table, 4 and Fig., 1). Results agreed with findings of Abd –El Hafez *et al.* (1996) who found that, treatments with the insecticides: Sumi-alpha, Meothrin, Fenom, Ripcord, Polytrin, Delfos, Bulldok, Bestox, Cyanox, Dursban,

Sevin and Larvin, led to significantly lower emergence of *T. evanescens* and *Trichogrammatoidea bacterae* adult parasitoids from treated parasitized eggs of *P. gossypiella,* where Dursban, Ripcord and Delfos completely inhibited emergence of parasitoids.

By comparing the effects of the three tested compounds MVP_{II}, Cascade and Dursban on the mortality percentages at concentration of 25 p.p.m. on parasitized and unparasitized *O. nubilalis* eggs, the recorded values were 16.67, 50.00 and 86.67 % for parasitized eggs. For unparasitized eggs they were 20.00, 56.67 and 90.00 %, respectively. These results indicated that MVP_{II} had the lowest toxic effect on the emergence of adult parasitoids. Dursban was the most toxic compound, while Cascade treatment showed moderate efficacy on the adult emergence compared with the other two compounds.

Insecticidal effects on third instar larvae of *O. nubilalis*

Treatment with the bioinsecticide MVP_{11}:

After 3 days from treatment, the mortality percentages ranged from 30.00 to 83.33 % by using concentrations ranging from 20 to 640 p.p.m., respectively. Data presented in Table (2) revealed that, the mortality percentages increased by increasing the tested concentrations of the bioinsecticide MVP_{II}. However, as shown in Table (4) and Fig. (2), the LC_{50} value was 69.50 p.p.m. While the LT_{50} values were 4.23, 2.83, 1.74 and 0.97 days at concentrations of 40, 80, 160 and 320 p.p.m., respectively (Table, 5 and Fig., 3). These values indicated a negative relationship between applied concentrations of MVP_{II} and LT_{50} values.

Results agreed with findings of El-Hussieni (1980-1981) on *O. nubilalis* larvae treated with the two bioinsecticides 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; Ebaid (2001) on larvae of *O. nubilalis* by studying the effect of Delfin bioinsecticide and El- Khawas (2001) when he used Agerin against *A. ipsilon.*

TABLE (I)

Corrected mortality percentages for unparasitized and parasitized *O. nubilalis* eggs treated with MVP_{II}, Cascade and Dursban after 2 days of treatments.

Treatments	Concentrations p.p.m.	% cumulative mortality after 2 days of treatments	
		Parasitized *O. nubilalis* eggs	Unparasitized *O. nubilalis* eggs
Bioinsecticide (MVP_{II})	0.0	3.33	3.33
	6.3	3.33	6.67
	12.5	10.00	13.33
	25	16.67	20.00
	50	23.33	26.67
	100	33.33	36.67
Insect Growth Regulator (Cascade)	0.0	3.33	3.33
	5	16.67	23.33
	15	33.33	40.00
	25	50.00	56.67
	35	63.33	70.00
	45	76.67	83.33
Chemical insecticide (Dursban)	0.0	3.33	3.33
	5	33.33	36.67
	10	53.33	56.67
	15	66.67	73.33
	20	76.67	83.33
	25	86.67	90.00

Treatment with the Insect Growth Regulator Cascade:

After 24 hours of treatment, the corrected mortality percentages were 20.00, 33.33, 46.67, 56.67, 66.67 and 73.33 % at concentrations of 40, 80, 120, 160, 200 and 240 p.p.m., respectively (Table, 2). The LC_{50} value was 123.72 p.p.m. (Table, 4 and Fig., 2).

LT_{50} values (Table, 5 and Fig., 4) indicated a negative relationship between the applied concentrations of Cascade and LT_{50} values. These values were 3.9, 2.5 and 1.48 days at concentrations of 40, 80 and 120 p.p.m., respectively. The same results were recorded by Ebaid (2001), when carrying out laboratory studies to evaluate the effect of Consult on larvae of *S. cretica*; El-Khawas (2001) when evaluating the effect

of Consult on *A. ipsilon* larvae and Mansour (2001) who estimated the effect of Mimic on *S. littoralis* larvae.

