RESULTS AND DISCUSSION

I. Laboratory bioassay tests on *S. cretica* larvae:

Different instars of *S. cretica* larvae (1^{st}, 3^{rd} and 5^{th} instars) were fed on fresh tender pieces of maize stems treated with biopesticides.

I.1. (LT_{50}'s) of different assayed biopesticides (entomopathogenic bacteria & nematodes):

A- 1^{st} instar larvae:

Data presented in Table (1) demonstrate the cumulative mortality percentages among *S. cretica* larvae treated in their 1^{st} instar on the assayed biopesticides after 3, 6, 10, 14 and 18 days from treatment. These data showed that the mortality percentages increased as the applied concentration was increased, on one hand, and by prolongation of the period after treatment, on the other hand.

Treatments of maize stem pieces by the different biopesticides (at 8 gm / liter and 1000 J / ml concentration, for entomopathogenic bacteria and nematode, respectively) caused mortalities among *S. cretica* 1^{st} instar larvae that ranged from 30.3% (recommended pesticide; Diazinox treatment) to 66.6% (*S. carpocapsae* treatment) after 3 days from treatment. After 6 days, the mortality percentages increased to range from 46.6% (Diazinox treatment) to 73.2% (*S. carpocapsae* treatment), then reached to range from 49.9% (Xentari +

Table (1): Corrected mortality percentages for *S. cretica* 1[st] instar larvae after feeding on tender maize stem pieces treated with different biopesticides, (data from 80 larvae / treatment).

Treatments	Conc. gm / L or IJs / ml	Cumulative mortality % after days of treatments				
		3	**6**	**10**	**14**	**18**
1- Dipel 2X	2	33.3	46.6	56.6	59.9	79.9
	4	40	53.3	66.6	76.6	89.8
	8	56.6	63.2	76.5	86.5	89.8
2- Dipel 2X + molasses 10%	2	43.2	49.8	56.4	56.4	66.3
	4	49.8	56.4	59.7	59.7	72.9
	8	53.1	59.7	69.7	72.9	76.2
3- Dipel 2X + K_2CO_3 1%	2	33.3	39.9	49.9	59.9	66.5
	4	40	43.3	59.9	63.2	69.9
	8	50	56.6	63.3	69.9	75.5
4-Xentari	2	43.2	46.9	50	53.1	59.9
	4	46.6	50	53.1	56.5	63.2
	8	50	60	63.2	66.6	75.5
5- Xentari + molasses 10%	2	36.6	40	43.2	49.9	53.2
	4	46.6	50	50	53.2	63.3
	8	53.3	59.6	63.3	69.9	70
6- Xentari + K_2CO_3 1%	2	39.9	43.2	46.6	53.1	56.6
	4	43.2	50	56.6	59.7	63.3
	8	50	53.6	63.6	70.2	73.5
7- *Steinernema carpocapsae.*	4000	43.2	53.6	56.6	66.5	73.5
	2000	53.3	63.6	69.9	76.5	79.8
	1000	66.6	73.2	79.8	86.5	89.8
8- *Steinernema riobravae*	4000	40	43.2	53.3	62.5	66.6
	2000	46.6	49.9	56.6	69.8	69.9
	1000	53.3	56.6	63.2	76.5	76.5
9- Dipel 2X + *S. carpocapsae* LC_{50} (≈ 250 IJ /ml)	2	39.9	43.2	59.9	69.9	76.5
	4	46.6	56.6	66.6	83.2	86.5
	8	56.6	66.6	73.2	86.5	93.1
10- Dipel 2X + *S. riobravae* LC_{50} (≈ 375 IJ / ml)	2	40	46.6	56.6	66.6	76.6
	4	46.6	59.9	69.9	72.9	79.9
	8	53.3	63.3	73.3	83.3	83.3
11- Xentari + *S. carpocapsae* LC_{50} (≈ 250 IJ /ml)	2	36.6	40	46.6	53.2	63.6
	4	43.2	49.9	53.3	59.9	69.9
	8	50	60	66.6	73.2	79.8
12- Xentari + *S. riobravae* LC_{50} (≈ 375 IJ / ml)	2	36.6	39.9	43.2	53.3	63.6
	4	39.9	43.2	46.6	63.6	66.6
	8	43.2	46.5	49.9	76.6	76.6
13- Diazinox	2	28.2	40	46.6	53.3	62.5
	4	28.2	43.2	50	59.9	73.2
	8	30.3	46.6	56.6	63.6	76
14- Control	0	10	13.3	15.3	18.3	20

Table (2): LT_{50} values calculated after biopesticides treatment to *S. cretica* 1st instar larvae.

Treatments	LT_{50} days	Slope	Confidence limits PO 0.05
			LT_{50}
1- Dipel 2X	3.37	1.432	2.206 : 4.366
2- Dipel 2X + molasses 10%	3.816	0.780	1.460 : 5.631
3- Dipel 2X + K_2CO_3 1%	5.581	0.788	3.005 : 7.747
4- Xentari	4.880	0.703	1.978 : 7.116
5- Xentari + molasses 10%	3.903	0.506	– : –
6- Xentari + K_2CO_3 1%	5.581	0.788	3.005 : 7.747
7- *Steinernema carpocapsae*	1.623	1.003	0.465 : 2.756
8- *Steinernema riobravae*	4.423	0.844	2.163 : 6.201
9- Dipel 2X + *S.carpocapsae* LC_{50}	3.349	1.49	2.241 : 4.303
10- Dipel 2X + *S.riobravae* LC_{50}	3.593	1.197	2.16 : 4.789
11- Xentari + *S.carpocapsae* LC_{50}	4.552	0.9973	2.626 : 6.121
12- Xentari + *S.riobravae* LC_{50}	7.89	1.235	– : –
13- Diazinox	10.56	1.338	8.700 : 13.34

