Egypt. J. Agric. Res., 78 (3), 2000.

EFFICACY OF TWO FORMULATIONS OF PATHOGENIC BACTERIA *BACILLUS THURINIGIENSIS* AGAINST THE FIRST INSTAR LARVAE OF *SPODOPTERA LITTORALIS* (BOISD.) AND *AGROTIS IPSILON* (HFN.) (LEPIDOPTERA-NOCTUIDAE)

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(Manuscript received 4 Novermber, 1998)

Abstract

Laboratory tests were carried out to determine the efficacy of two commercial preparations of *Bacillus thurinigiensis*, namely MVPII and Xantari, against the first instar larvae of the cotton leafworm, *Spodoptera littoralis* (Boisd.) and the black cutworm, *Agrotis ipsilon*(Hfn.). Newly hatched, one-day and two-days old larvae of the two insects were allowed to feed on castor oil leaves treated with different concentrations of the two biocides for 48 hrs. Mortality among larvae of both insects increased by increasing the concentration, or post treatment period. Newly hatched larvae were the most sensitive to the toxic effect especially at high concentrations and 2-days old larvae were the most tolerant, while one-day old larvae expressed a moderate tolerance. On the other hand, *S.littoralis* was more sensitive than *A.ipsilon*, LC50 values for initial mortality were 0.0424 & 0.984 mg/ml when newly hatched larvae of the two insects were treated with MVPII and 0.0701 & 0.945 mg/ml when treated with Xantari.

Two the tested formulations had also a detrimental effect of certain biological aspects of the two insects. A negative relationship was observed between concentration and both pupation percentage or moth emergence. At any tested concentration, the percentages of pupation and moth emergence increased by increasing larval age before treatment. Also, remarkable latent adverse effects were recorded for egg-deposition as well as for egg hatchability.

Key words : *Spodoptera littoralis, Agrotis ipsilon,* and *Bacillus thurinigiensis.*

INTRODUCTION

The use of biological agents to control pests has been known and practiced for a long time. *Bacillus thurinigiensis* (B.t.) is safe to human beings and animals, and does not cause environmental pollution or harmful effects for natural enemies. In this concern, the development of the microbial control agent, *B.thurinigiensis* for possible use against some key lepidopterous pests received a great attention during the last two decades (El-Husseini and Afify 1984; Salama and Foda 1984; Gadallah *et al.* 1990; Emmarra *et al.* 1991; Abd El-Hafez *et al.* 1994; Taher *et al.* 1994). The successful use of

B.thurinigiensis to control leafworm *S.littoralis* and the black cutworm *A.ipsilon*. was repeatedly investigated in Egypt (Abdel-Halim, 1993 & 1997; Abou Bakr 1997).

The present investigation evaluates the effect of two commercial preparations of *B.thuringiensis* on the first instar larvae of *S.littoralis* and *A.ipsilon*.

MATERIALS AND METHODS

Insects culture: Insect larvae used were obtained from laboratory strains of *Spodoptera littoralis* and *Agrotis ipsilon* reared on castor oil leaves for several generations under controlled conditions of 25±2°C and 65±5% R.H.

***B.t.*preparations:** Two commercial products of *B.thurinigiensis* were used; Xantari wettable powder (35, 000 units/mg.) and MVPII (active ingredient; δ-endotoxin of B.t.bioencapsulated in killed *Pseudomonas fluorescens* bacterium prepared as aqueous suspension).

Bioassay technique: Five serial dilutions of Xantari and MVPII were prepared. Concentrations were 0.2, 0.1, 0.05, 0.02 and 0.01 mg/ml for *S.littoralis* and 2, 1.5, 1,0.75 and 0.5 mg/ml for *A.ipsilon*. Tests were done by dipping castor leaves in each of the different concentrations and were left until completely dried. Three age-groups of 1st instar larvae were tried; newly hatched, 1-day old and 2-days old. For every concentration, fourty larvae of each age-group were provided with treated castor leaves for 48 hours, then transferred to untreated leaves to continue feeding. Larvae of the check were reared on untreated leaves. Counts of dead larvae were recorded after 2, 5 and 9 days after treatment in case of *S.littoralis* and after 2,3,5 and 9 days in that of *A.ipsilon*. LC_{50}, slope values and fiducial limits of mortality were statistically calculated using a Proban Software Computer Program. In addition, the cumulative mortality was calculated at the end of the larval stage and illustrated graphically. Toxicity index (Ti) was determined by using Sun's equation (1950) as follows:

$$\text{Toxicity index (Ti)} = \frac{LC_{50}\ (LC_{90}) \text{ of the compound A}}{LC_{50}\ (LC_{90}) \text{ of the compound B}} \times 100$$

Where A: is the most effective compound

B: is the other tested compound

To study the latent effect of the two tested B.t. formulations on some biological aspects of the two insects, surviving larvae were examined daily until pupation and/or moth emergence. The percentages of pupation and adult emergence were also calculated. After moth eclosion, pairs of moths were introduced into oviposition glass cages provided with cotton wool soaked in 10% sucrose solution for feeding and fresh branches of *Nerium oleander* to serve as oviposition sites. Egg-masses were collected daily, held at the same controlled conditions until hatching and the percentage of hatchability was calculated. Also, percent reduction of pupation, adult emergence, fecundity and egg viability were calculated according to the following equation:

$$\% \text{ Reduction} = \frac{C - T}{C} \times 100$$

Where, C = the estimated parameter in check and T = the same parameter in treatment.