Treatment with the chemical insecticide Dursban

Mortality values among larvae of *O. nubilalis* treated with the chemical insecticide Dursban with different concentrations are presented in Table (2). The corrected mortality percentages after 24 hours of treatment ranged from 20.00 to 86.67 % at concentrations ranged from 10 to 60 p.p.m. Therefore, increasing the chemical insecticide concentration was followed by an increase in mortality percentages of *O. nubilalis* larvae. Zidan *et al.*, (1998) found the same results, when 4th instar larvae of *A. ipsilon* were exposed to four chemical insecticides (Cyanophos, Fenvalerate, Premept and Pyriproxyfen). Also, El- Khawas (2001) recorded the same findings for the chemical insecticide Marchal against *A. ipsilon.*

The LC_{50} value obtained was 26.02 p.p.m. after 24 hours from treatment (Table, 4 and Fig., 2). Obtained results agreed with those of El- Khawas (2001), when he tested the chemical insecticide Marchal on larvae of *A. ipsilon and* also by results previously found by Mansour (2001) when testing the chemical insecticide Cyfluthrin on larvae of *S. littoralis.*

The recorded data in Table (2), show that the chemical insecticide Dursban had the highest effect at low concentrations on larvae of *O. nubilalis* compared with the Insect Growth Regulator Cascade and the bioinsecticide MVP_{II}, respectively.

Insecticidal effects on adult parasitoids of *T. evanescens*
Treatment with the bioinsecticide MVP_{II}

Four days after treatment, the mortality percentages of the bioinsecticide ranging from 7.14 to 17.85% at concentrations ranged from 20 to 320 p.p.m. respectively, compared with 6.67% of the untreated control (Table, 3). This low effect may be a result of the additive materials added to the main component of the commercial bioinsecticide MVP_{II}. In general, mortality percentages of adult parasitoids treated with the different concentrations of the bioinsecticide MVP_{II} show that MVP_{II} had low harmful effect on adult parasitoids.

Obtained results indicated accepted degree of safety by using the bioinsecticide MVP_{II} on adults of *T. evanescens.* Similar results on the safety of microbial insecticides of *B. thuringiensis* on beneficial species attacking many lepidopterous pests were previously shown by Abdel- Megeed (1984-1985); Emara *et al.* (1991); Medvecky & Zalom (1992); Morris (1993); Fhmay (1994) and Taher *et al.* (1994). However Kaya and Dunbar (1972) showed that, the egg parasitoid *Telenomus alsophilae* (an egg- parasitoid of the elm span worm *Ennomos subsiqunarius*) was not affected by the field application of *B. thuringiensis.* The effect of microbial insecticide on *Trichogramma* was shown by many authors, Hassan *et*

al., (1983) stated that *B. thuringiensis* was harmless to *Trichogramma* spp Microbial pesticides were found to be fully compatible with *Trichogramma* spp. (Bull and Coleman, 1985). Ebaid (2001) in Egypt, obtained good results when controlling *O. nubilalis* eggs and larvae by using *T. evanescens* and *B. thuringiensis*.

TABLE (II)

Corrected mortality percentages for third instar larvae of *O. nubilalis* fed on maize plants treated with MVP_{II}, Dursban.

Treatments	Concentrations p.p.m.	% cumulative mortality after days of treatments					
		1	2	3	4	5	6
Bioinsecticide (MVP_{II})	0.0	0.00	0.00	3.33	3.33	6.67	6.67
	20	10.00	20.00	30.00	43.33	46.43	46.43
	40	16.67	33.33	43.33	50.00	53.57	53.57
	80	23.33	46.67	56.67	60.00	60.71	64.29
	160	36.67	56.67	63.33	66.67	67.86	71.43
	320	50.00	66.67	76.67	80.00	82.14	85.72
	640	60.00	76.67	83.33	86.67	89.29	92.85
Insect Growth Regulator (Cascade)	0.0	0.00	0.00	3.33	3.33	6.67	6.67
	40	20.00	26.67	46.67	53.33	57.14	57.14
	80	33.33	40.00	56.67	63.33	64.29	67.86
	120	46.67	53.33	60.00	66.67	75.00	82.14
	160	56.67	66.67	70.00	76.67	82.14	85.72
	200	66.67	76.67	80.00	86.67	89.29	92.85
	240	73.33	83.33	86.67	93.33	96.43	100.0
Chemical insecticide (Dursban)	0.0	0.00	0.00	3.33	3.33		
	10	20.00	26.67	30.00	33.33		
	20	36.67	40.00	43.33	46.67		
	30	50.00	53.33	56.67	60.00		
	40	63.33	66.67	70.00	73.33		
	50	76.67	80.00	83.33	86.67		
	60	86.67	90.00	93.33	96.67		