- bacterial products were applied at 8 gm / L
- nematodes were applied at 1000 IJ / ml

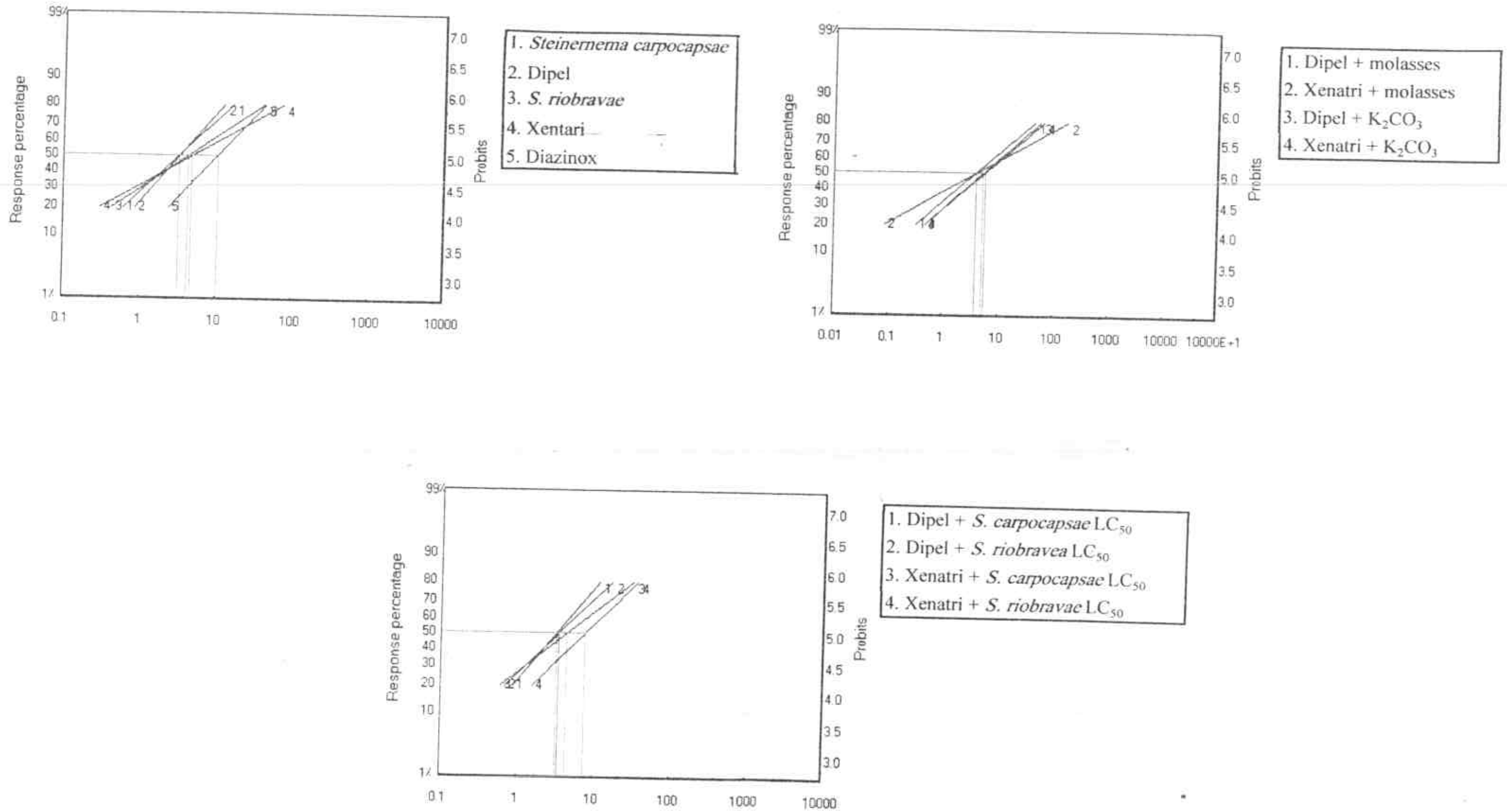


Fig (1): Probit- regression – time lines showing response of 1[st] instar *S. cretica* larvae fed on tender pieces of maize stems treated with different biopesticides.

S. riobravae LC_{50} treatment) to 79.8% (*S. carpocapsae* treatment), 10 days after treatment. Noticeable increase occurred in mortalities at the day 14^{th} after treatment, ranging from 63.6% (Diazinox treatment) to 86.5% (from Dipel 2X, (*S. carpocapsae* and Dipel 2X + *S. carpocapsae* LC_{50}, treatments). At the 18^{th} day after treatment, the cumulative mortality percentages increased to range from 76% (Diazinox treatment) to 93.1% by feeding the larvae on food treated with Dipel 2X + *S. carpocapsae* LC_{50} treatment (Table, 1).

Data of LT_{50} values indicated that the shorter LT_{50}'s (Higher efficacy) were obtained as a result from *S. carpocapsae*, Dipel 2X + *S. carpocapsae* LC_{50} and Dipel 2X treatments, being 1.62, 3.35 and 3.37 days, respectively. Intermediate values were obtained from treatments by Xentari + molasses 10%, *S.* and Xentari + *S. carpocapsae* LC_{50}, being 3.90, 4.42 and 4.55 days, respectively. While, the longest LT_{50} (lowest efficacy) was 10.6 days after Diazinox treatment at 6 Kg / feddan (Table, 2 Fig., 1).