RESULTS AND DISCUSSION

Insecticidal activity: Table 1 presents the results of feeding 1st instar larvae of *S.littoralis* on various concentrations of two commercial formulations of *Bacillus thurinigiensis.* Data indicate that the two formulations had a great effect on the three age-groups of 1st instar larvae. A positive relationship existed between larval mortality and concentration. For *S.littoralis,* mortalities of 70.6 and 63.4% of newly hatched larvae were achieved after 48 hr with the highest concentration (0.2 mg/ml) of the MVPII and Xantari, respectively. After the same period, mortalities were 30.7 and 26.2%, respectively, at the lowest concentration (0.01 mg/ml) of the two formulations. Older larvae (1 and 2-days old) seemed to be more resistant to the two tested formulations. The lowest concentration of the two formulations caused 21.5% mortality to one-day old larvae after 48 hrs. and 2.7-3.8% for two-days old larvae. The highest concentration caused 32.6 and 53.1% mortality to the former age-group and 17.8 and 11.4%, respectively, to the latter age-group after the same period. Such results coincide with (El-Husseini and Afify 1981; Abou Bakr *et al.*, 1993; Abou Bakr 1997).

Table 1 shows also that larval mortality was related to the periods after digestion. The percentages of mortality increased to 33.7 & 34.6, 34.7 & 39.1 and 4.6 & 13.3% after 5 and 9 days of treatment for newly hatched, 1-day and 2-days old larvae with the lowest concentration of MVPII, respectively. At the highest concentration, the corresponding mortalities reached 77.8 & 78.8, 70.8& 71.3 and 42.8 & 59.3%, respectively. On the other hand, the corresponding respective mortality percentages for

Table 1. Insecticidal activity of MVPII and Xantari formulations (*Bacillus thurinigiensis*) against three age-groups of *S.littoralis* 1st instar larvae after different post treatment periods.

Concentration (mg/ml)	AGE-GROUP OF 1st instar larvae											
	Newly hatched larvae				1-day old larvae				2-days old larvae			
	% Mortality after:				% Mortality after:				% Mortality after:			
	2-DAYS	5-DAYS	9-DAYS	Larval period	2-DAYS	5-DAYS	9-DAYS	Larval period	2-DAYS	5-DAYS	9-DAYS	Larval period
MVPII												
0.01	30.7	33.7	34.6	58.8	21.5	34.7	39.1	52.4	3.8	4.6	13.3	24.1
0.02	39.7	43.8	44.9	64.0	23.9	42.8	46.5	57.9	5.8	9.1	21.2	35.5
0.05	52.3	58.2	59.3	70.5	27.2	54.2	54.6	65.0	9.4	19.0	34.9	55.0
0.1	61.8	68.6	69.7	75.1	29.8	62.8	64.1	70.1	13.2	29.8	46.9	70.1
0.2	70.6	77.8	78.8	79.2	32.6	70.8	71.3	74.8	17.8	42.8	59.3	82.7
Slope	0.803	0.959	0.961	0.468	-	0.763	0.693	0.494	-	-	1.0349	1.442
LC_{50}	0.0424	0.0348	0.0324	0.0044		0.0437	0.0387	0.0119			0.0068	0.0499
95% fiducial limits	0.023	0.02	0.019	0.003		0.023	0.018	0.0001			0.0016	0.037
	-0.075	-0.054	-0.05	-0.015		-0.08	-0.074	-0.029			-0.139	-0.069
Toxicity index (Ti)	100	56.9	44.75	100		100	80.6	100				100
Xantari												
0.01	26.2	35.6	42.5	46.1	21.5	27.7	39.4	40.0	2.7	7.3	11.5	25.9
0.02	34.1	50.3	56.6	61.2	27.8	35.8	45.8	46.6	3.9	9.9	15.4	32.7
0.05	45.6	69.3	73.7	78.5	37.3	47.4	54.4	55.5	6.1	14.2	21.8	42.6
0.1	54.6	81.0	83.8	87.9	45.1	56.4	60.8	62.1	8.5	18.2	27.5	50.4
0.2	63.4	89.5	91.0	94.0	53.1	65.1	66.9	68.3	11.4	22.9	33.9	58.2
Slope	0.7525	1.2479	1.1755	1.2681	0.6646	0.7531	0.543	0.5619	-	-	-	0.6561
LC_{50}	0.0701	0.0198	0.0145	0.0119	0.1532	0.0611	0.0312	0.0283				0.0963
95% fiducial limits	0.043	0.0124	0.008	0.006	0.078	0.035	0.007	0.006				0.052
	-0.141	-0.027	-0.021	-0.018	-1.004	-0.13	-0.07	-0.06				-0.375
Toxicity index (Ti)	60.48	100	100	36.97		71.52	100	42.05				51.82

(-) mortality among larvae less than 50% for all concentrations.

Xantari were 35.6 & 42.5, 27.7 & 39.4 and 7.3 & 11.5% at the lowest concentrations and 89.5 & 91.0, 65.1 & 66.9 and 22.9 & 33.9% at the highest one.