Treatment with the Insect Growth Regulator Cascade:

Tests involving treatments with Cascade are listed in Table (3), where mortality percentages of adult parasitoid ranged from 17.85 to 60.71% at concentrations of 10 to 50 p.p.m., respectively, after 4 days of treatments. Results showed that Cascade had moderate toxic effect on adult parasitoids of *T. evanescens*. The LC_{50} obtained was 42.46 p.p.m. after 72 hours of treatment (Table, 4 and Fig., 5), while the LT_{50} values were 3.35 and 2.42 days at the concentrations of 40 and 50 p.p.m., respectively (Table, 5 and Fig., 6).

TABLE (III)

Corrected mortality percentages for *T. evanescens* adult parasitoids treated with MVP_{II}, Cascade and Dursban.

Treatments	Concentrations p.p.m.	% cumulative mortality after days of treatments				
		1	2	3	4	All the adult parasitoids of *T. evanescens* died including the untreated control
Bioinsecticide (MVP_{II})	0.0	0.00	0.00	3.33	6.67	
	20	0.00	3.33	6.67	7.14	
	40	0.00	3.33	6.67	7.14	
	80	0.00	6.67	10.00	10.71	
	160	3.33	10.00	13.33	14.28	
	320	6.67	13.33	16.67	17.85	
Insect Growth Regulator (Cascade)	0.00	0.00	0.00	3.33	6.67	
	10	3.33	13.33	20.00	17.85	
	20	6.67	20.00	30.00	32.14	
	30	13.33	30.00	43.33	42.86	
	40	20.00	36.67	50.00	53.57	
	50	30.00	46.67	56.67	60.71	
Chemical insecticide (Dursban)	0.00	0.0	0.00	3.33	6.67	
	5	16.67	33.33	60.00	75.00	
	10	26.63	43.33	66.67	82.14	
	15	40.00	63.33	83.33	96.43	
	20	63.33	80.00	93.33	100.00	
	25	80.00	96.67	100.00	100.00	

TABLE (IV)

Comparative toxicity of unparasitized and parasitized *O. nubilalis* eggs, 3rd instar larvae of *O. nubilalis* and adult parasitoids of *T. evanescens* treated with different concentrations of MVP_{II}, Cascade and Dursban.

Treatments	Treated stage	After treatments	LC_{50} p.p.m.	Slope	Confidence limits at Po 0..5 of LC_{50}
Bioinsecticide (MVP_{II})	Pest larvae	3	69.50	1.01 ± 0.11	52.44 : 88.71
Insect Growth Regulator (Cascade)	Parasitized eggs	2	23.37	1.85 ± 0.19	20.16 : 27.22
	Unparasitized eggs	2	17.92	1.75 ± 0.25	15.17 : 20.90
	Pest larvae	1	123.72	1.90 ± 0.22	108.59 : 140.87
	Adult parasitoid	3	42.46	1.58 ± 0.25	35.35 : 55.91
Chemical insecticide (Dursban)	Parasitized eggs	2	9.05	2.15 ± 0.25	7.65 : 10.35
	Unparasitized eggs	2	7.97	2.33 ± 0.25	6.70 : 9.11
	Pest larvae	1	26.02	2.40 ± 0.23	23.20 : 28.86
	Adult parasitoid	1	14.98	2.55 ± 0.27	9.79:25.58

TABLE (V)

Comparative mortality time for MVP_{II}, Cascade and Dursban on 3rd instar larvae of *O. nubilalis* and adult parasitoids of *T. evanescens*.