B- 3rd instar larvae:

Treatments of maize stem pieces by the different biopesticides at 8 gm of bacterial product / liter; 1000 IJ of entomopathogenic nematode / ml distilled water or their mixtures caused mortalities among *S.*

Table (3): Corrected mortality percentages among *S. cretica* larvae after 3rd instar larval feeding on fresh succulent maize stems treated by different biopesticides (80 larvae / treatment).

Treatments	Conc. gm / L or IJs / ml	Cumulative mortality % after days of treatments			
		2	**6**	**9**	**12**
1- Dipel 2X	2	40	50	63.3	73.3
	4	46.6	63.3	80	89.9
	8	60	73.3	83.2	90.3
2- Dipel 2X + molasses 10%	2	43.3	46.6	53.2	59.9
	4	46.6	53.2	59.8	66.6
	8	50	56.6	66.6	76.6
3- Dipel 2X + K_2CO_3 1%	2	53.3	59.9	63.3	66.6
	4	56.6	63.3	66.6	69.8
	8	63.3	63.3	69.8	73.2
4-Xentari	2	26.6	40	49.9	63.3
	4	26.6	43.3	60	63.3
	8	40	43.3	60	73.3
5- Xentari + molasses 10%	2	36.6	43.2	49.9	56.6
	4	40	46.6	53.3	59.9
	8	43.3	53.3	63.3	73.3
6- Xentari + K_2CO_3 1%	2	33.3	39.9	46.5	59.8
	4	36.6	43.2	49.8	63
	8	40	46.6	56.6	66.6
7- *Steinernema carpocapsae.*	4000	43.3	49.6	50.8	69.8
	2000	49.9	56.6	66.6	76.5
	1000	70	80.3	82	84.5
8- *Steinernema riobravae*	4000	43.3	49.9	53.3	66
	2000	46.6	49.9	59.9	63.3
	1000	56.6	66.6	73.2	80
9- Dipel 2X + *S. carpocapsae* LC_{50} (≈ 315 IJ / ml)	2	46.6	63.2	56.6	80.3
	4	50	63.2	63.3	84.5
	8	53.3	66.6	76.6	89.8
10- Dipel 2X + *S. riobravae* LC_{50} (≈ 625 IJ / ml)	2	40	50	56.6	63.2
	4	43.3	53.3	59.8	66.6
	8	50	56.6	63.2	76.5
11- Xentari + *S. carpocapsae* LC_{50} (≈ 315 IJ / ml)	2	66.6	73.2	79.8	80
	4	76.6	79.9	89.9	90
	8	83.2	86.6	93.2	93.1
12- Xentari + *S. riobravae* LC_{50} (≈ 625 IJ / ml)	2	36.6	36.6	39.9	46.5
	4	36.6	36.6	49.9	63.2
	8	40	53.3	76.6	76.6
13- Diazinox	2	30	33.3	43.3	60
	4	33.3	40	50	66.6
	8	40	43.3	60	73.3
14- Control	0	6.6	9.9	16.5	19.8

Table (4): LT_{50} values (days) calculated after biopesticides treatment to *S. cretica* 3rd instar larvae.

Treatments	LT_{50}	Slope	Confidence limits PO 0.05 LT_{50}
1- Dipel 2X	1.643	1.118	0.693 : 2.494
2- Dipel 2X + molasses 10%	3.764	0.755	1.698 : 5.515
3- Dipel 2X + K_2CO_3 1%	6.76	0.551	— : —
4- Xentari	7.591	0.961	— : —
5- Xentari + molasses 10%	5.6	0.876	3.75 : 7.971
6- Xentari + K_2CO_3 1%	9.785	0.719	6.559 : 24.35
7- *Steinernema carpocapsae*	1.519	0.723	0.201: 2.759
8- *Steinernema riobravae*	2.834	0.975	0.86 : 4.184
9- Dipel 2X + *S.carpocapsae* LC_{50}	2.53	1.246	— : —
10- Dipel 2X + *S.riobravae* LC_{50}	3.815	0.828	— : —
11- Xentari + *S.carpocapsae* LC_{50}	4.52	1.474	— : —
12- Xentari + *S.riobravae* LC_{50}	4.71	1.331	3.575 : 5.875
13- Diazinox	5.52	0.642	2.85 : 9.389

- bacterial products were applied at 8 gm / L
- nematodes were applied at 1000 IJ / ml