As for *A.ipsilon*, 1st instar seemed to be more tolerant to the adverse effect of *B.t.* compounds than *S.littoralis*. Although concentrations were higher (0.5-2.0 mg/ml) than those used on *S.littoralis* (0.01 - 0.2 mg/ml), low numbers of larvae died (1-2 larvae) 48 hrs. after treatment. Considerable mortality among treated larvae was recorded3-days after treatment. As in *S.littoralis*, larval mortality was positively related to the concentration of any of the two tested formulations and post treatment period and negatively related to larval age. Data in Table 2 reveal that, the newly hatched larvae treated with MVP II and Xantari concentrations expressed different rates of mortality (20.7 - 80.3 and 15.9 - 87.9%) within 72 hrs. from treatment. With increase of larval age to 1-day, mortality percentages decreased to 18.16 - 54.46 and 16.7 - 63.9% for Xantari and MVP II, respectively. Further decrease in mortality was observed in 2-days old larvae (17.2 - 34.9 and 4.4-27.1%, respectively). Increase of post treatment period increased mortality among treated larvae as the percentage of corrected mortality recorded 85.1 - 86.5, 61.59 - 74.38 and 49.4-67.61% after 5 and 9 days after treatment of newly hatched, 1-day and 2-days old larvae with the highest concentration of MVPII, respectively. The corresponding mortalities for Xantari were 95.1 - 95.5, 72.8-77.3 and 32.0-50.0%, respectively.

Regarding the cumulative mortality after treating, *S.littoralis* newly hatched and 1-day old larvae showed high mortality percentages at all concentrations within the first two days of treatment, Fig. 1. Mortality continued according to pathogen concentration. At higher concentrations, most larvae died within 5 days after treatment, while at low concentrations mortality among larvae occurred up to pupation. It could be stated, therefore, that more time was needed after digestion to cause more mortality among 2-days old larvae. Accordingly, higher percentages of mortality occurred at the different tested concentrations after 9 days and up to the end of the larval period. Treatment of 2-days old larvae at the highest concentration of MVPII (0.2 mg/ml) showed lower initial mortality (17.8%) than the newly hatched (70.6%) or 1-day old larvae (32.6%). However, mortality in this age-group increased by increase of post treatment period to reach 82.7% by the end of the larval stage versus 79.2 and 74.8% for newly hatched and 1-day old larvae, respectively. In the case of Xantari, mortality of 2-days old larvae at 0.2 mg/ml concentration increased from 11.4% (initial mortality) to 58.2% at the end of the laral period, while that for newly hatched and 1 day-old larvae increased from 63.4 to 94 and from 53.1 to 68.3%, respectively.

As for *A.ipsilon*, Fig. 2, larval mortality continued to increase progressively until the end of the larval period. Comparison between *S.littoralis* and *A.ipsilon* indicates that mortality started later, but continued faster in the case of *A.ipsilon*. That fact that no progressive mortality occurred 5 days after treatment with 1 and 2-days old larvae of *A.ipsilon* using the lowest concentration of MVPII supports the after-mentioned deduction.

Data in Tables 1 and 2 show that the activity of the two *B.thurinigiensis* formulations differed for the two considered pests according to larval age. Based on the LC_{50} values and toxicity index (Ti) two days after treatment, MVPII was more toxic (the LC_{50} = 0.0424 mg/ml & Ti = 100) to the newly hatched larvae of *S.littoralis* than Xantari (LC_{50} = 0.0701 mg/ml & Ti = 60.48). As the post treatment period was prolonged to 5 or 9 days Xantari became more effective (LC_{50} = 0.0198 mg/ml & Ti = 100) than MVPII (LC_{50} = 0.0348 mg/ml & Ti = 56.9).

Regarding the cumulative mortality at the end of the larval stage, MVPII seemed to be more effective on *S.littoralis* (Ti = 100) than Xantari (Ti = 51.82). However, the opposite occurred in the case of *A.ipsilon*. Therefore, LC_{50} values for MVPII after treating newly hatched, 1-day and 2-days old larvae of *S.littoralis*, were 0.0044, 0.0119 and 0.0499 mg/ml at the end of the larval stage, respectively, while those for Xantari were 0.0119, 0.0283 and 0.0963 mg/ml, respectively. In the case of *A.ipsilon*, Xantari expressed a higher toxicity index (Ti = 100) against newly hatched and 1-day old larvae than MVPII (82.6 - 96.04 and 57.7 - 84.1, respectively), while the opposite was true in the case of 2-days old larvae. Treatment of 2-days old larvae with the different concentration of the two formulations caused lower mortality among larvae (17.2-49.4 and 4.4-32.0% for MVPII and Xantari, respectively) until the 5th day of treatment. By the end of the larval stage, LC_{50} values were 0.621, 0.8235 and 2.067 mg/ml in the case of Xantari and 0.6932, 0.9793 and 1.362 mg/ml in that of MVPII, respectively. Levels of toxicity were determined for certain B.t. formulations on some cotton insect insect pests by many investigators (Hosney *et al.*, 1983; Raslan, 1988; Gadallah *et al.*, 1990; Bai *et al.*, 1992; Hafez, 1993; Abd El-Halim, 1993; Abou Bakr, 1997).