Treatments	Stage	Concentrations p.p.m.	LT_{50} (days).	Slope	Confidence limits at Po 0..5 of LT_{50}
Bioinsecticide (MVP_{II})	Pest larvae	40	4.23	1.48 ± 0.25	3.49 : 5.70
		80	2.83	1.33 ± 0.24	2.33 : 3.39
		160	1.74	1.11 ± 0.2	1.18 : 2.20
		320	0.97	1.35 ± 0.21	0.58 : 1.31
Insect Growth Regulator (Cascade)		40	3.90	1.57 ± 0.25	3.27 : 5.00
		80	2.50	1.24 ± 0.20	1.98 : 3.03
		120	1.48	1.18 ± 0.20	0.98 : 1.90
Insect Growth Regulator (Cascade)	Adult parasitoids	40	3.35	1.57 ± 0.299	2.75 : 4.59
		50	2.42	1.33 ± 0.291	1.93 : 3.13
Chemical insecticide (Dursban)		5	2.47	2.79 ± 0.32	2.21 : 2.77
		10	1.98	2.49 ± 0.31	1.73 : 2.23
		15	1.29	1.56 ± 0.29	

Treatment with the chemical insecticide Dursban

The mortality percentages of *T. evanescens* adult parasitoids by using Dursban were 75.00 and 82.14 % at the lowest concentrations of 5 and 10 p.p.m. and were 96.43, 100 and 100 % at the highest concentrations of 15, 20 and 25 p.p.m. after 4 days of treatment respectively (Table, 3). These data indicated highly toxic effect of the chemical insecticide on adult parasitoids. The recorded LC_{50} value was 14.98 p.p.m. after 24hours of treatment (Table, 4 and Fig., 5). While, the LT_{50} values were 2.47, 1.98 and 1.29 days at the tested concentrations of 5, 10 and 15 p.p.m., respectively (Table, 5 and Fig., 7). Similarly, Beasley and Henneberry (1984) and Staten *et al.* (1987) showed that the major obstacle for successful establishment of *Trichogramma* in cotton is the heavy annual use of organophosphate and pyrethroid insecticides applied to cotton primarily for controlling *P. gossypiella*. Hutchsion *et al.* (1990) reported that, for successful establishment of *Trichogramma*, insecticide applications for *P. gossypiella* and other cotton pests must be minimized. Also, Narayana and Babu (1992) revealed that the efficacy of Trichogramatids is influenced by the insecticide spray schedule imposed prior and after the release.

Comparing the effects of the three tested compounds; MVP_{II}, Cascade and Dursban, it was found that at the concentration of 20 p.p.m., the mortality percentages of adult parasitoids were 7.14 % in case of MVP_{II}, 32.14 % for Cascade and 100 % for Dursban treatments compared with the untreated control (Table, 3). Thus, results

for Dursban treatments compared with the untreated control (Table, 3). Thus, results indicated that the sequence of toxicity on adult parasitoids of *T. evanescens* was as follow: Dursban > Cascade>MVP_{II}.

Based on the obtained results, it could be concluded that treatment with bioinsecticide MVP_{II} induced the lowest harmful effects on adult parasitoids of *Trichogramma evanescens* and also on parasitized *Ostrinia nubilalis* eggs. On the other hand, this bioinsecticide proved to be effective against *O. nubilalis* larvae, indicating that its use for controlling this pest in late cultivated maize may give good results without affecting this parasitoid. High efficient, control was obtained by the chemical insecticide, which caused high mortality on *O. nubilalis* larvae. But it affected the survival of adult parasitoids and its emergence from parasitized eggs. Intermediate effect was recorded for the Insect Growth Regulator Cascade, which caused moderate effect compared with the other two compounds.

From this study, it could be recommended that, in planning Integrated Pest Management (I.P.M.) programs for controlling *O. nubilalis,* the use of the bioinsecticide with a sublethal dose of the I.G.R. may introduce good control results. As such treatment will minimize the environmental pollution and will reduce the harmful effect on *T. evanescens* adults, which play an important natural role in suppressing the population density of the pest during August and September. The chemical insecticide must only be used in the occurrence of severe infestations with *O. nubilalis*.