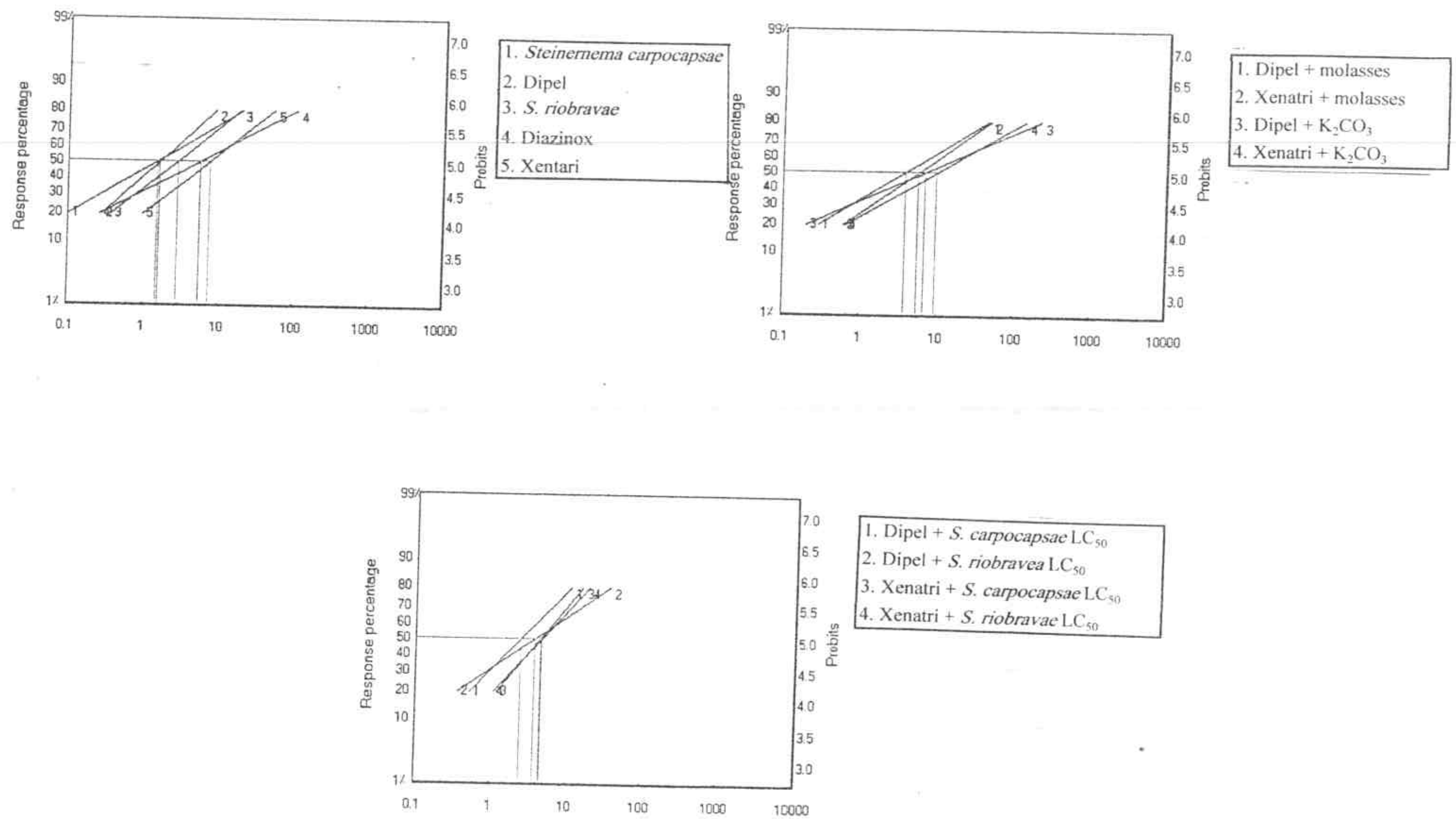


Fig (2): Probit- regression – time lines showing response of 3[rd] instar *S. cretica* larvae fed on tender pieces of maize stems treated with different biopesticides.

cretica 3rd instar larvae, that ranged from 40% (for Xentari, Xentari + K_2CO_3 1%, Xentari + *S.* LC_{50} and Diazinox treatments) to 83.2% (Xentari + *S. carpocapsae* LC_{50} treatment) after 2 days from treatment. After 6 days from treatment, the mortality percentages increased to range from 43.3% (Xentari and Diazinox treatments) to 86.6% (for Xentari + *S. carpocapsae* LC_{50} treatment) then to a range from 56.6% (X + K_2CO_3 1%) to 93.2% for both treatments of (Xentari + *S. carpocapsae* LC_{50}), 9 days after treatment. Noticeable increase occurred in mortality at the day 12th after treatment, ranging from 66.6% (Xentari + K_2CO_3), to 93.1% (Xenatri + *S. carpocapsae* LC_{50} treatments), (Table, 3).

Data of LT_{50} values, after treatment by each of the biopesticides at 8 gm of *B.t.* product / liter, 1000 IJs / ml concentration or their mixtures, indicated that the shorter LT_{50}'s (Higher efficacies) were obtained as a result of treatment by *S. carpocapsae*, Dipel 2X and (Dipel 2X + *S. carpocapsae* LC_{50}) and *S.* treatments, being 1.52, 1.64 and 2.53 and 2.83 days, respectively. Intermediate values were obtained after treatments by (Dipel 2X + molasses 10%), (Dipel 2X + *S.* LC_{50}), (Xenatri + *S. carpocapsae* LC_{50}) and (Xenatri + *S.r.* LC_{50}) being (3.76, 3.82, 4.52 and 4.71 days, respectively). While, the longest LT_{50} (lowest efficacy) was 9.78 days obtained from Xentari + K_2CO_3 1% treatment (Table, 4 Fig., 2).

C- 5th instar larvae:

The cumulative mortality percentages among *S. cretica* larvae after 3, 6, 9 days from 5th instar larval treatments are tabulated in Table (5). These data showed also that the mortality percentages increased as the applied concentration was increased and by prolongation of the period after treatment.

Treatments of maize stem pieces by the bacterial biopesticides at 8 gm / liter, the nematodes at 1000 IJ / ml and their mixtures, and offering the treated food to *S. cretica* 5th instar larvae caused mortalities among the treated larvae, that ranged from 46.6% (Xenatri and Xenatri + *S.r.* LC_{50} treatments) to 66.6% (Dipel 2X + K_2CO_3 treatment) after 3 days from treatment. Three days later, these percentages ranged from 59.9% (Xentari) to 73.2% (Dipel 2X + K_2CO_3 and Dipel 2X + *S.c.* LC_{50} treatments), then reincreased to 69.8% (Xentari + molasses 10%) treatment to 93.3% Dipel 2X, after 9 days from treatment, (Table, 5).