Effect on certain biological aspects

Percentage of pupation and moth emergence: In addition to the high mortality rates among larvae, the adverse effect of MVPII or Xantari included decrease of pupation percentage according to both concentration and age-group of larvae, Tables 3 & 4. Treated newly hatched larvae showed the least pupation percentages. For un-

Table 2. Insecticidal activity of MVPII and Xantari formulations (*Bacillus thurinigiensis*) against three age-groups of *A.ipsilon* 1st instar larvae after different post treatment periods.

Concentration (mg/ml)	AGE-GROUP OF 1st instar larvae											
	Newly hatched larvae				1-day old larvae				2-days old larvae			
	% Mortality after:				% Mortality after:				% Mortality after:			
	3-DAYS	5-DAYS	9-DAYS	Larval period	3-DAYS	5-DAYS	9-DAYS	Larval period	3-DAYS	5-DAYS	9-DAYS	Larval period
MVPII												
0.5	20.7	25.8	31.7	36.0	18.16	25.00	25.0	25.0	17.2	21.68	22.0	22.0
0.75	37.1	43.9	49.4	53.4	27.08	34.00	37.17	39.5	21.7	28.83	29.16	31.94
1.0	50.7	57.8	62.3	65.6	34.51	42.48	48.04	50.8	25.2	34.49	39.39	41.92
1.5	69.4	75.6	78.1	80.1	46.02	53.73	64.01	66.4	30.7	43.08	55.93	57.51
2.0	80.3	85.1	86.5	87.7	54.46	61.59	74.38	76.2	34.9	49.4	67.61	68.33
Slope	2.776	2.811	2.628	2.523	1.696	1.609	2.482	2.0222	-	-	2.605	2.433
LC_{50}	0.984	0.85	0.7588	0.6932	1.7179	1.3119	1.555	0.9793			1.4235	1.362
95% fiducial limits	0.833	0.705	0.602	0.5264	1.314	1.059	0.973	0.7985			1.203	1.142
	-1.153	-0.99	-0.896	-0.8288	-3.156	-2.019	-1.411	-1.185			-1.815	-1.748
Toxicity index (Ti)	96.04	82.6	84.9	89.6	80.1	83.8	57.7	84.1			100	100
Xantari												
0.5	15.9	29.5	35.2	37.2	16.7	21.2	29.1	33.0	4.4	12.6	12.6	15.8
0.75	35.8	54.1	59.0	61.1	28.1	34.9	43.2	46.7	8.3	17.2	20.9	23.7
1.0	53.5	71.2	74.5	76.2	38.0	46.1	54.0	66.7	12.4	21.0	28.3	30.4
1.5	76.5	88.5	89.7	90.7	53.2	62.3	68.4	70.0	20.1	27.2	40.6	41.0
2.0	87.9	95.1	95.5	96.0	63.9	72.8	77.3	78.2	27.1	32.0	50.0	50.0
Slope	3.604	3.649	3.452	3.454	2.197	2.336	2.157	2.0222	-	-	1.904	1.624
LC_{50}	0.945	0.702	0.644	0.621	1.376	1.0996	0.898	0.8235			1.997	2.067
95% fiducial limits	0.402	0.214	0.002	0.0036	1.135	0.913	0.707	0.615			1.52	1.506
	-1.702	-1.013	-0.998	-0.9984	-1.839	-1.349	-1.093	-1.012			-3.74	-4.925
Toxicity index (Ti)	100	100	100	100	100	100	100	100			71.28	67.9

(-) mortality among larvae less than 50% for all concentrations.

treated larvae, the percentages of pupation were 82.5 and 92.55% for *S.littoralis* and *A.ipsilon*, respectively, and 75.0 & 20.0, 45.0.0 & 22.5 and 37.5 & 12.5% for 2-days old, one-day old and newly hatched larvae of *S.littoralis* treated with the lowest and highest concentrations of MVPII, respectively. Corresponding percentages for Xantari were 77.5 & 40.0, 60.0 & 32.5 and 54.0 & 6.0%, respectively. For *A.ipsilon,* the corresponding percentages were 75.0 & 25.0, 70.0 & 17.5 and 60.0 & 10.0% for MVPII, and 82.5 & 47.5, 67.6 & 22.5 and 50 & 0% for Xantari, respectively. Xantari seemed to be more sever on newly hatched larvae than MVPII, while the opposite was true in the case of 1and 2-days old larvae. In comparison to untreated insects, the percentage of reduction of pupation after treatment of the three aforementioned age-groups of *S.littoralis* larvae with MVPII ranged 9.09 - 75.76, 45.45-72.73, and 54.55-84.85%, respectively, versus 6.60-50.52,27.27-60.61 and 34.55-92.73% with Xantari. The corresponding ranges for *A.ipsilon* were 18.92-72.97, 24.32-81.08 and 35.14 - 89.19%, respectively in case of MVPII and 10.81 - 48.65, 26.92-72.68 and 45.95-100%, respectively, in that of Xantari.