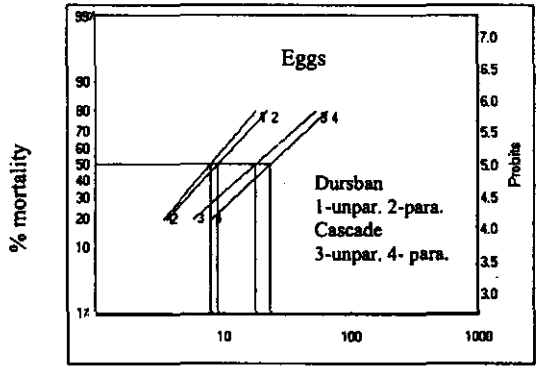

Fig. (1): Log concentration probit lines showing response of parasitized and unparasitized *O. nubilalis* eggs treated with Cascade and Dursban (computed from 48 hours mortality data).

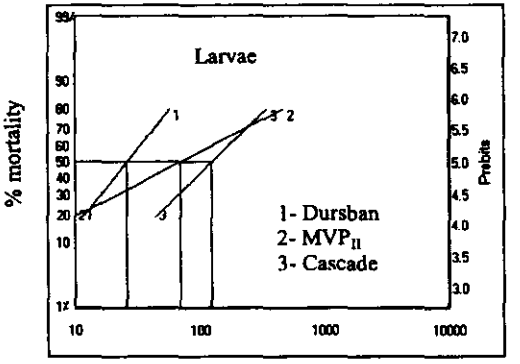

Fig. (2): Log concentration probit lines showing response of 3rd instar *O. nubilalis* larvae treated with MVP$_{II}$, Cascade and Dursban (computed from 72 hours mortality for MVP$_{II}$ and 24 hours for Cascade and Dursban).

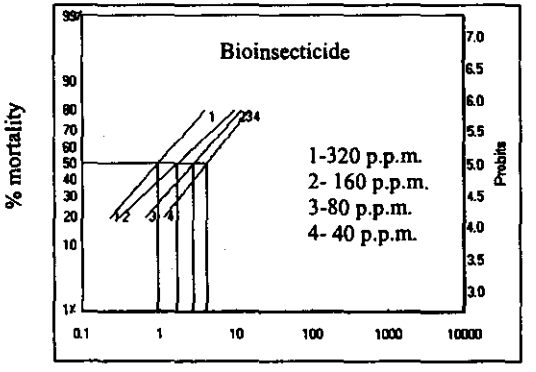

Fig. (3): Probit regression mortality time showing response of 3rd instar *O. nubilalis* larvae at concentrations of 40, 80, 160 and 320 p.p.m. of MVP$_{II}$.

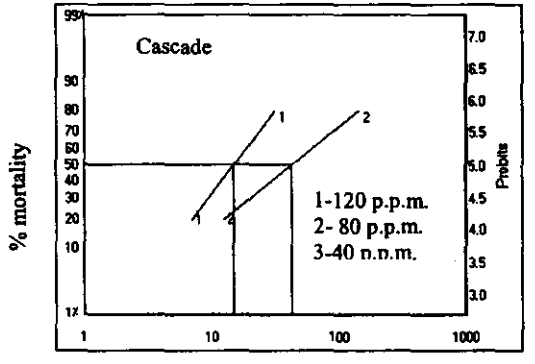

Fig. (4): Probit regression mortality time showing response of 3rd instar *O. nubilalis* larvae at concentrations of 40, 80 and 120 p.p.m., of Cascade.

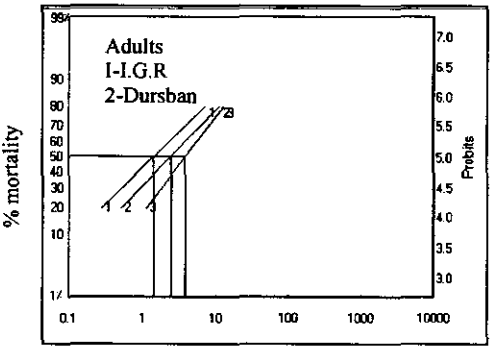

Fig. (5): Log concentration probit lines showing response of adult parasitoids of *Trichogramma evanescens* treated with Cascade and Dursban (computed from 72 hours for Cascade and 24 hours for Dursban).