Data of LT_{50} values, after treatment by each of the biopesticides at 8 gm *B.t.* product / liter, 1000 IJs / ml concentration or their mixtures are presented in Table (6) and Fig. (3). The shorter LT_{50}'s (1.6, 2.1 and 2.3 days) were obtained from *S. carpocapsae*, Dipel 2X + *S. carpocapsae* LC_{50} and Dipel 2X treatments, respectively.

Table (5): Corrected mortality percentages among *S. cretica* larvae after 5^{th} instar larval feeding on fresh succulent maize stems treated with different assayed materials (80 larvae / treatment).

Treatments	Conc. gm / L or IJs / ml	Cumulative mortality % after days of treatments		
		3	**6**	**9**
1- Dipel 2X	2	43.3	59.9	76.1
	4	53.2	69.8	79.8
	8	60	70	93.3
2- Dipel 2X + molasses 10%	2	50	56.6	63.2
	4	53.3	63.3	69.9
	8	56.6	66.6	76.6
3- Dipel 2X + K_2CO_3 1%	2	56.6	66.6	69.9
	4	63.3	66.6	76.6
	8	66.6	73.2	79.8
4-Xentari	2	30	46.6	56.6
	4	33.3	53.3	59.9
	8	46.6	59.9	73.2
5- Xentari + molasses 10%	2	43.3	50	60
	4	50	56.6	63.2
	8	53.3	63.2	69.8
6- Xentari + K_2CO_3 1%	2	40	50	60
	4	46.6	53.2	63.2
	8	50	60	70
7- *Steinernema carpocapsae.*	4000	50	53.3	63.3
	2000	53.3	69.9	76.6
	1000	73.3	86.6	93.2
8- *Steinernema riobravae*	4000	50	53.3	63.3
	2000	50	56.6	66.6
	1000	56.6	69.9	73.2
9- Dipel 2X + *S. carpocapsae* LC_{50} (≈ 250 IJ / ml)	2	50	46.6	73.2
	4	56.6	56.6	76.6
	8	60	73.2	80
10- Dipel 2X + *S. riobravae* LC_{50} (≈ 375 IJ / ml)	2	50	60	63.3
	4	53.3	63.3	66.6
	8	56.6	66.6	79.9
11- Xentari + *S. carpocapsae* LC_{50} (≈ 250 IJ / ml)	2	40	60	63.2
	4	46.6	66.6	69.8
	8	50	66.6	73.3
12- Xentari + *S. riobravae* LC_{50} (≈ 375 IJ / ml)	2	40	46.6	70
	4	43.3	53.2	73.2
	8	46.6	63.2	76.5
13- Diazinox	2	40	46.6	60
	4	43.3	53.2	63.3
	8	49.9	63.6	73.3
14- Control	0	9.9	13.2	16.5

Table (6): LT_{50} values calculated after bioinsecticide treatments to *S. cretica* 5[th] instar larvae.

Treatments	LT_{50} days	Slope	Confidence limits PO 0.05
			LT_{50}
1- Dipel 2X	2.296	1.551	– : –
2- Dipel 2X + molasses 10%	2.87	0.855	1.083 : 4.252
3- Dipel 2X + K_2CO_3 1%	2.87	0.855	1.083 : 4.252
4- Xentari	5.106	1.154	3.738 : 7.176
5- Xentari + molasses 10%	4.205	0.695	– : –
6- Xentari + K_2CO_3 1%	5.189	0.834	3.263 : 9.108
7- *Steinernema carpocapsae*	1.606	0.977	0.416 : 2.567
8- *Steinernema riobravae*	2.529	0.963	1.046 : 3.665
9- Dipel 2X + *S.carpocapsae* LC_{50}	2.055	0.94	0.644 : 3.126
10- Dipel 2X + *S.riobravae* LC_{50}	2.817	0.999	1.36 : 3.977
11- Xentari + *S.carpocapsae* LC_{50}	4.01	1.067	2.612 : 5.524
12- Xentari + *S.riobravae* LC_{50}	4.447	1.341	3.331 : 5.768
13- Diazinox	4.309	1.027	2.835 : 6.09

- bacterial products were applied at 8 gm / L
- nematodes were applied at 1000 IJ / ml