Treatment of 1st instar larvae of both *S.littoralis* and *A.ipsilon* with MVPII and Xantari affected moth emergence in an almost similar trend to that observed in the case of pupation percentage. Compared to untreated insects, the percentage of reduction of moth emergence after the treatment of 2-days old, 1-day old and newly hatched larvae of *S.littoralis* with the different concentrations of MVPII ranged 20.69-79.31, 37.93-79.31 and 51.72-93.10%, respectively, while those for Xantari ranged 17.24-72.41, 37.93-68.97 and 36.55-100%, respectively. As for *A.ipsilon*, the respective percentages of reduction ranged 37.21-77.17, 45.78-85.73 and 48.63-97.15% after treatment with MVPII and 28.65-74.32, 48.63-68.61 and 62.9-100% after treatment with Xantari.

Fecundity and fertility of the emerged moths: The fecundity and fertility of *S.littoralis* and *A.ipsilon* moths were adversely affected by the treatment of 1st instar larvae with *B.thurinigiensis*. For *S.littoralis*, the number of deposited eggs was 604 eggs/untreated female, and was sharply reduced after treatment of any age with any used concentration of MVPII or Xantari. It ranged 166-301, 118-223 and 107-198 eggs/female after treatment of newly hatched, 1-day and 2-days old larvae with MVPII, respectively, and 165-441, 115-216 and 132-297 eggs/female, respectively, after treatment with Xantari, Table 3. The corresponding figures of percentage of hatchability were 0.0-32.7 & 24.3 - 47.6, 23.6-66.03 & 10.03-76.8 and 29.6-62.7 & 33.8-77.0%, respectively. Although the number of deposited eggs at the different concentrations and treated age-groups seemed to be conflicted, the percentage of reduction

was more than 50% (50.17 - 82.28%) and 26% (26.99-80.96%) at all treatments of MVPII and Xantari, respectively. On the contrary, the percentage of reduction of egg viability was correlated with increase of the concentration. Females emerged after treatment of newly hatched larvae with 0.1 and 0.2 mg/ml of MVPII deposited nonviable eggs.

Data in Table 4 reveal that the fecundity and fertility of *A.ipsilon* moths were related to the concentrations of the two tested formulations. The mean number of deposited eggs was 434/untreated female and the normal percentage of hatchability was 85.02%. Females ceased egg laying or laid nonviable eggs as a latent effect to previous treatment of newly hatched larvae with 1.5 & 2.0 mg/ml of MVPII or with 1.0 & 1.5 mg/ml of Xantari, respectively. Also, females laid nonviable eggs as a result to previous treatment of one-day old larvae with 2.0 mg/ml of MVPII or Xantari. The mean number of eggs/female ranged 84.3-254.9 & 48.3-199.5, 108.7-318.4 & 106.8-293.7 and 139.7-328.6 & 161.3-303.6% when the three aforementioned ages were treated with the two biocides, respectively. The corresponding figures of hatchability were 18.03-36.19 & 0.0-48.2, 0.0-29.86 & 0.0-43.53 and 17.48-54.4 & 8.81-41.44%, respectively. Similar results were obtained by Hafez *et al.* (1993) on a study on the effectiveness of *B.thurinigiensis* against the eggs, prepupal & pupal stages and moths of *A.ipsilon*.

In the light of the above results, it could be concluded that MVPII and Xantari seem to be promising formulations for the control of first instar larvae of both *S.littoralis* and *A.ipsilon*. Newly hatched larvae are more sensitive to the treatment than older ones.

Table 3. Effect of treatment of 1st instar larvae of *S.littoralis* with different concentrations of MVPII and Xantari (*Bacillus thurinigiensis* formulations) on the percentage or reduction of pupation, adult emergence and fertility of moths.