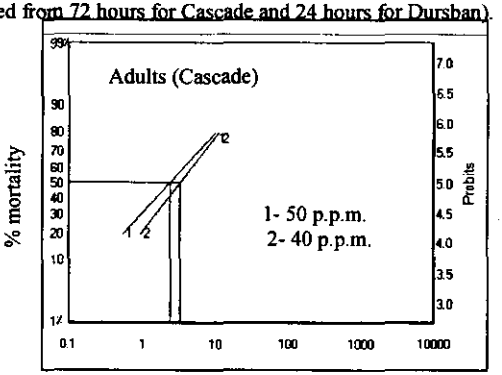

Fig. (6): Probit regression mortality time showing response of adult parasitoids of *Trichogramma evanescens* at concentrations of 40 and 50 p.p.m. of Cascade.

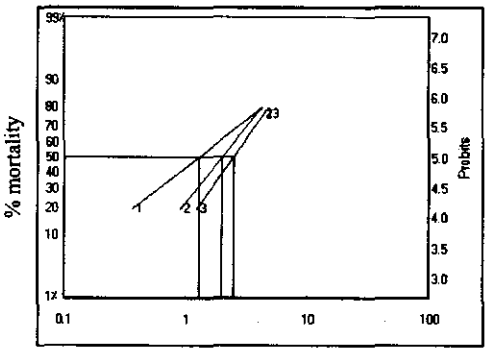

Fig. (7): Probit regression mortality time showing response of adult parasitoids of *Trichogramma evanescens* at concentrations of 5, 10 and 15 p.p.m. of Dursban.

SUMMARY

The efficacy of using three commercial products; a microbial insecticide (MVP_{II}), an Insect Growth Regulator (Cascade) and a chemical insecticide (Dursban) was studied against *Ostrinia nubilalis* unparasitized eggs ; parasitized eggs by *Trichogramma evanescens*, 3rd instar pest larvae and adult parasitoids of *T. evanescens* under laboratory condition of 25 ± 2 °C and 65 ± 5 % R.H.. Obtained data indicated slight mortality percentages among eggs (either parasitized or unparasitized) and also among adult parasitoids after bioinsecticide treatment. This treatment proved to be effective against 3rd instar larvae of *O. nubilalis* where, the recorded LC_{50} value was 69.50 p.p.m. after 3 days of treatment. While, the LT_{50} values were 4.23, 2.83, 1.74 and 0.97 days at concentrations of 40, 80, 160 and 320 p.p.m., respectively. Dursban, caused high mortality percentages among eggs (parasitized or unparasitized), larvae and adult parasitoids. The LC_{50} values of Dursban after 2 days of treatment were 9.05 and 7.97 p.p.m. for parasitized and unparasitized eggs, respectively. Meanwhile, the recorded LC_{50} values for larvae and adult parasitoids after 24 hours of treatment were 26.02 and 14.98 p.p.m., respectively. The LT_{50} values for adult parasitoids were 2.79, 2.49 and 1.56 days at concentrations of 5, 10 and 15 p.p.m., respectively. Cascade effect was moderate compared to the other two compounds. The LC_{50} values after two days were 23.37 and 17.92 p.p.m. for parasitized and unparasitized eggs. Values for pest larvae and adult parasitoid were 123.72 p.p.m. (after 24 hours) and 42.46 p.p.m. (after 72 hours) respectively. The LT_{50} values obtained for larvae were 3.90, 2.50 and 1.48 days at concentration of 40, 80 and 120 p.p.m., while those for adult parasitoids were 3.35 and 2.42 days at concentrations of 40 and 50 p.p.m., respectively. In general, a positive relationship was detected between applied concentrations and mortality percentages, while a negative relationship was found between applied concentrations and LC_{50} or LT_{50} values. This study may help planning Integrated pest Management (I.P.M.) programs for controlling *O. nubilalis*. The use of the bioinsecticide with a sublethal dose of the I.G.R. may introduce good control results. Such treatments will minimize the environmental pollution and will also reduce harm on *T. evanescens* parasitoids, which play an important natural role in suppressing the population density of this pest during August and September. The chemical insecticide must only be used in case of the occurrence of severe infestation by *O. nubilalis*.

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