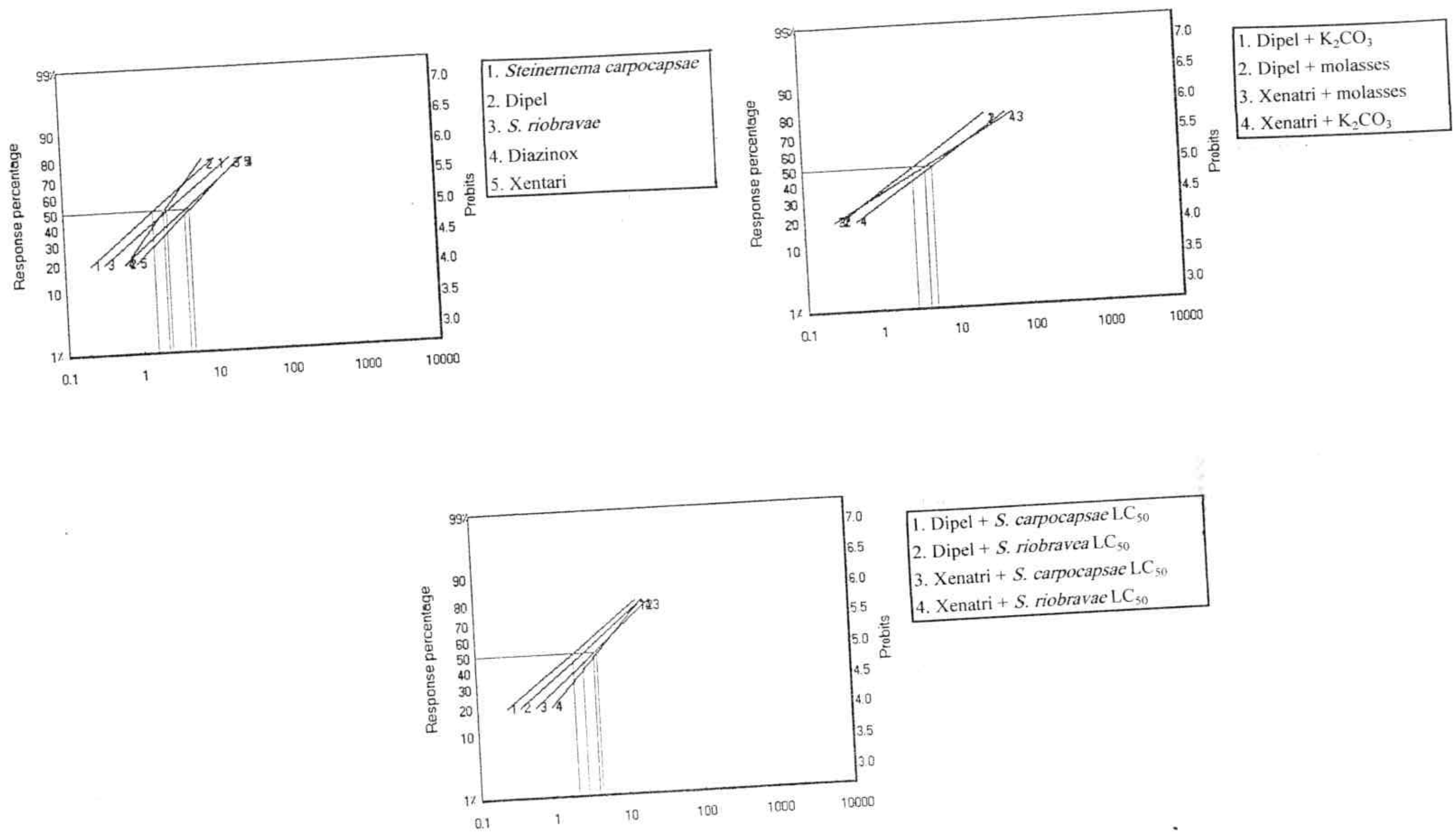


Fig (3): Probit- regression – time lines showing response of 5[th] instar *S. cretica* larvae fed on tender pieces of maize stems treated with different biopesticides.

Accordingly, these 3 treatments could be considered of higher efficacy. Intermediately effective materials were Dipel 2X + molasses 10%, Dipel 2X + K_2CO_3 1%, Xentari + *S. carpocapsa* LC_{50} and Xentari + molasses 10%, (2.9, 2.9, 4.0 & 4.2 days, respectively. While, the longest LT_{50} (lowest efficacy) was 5.18 days after Xentari + K_2CO_3 1% treatment, followed by (Xentari, 5.1 days) and (Xentari + *S.* LC_{50}; 4.5 days) (Table, 6 Fig., 3).

I.2. Comparative toxicity (LC_{50}'s) of different assayed biopesticides (*B.t.* bioinsecticides & entomopathogenic nematodes):

A- 1st instar larvae:

Calculated LC_{50} values after 14 days from treatments of *S. cretica* 1st, larval instars by different concentrations of the assayed materials are presented in Table (7) and Fig. (4). (Xentari + *S.r.* LC_{50}) manifested the highest efficacy (LC_{50} = 0.036 gm / L) followed by Dipel 2X + *S.riobravae* LC_{50} (0.04 gm / L) and Dipel 2X + *S. carpocapsae* LC_{50} (0.061 gm / liter). While, the LC_{50} after treatments by the recommended insecticide Diazinox reached 0.174 gm / L. The intermediate efficacy was obtained from

Table (7): LC_{50} values of different assayed biopesticides on *S. cretica* treated as 1st instar larvae, after 14 days from treatment.

Treatments	LC_{50} after 14 days	Slope	Confidence limits PO 0.05
			LC_{50}
1- Dipel 2X	0.084	1.04	0.056 : 0.112
2- Dipel 2X + molasses 10%	0.121	0.662	0.068 : 0.179
3- Dipel 2X + K_2CO_3 1%	0.083	0.523	0.028 : 0.139
4- Xentari	0.203	0.653	0.132 : 0.313
5- Xentari + molasses 10%	0.168	0.575	0.096 : 0.267
6- Xentari + K_2CO_3 1%	0.149	0.66	0.091 : 0.221
7- *Steinernema carpocapsae*	258.95	0.84	124.788 :394.041
8- *Steinernema riobravae*	356.298	0.705	166.923 : 545.01
9- Dipel 2X + *S.carpocapsae* LC_{50}	0.061	1.026	0.037 : 0.085
10- Dipel 2X + *S.riobravae* LC_{50}	0.04	0.752	0.015 : 0.066
11- Xentari + *S.carpocapsae* LC_{50}	0.146	0.746	0.095 : 0.206
12- Xentari + *S.riobravae* LC_{50}	0.036	0.621	0.0088 : 0.067
13- Diazinox	0.174	0.562	0.1 : 0.283