Concentration (mg/ml)	AGE-GROUP OF 1st instar larvae:											
	Newly hatched				1-day old				2-days old			
	% Pupation	% Emergence	No. eggs/ female±SE	% Hatch	% Pupation	% Emergence	No. eggs/ female±SE	% Hatch	% Pupation	% Emergence	No. eggs/ female±SE	% Hatch
MVPII												
Check	82.5	72.5	604±65	88.7	82.5	72.5	604±65	88.7	82.5	72.0	604±65	88.7
0.01	37.5	35.0	301±67	32.7	45.0	45.0	159±62	66.03	75.0	57.5	195±25	62.7
	(54.55)	(51.72)	(50.17)	(63.13)	(45.45)	(37.93)	(73.68)	(25.56)	(9.09)	(20.69)	(67.7)	(29.31)
0.02	35.0	35.0	267±67	31.2	42.5	42.5	118±62	51.8	65.0	40.0	198±94	58.1
	(57.58)	(51.72)	(55.79)	(64.80)	(48.48)	(41.38)	(80.46)	(41.60)	(21.21)	(44.83)	(67.22)	(34.50)
0.05	35.0	32.5	166±54	19.8	40.0	32.5	141±14	45.7	50.0	30.0	158±53	54.9
	(57.58)	(55.17)	(72.52)	(77.68)	(51.52)	(55.17)	(76.66)	(48.48)	(39.39)	(51.52)	(73.84)	(38.10)
0.1	32.5	22.5	175±11	0.0	30.0	22.5	127±75	27.5	30.0	17.5	142±32	44.4
	(60.61)	(68.97)	(71.03)	(100)	(63.64)	(68.97)	(78.97)	(68.70)	(72.73)	(75.86)	(76.49	(49.94)
0.2	12.5	5.0	184±26	0.0	22.5	15.0	223±44	23.6	20.0	15.0	107±12	29.6
	(84.85)	(93.10)	(69.54)	(100)	(72.73)	(79.31)	(63.08)	(73.28)	(75.76)	(97.31)	(82.28)	(66.63)
Xantari												
Check	82.5	72.5	604±65	88.7	82.5	72.5	604±65	88.7	82.5	72.5	604±65	88.7
0.01	54.0	46.0	441±86	47.6	60.0	45.0	198±29	67.8	77.5	60.0	297±66	77.0
	(34.55)	(36.55)	(26.99)	(46.34)	(27.27)	(37.93)	(67.22)	(23.56)	(6.60)	(17.24)	(50.83)	(13.19)
0.02	28.0	22.0	314±56	33.2	52.5	37.5	174±38	55.6	62.5	45.0	225±44	55.1
	(66.06)	(69.99)	(48.01)	(62.57)	(36.36)	(48.28)	(71.19)	(37.32)	(24.24)	(37.93)	(62.75)	(33.60)
0.05	24.0	14.0	165±33	24.3	47.5	27.5	115±21	52.7	57.5	45.0	161±39	51.8
	(70.91)	(80.69)	(72.68)	(72.60)	(42.42)	(62.07)	(80.96)	(40.59)	(30.30)	(37.93)	(73.34)	(41.60)
0.1	10.0	0.0	-	-	35.0	25.0	163±31	28.1	50.0	35.0	132±27	51.6
	(87.88)	(100)			(57.58)	(65.52)	(73.01)	(68.32)	(39.39)	(51.72)	(78.15)	(41.83)
0.2	6.0	0.0	-	-	32.5	22.5	216±43	10.03	40.0	20.0	137±22	33.8
	(92.73)	(100)			(60.61)	(68.97)	(64.24)	(88.69)	(51.52)	(72.41)	(77.32)	(61.89)

Table 4. Effect of treatment of 1st instar larvae of *A.ipsilon* with different concentrations of MVPII and Xantari (*Bacillus thurinigiensis* formulations) on the percentage or reduction of pupation, adult emergence and fertility of moths.

Concentration (mg/ml)	AGE-GROUP OF 1st instar larvae:											
	Newly hatched				1-day old				2-days old			
	% Pupation	% Emergence	No. eggs/ female±SE	% Hatch	% Pupation	% Emergence	No. eggs/ female±SE	% Hatch	% Pupation	% Emergence	No. eggs/ female±SE	% Hatch
MVPII												
Check	92.5	87.6	434±28	85.02	92.5	87.6	434±28	85.02	92.5	87.6	434±28	85.02
0.50	60.0	45.0	254.9±44	36.19	70.0	47.5	318.4±42	29.86	75.0	55.0	328.6±35	54.40
	(35.14)	(48.63)	(41.27)	(57.42)	(24.32)	(45.78)	(26.73)	(64.88)	(18.92)	(37.21)	(24.28)	(63.02)
0.75	50.0	42.5	188.8±15	26.43	62.5	45.5	217.8±18	22.44	70.0	52.5	298.9±46	31.48
	(45.95)	(51.48)	(56.50)	(68.91)	(32.43)	(48.06)	(49.82)	(73.61)	(24.32)	(40.07)	(31.13)	(62.97)
1.00	37.5	37.5	84.3±3	18.03	55.0	42.5	237.3±58	15.91	62.5	32.5	229.6±20	30.53
	(59.46)	(57.19)	(80.58)	(78.79)	(40.54)	(51.48)	(45.32)	(69.11)	(32.43)	(62.90)	(47.10)	(64.09)
1.50	20.0	25.0	0.0	-	37.5	30.0	134.8±26	13.72	47.5	32.5	212.1±26	25.20
	(78.38)	(71.46)	(100)		(59.46)	(65.75)	(68.94)	(71.3)	(48.65)	(62.90)	(51.13)	(70.36)
2.00	10.0	2.5	0.0	-	17.5	12.5	108.7±3	0.0	25.0	20.0	139.7±5	17.48
	(89.19)	(97.15)	(100)		(81.08)	(85.73)	(74.95)	(100)	(72.97)	(77.17)	(67.81)	(79.44)
Xantari												
Check	92.5	87.6	434±28	85.02	92.5	87.6	434±28	85.02	92.5	87.6	434±28	85.02
0.50	50.0	32.5	199.5±4.3	48.2	67.6	45.0	293.7±24	43.53	82.5	62.5	303.6±18	41.44
	(45.95)	(62.9)	(54.03)	(43.31)	(26.92)	(48.63)	(32.33)	(48.80)	(10.81)	(28.65)	(30.05)	(51.26)
0.75	0.5	22.5	173.4±9	42.3	57.5	37.5	278.8±35	28.63	77.5	47.5	290.6±32	35.00
	(37.84)	(74.32)	(60.05)	(50.25)	(37.84)	(57.19)	(35.76)	(66.33)	(16.22)	(45.78)	(33.04)	(58.83)
1.00	22.5	17.5	86.6±15	0.0	35.5	32.5	215.8±17	22.31	70.0	32.6	271.4±12	32.31
	(72.08)	(80.02)	(80.05)	(100)	(61.62)	(62.90)	(50.28)	(73.76)	(24.32)	(62.79)	(37.47)	(61.2)
1.50	10.0	10.0	48.3±10.9	0.0	32.5	27.5	184.7±40	19.13	62.5	32.5	246.2±47	23.70
	(89.2)	(88.58)	(88.89)	(100)	(64.86)	(68.61)	(57.44)	(77.50)	(32.65)	(62.9)	(43.27)	(72.12)
2.00	0.0	-	-	-	22.5	72.5	106.8±18.6	0.0	47.5	22.5	161.3±24	8.81
	(100)	-	-	-	(72.68)	(68.61)	(75.39)	(100)	(48.65)	(74.32)	(62.83)	(89.64)