N.B. LC_{50}'s were calculated after 14 days from treatment for the 1st instar

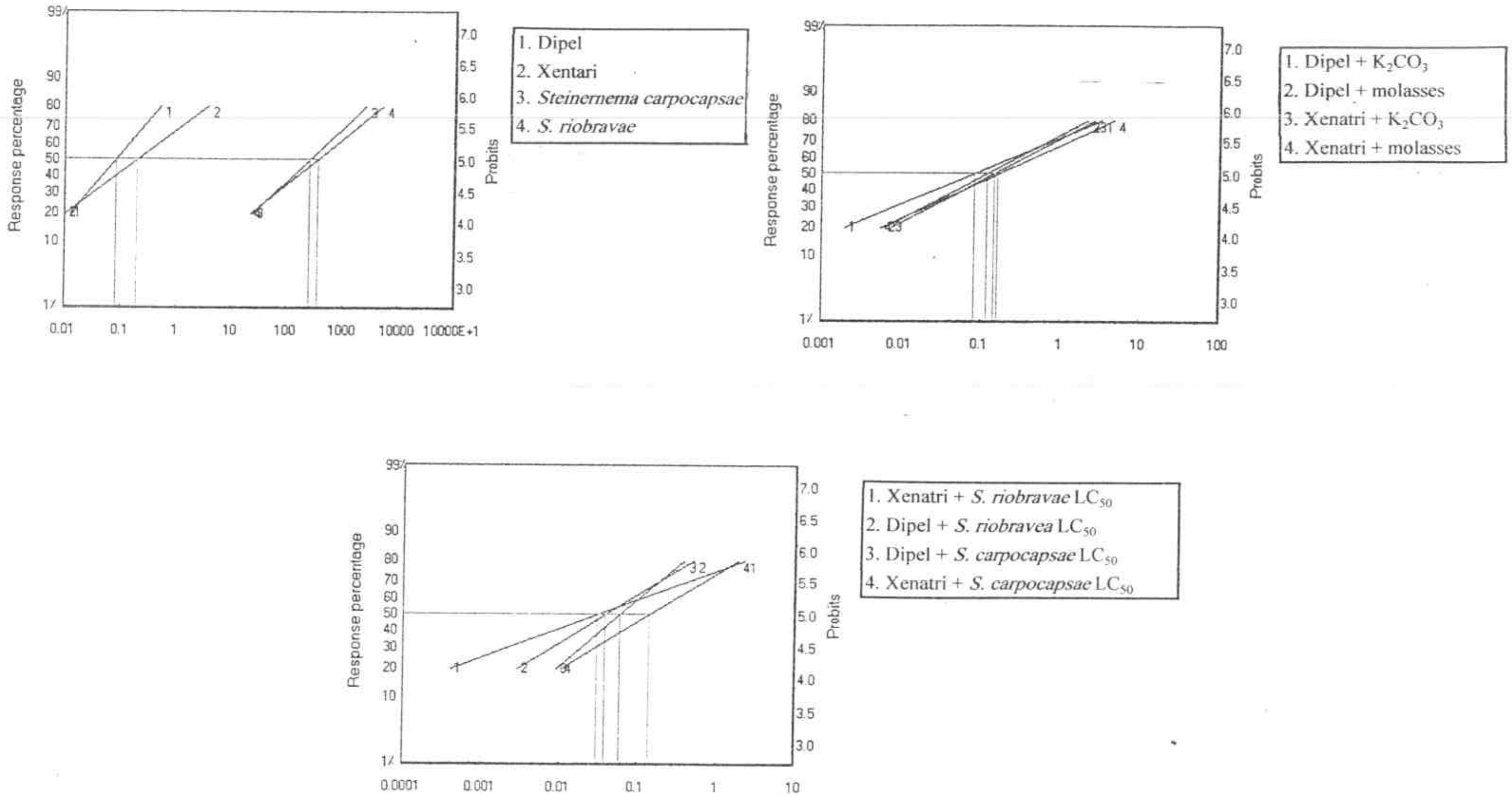


Fig (4): Log concentration probit lines showing response of 1st instar *S. cretica* larvae, 14 days after feeding on tender pieces of maize stems treated with different biopesticides.

treatments by Dipel 2X, Dipel 2X + molasses 10% and Xentari + *S. carpocapsae*, being 0.084, 0.121 and 0.146, respectively. Comparing the nematode treatments, *S. carpocapsae* was of higher efficacy (LC50 = 258.95 IJ / ml) than *S.r.* (356.298 IJ / ml; Table, 7).

B- 3rd instar larvae:

As shown in Table (8) and Fig. (5), 9 days after *S. cretica* 3rd instar larval treatment, the highest efficacy resulted from larval feeding on food treated by Xentari + *S.* LC_{50}) (LC_{50} = 0.013%), followed by Xenatri +*S. riobravae* (LC_{50} = 0.02 gm / L). While, on the contrary, the lowest efficacy (LC_{50} = 0.363 gm / L) resulted from treatment by the recommended chemical pesticide Diazinox. Intermediate LC_{50} values (0.07, 0.076, 0.081 and 0.087 gm / L) resulted from the following treatments, (Dipel 2X + K_2CO_3 1%), Dipel 2X, (Dipel 2X + *S.c.* LC_{50}) and (Dipel 2X + *S.* LC_{50}). For the nematode treatments, *S. carpocapsae* was of higher efficacy than *S.* , showing LC_{50}'s 292.371 and 596.863 J / ml, respectively, (Table, 8 and Fig., 5).

Table (8): LC_{50} values of different treatments, 9 days after treatment of *S. cretica* 3rd instar larvae.