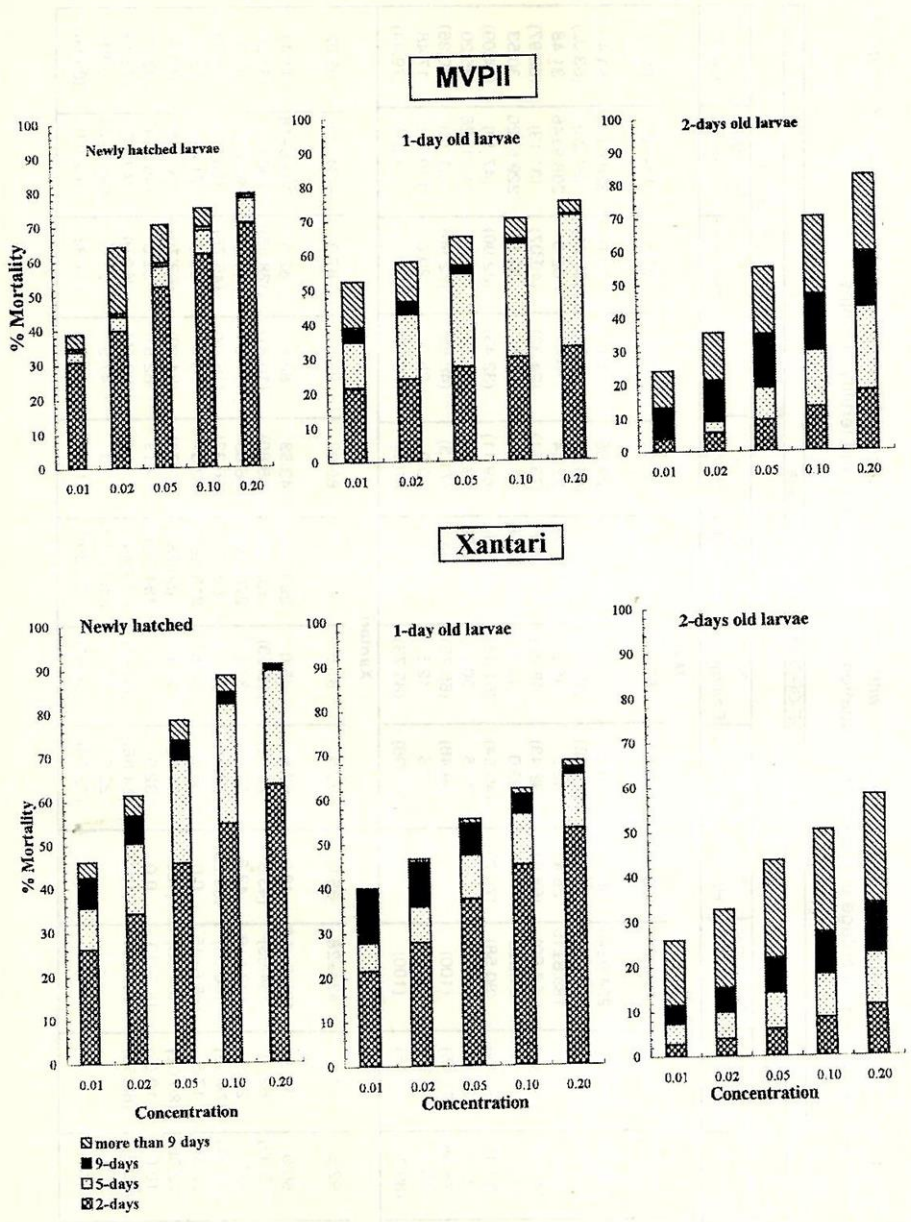

Fig.1. Cumulative mortality of *S.littoralis* larvae at different periods after treatment of three age-groups of 1st instar larvae with different concentrations of MVPII and Xantari.

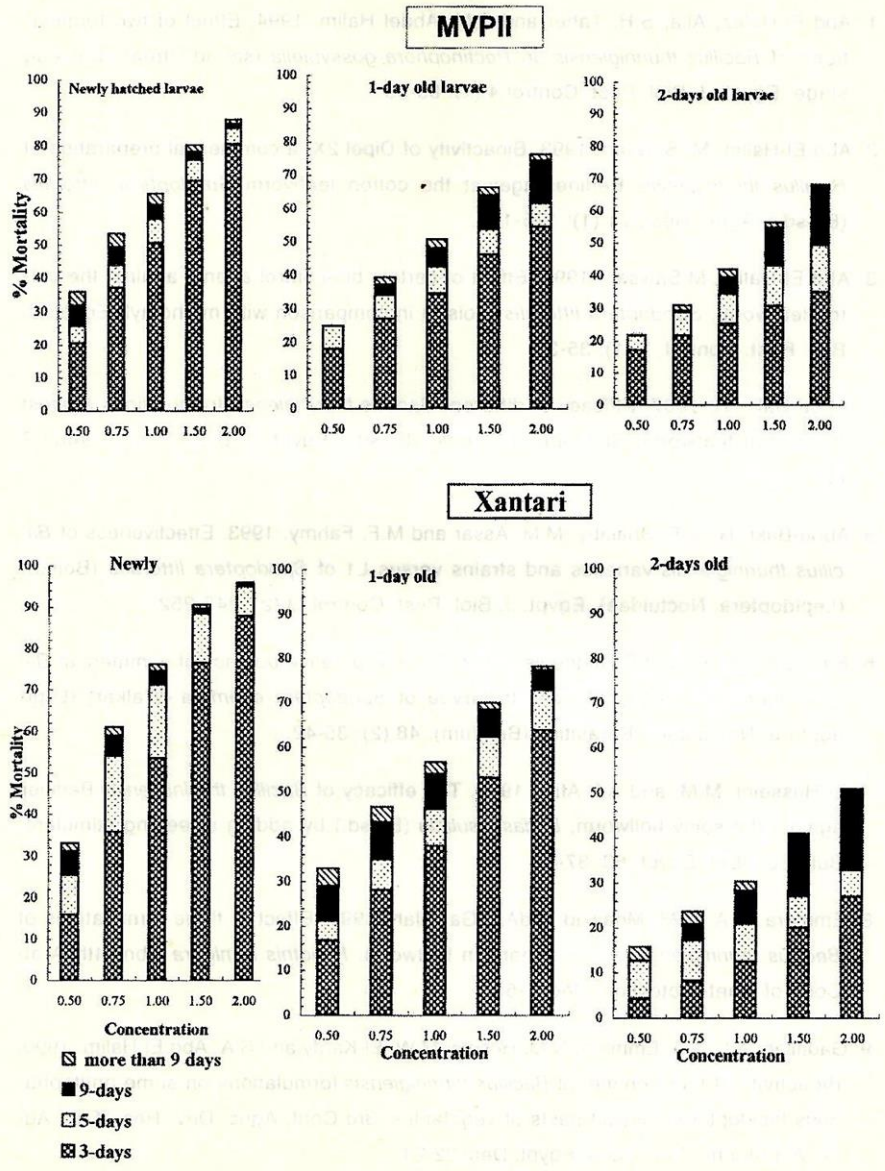

Fig.2. 2+ADI. Cumulative mortality of *A.ipsilon* larvae at different periods after treatment of three age-groups of 1st instar larvae with different concentrations of MVPII and Xantari.

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فعالية مستحضرين من البكتريا الممرضة باسيلليس ثورنجنسيز علي يرقات العمر الأول لكل من دودة ورق القطن *Spodoptera littoralis* والدودة القارضة السوداء *Agrotis ipsilon*

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أجريت اختبارات معملية لتقدير فعالية مستحضرين تجاريين من البكتريا الممرضة *Bacillus thuringiensis* هما MVPII, Xantari على يرقات العمر الأول لكل من دودة ورق القطن *Spodoptera littoralis* والدودة القارضة السوداء *Agrotis ipsilon*. غذيت اليرقات حديثة الفقس واليرقات عمر يوم ويومين لكلا الحشرتين لمدة ٤٨ ساعة علي أوراق الخروع المعاملة بتركيزات مختلفة من المركبين الحيويين المختبرين. ووجد أن نسبة الموت تزيد بزيادة التركيز المستخدم وطول الفترة بعد المعاملة. وكانت اليرقات حديثة الفقس أكثر حساسية للتأثير السمي واليرقات عمر يومين أكثر تحملا له، أما اليرقات عمر يوم واحد فقد أظهرت تحملا متوسطا. كذلك كانت يرقات دودة ورق القطن أكثر حساسية للتأثير السمى للمستحضرين من الدودة القارضة السوداء حيث كانت قيم التركيز القاتل لنصف عدد الأفراد من اليرقات حديثة الفقس لدودة ورق القطن والدودة القارضة السوداء ٠,٠٤٢٤ و ٠,٠٩٨٤ مج/مل بعد ٤٨ ساعة من المعاملة بالمركب MVPII علي التوالى و٠,٠٠٧٠١ و ٠,٠٠٩٤٥ مج / مل علي التوالي بعد المعاملة بـ Xantari.

وقد كان لكل من المستحضرين تأثير ضار علي بعض الجوانب البيولوجية لكلتا الحشرتين حيث وجدت علاقة سالبة بين كل من التركيز المستخدم ونسب التعذر أو خروج الفراشات. ومن ناحية أخري تزايدات نسب التعذر وخروج الفراشات بتزايد العمر اليرقي قبل المعاملة. وسجل أيضا تأثيرا متأخرا لكلا المستحضرين على عدد البيض ونسبة الفقس.