Treatments	LC_{50}	Slope	Confidence limits PO 0.05 LC_{50}
1- Dipel 2X	0.076	0.967	0.047 : 0.105
2- Dipel 2X + molasses 10%	0.114	0.479	0.042 : 0.194
3- Dipel 2X + K_2CO_3 1%	0.07	0.485	0.017 : 0.126
4- Xentari	0.192	0.554	0.112 : 0.321
5- Xentari + molasses 10%	0.148	0.508	0.072 : 0.249
6- Xentari + K_2CO_3 1%	0.252	0.366	– : –
7- *Steinernema carpocapsae*	292.371	0.728	128.217 :457.435
8- *Steinernema riobravae*	596.863	0.783	376.24 : 834.156
9- Dipel 2X + *S.carpocapsae* LC_{50}	0.081	0.614	0.034 : 0.127
10- Dipel 2X + *S.riobravae* LC_{50}	0.087	0.367	– : –
11- Xentari + *S.carpocapsae* LC_{50}	0.013	0.658	0.0014 : 0.031
12- Xentari + *S.riobravae* LC_{50}	0.02	0.559	0.002 : 0.046
13- Diazinox	0.363	0.759	0.256 : 0.602

N.B. LC_{50}'s were calculated after 9 days from treatment for the 3rd instar

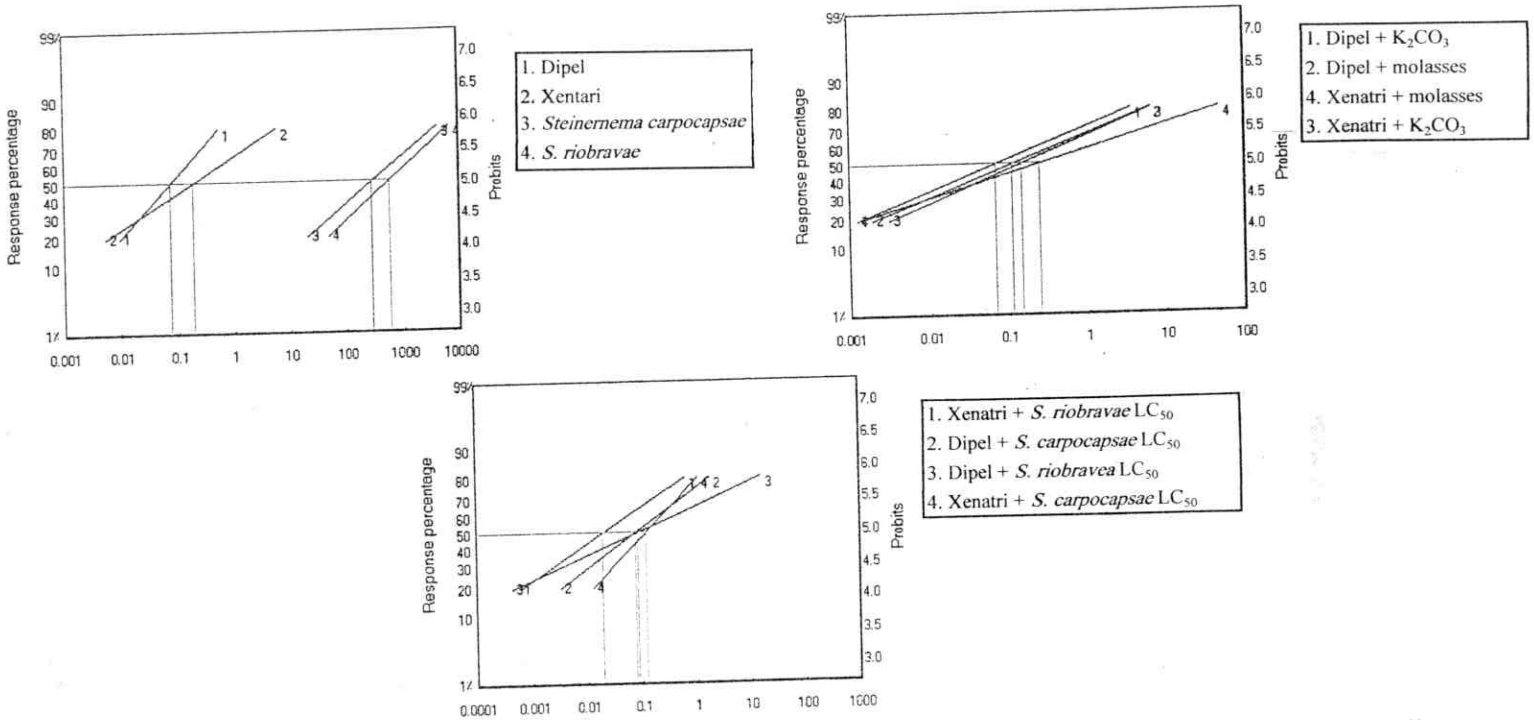


Fig (5): Log concentration probit lines showing response of 3rd instar *S. cretica* larvae, 9 days after feeding on tender pieces of maize stems treated with different materials.

C- 5^{th} instar larvae:

After 6 days from treatments by different concentrations of the assayed perapartations, (Dipel 2X+ *S.* LC_{50}) manifested the highest efficacy on *S. cretica* 5^{th} instar larvae, as this material led to the lowest LC_{50}, (0.027 gm / liter), followed by (Dipel 2X + K_2CO_3 1%; 0.052), (Xentari + *S. carpocapsae* LC_{50}; 0.076 gm / L), (Dipel 2X; 0.08 gm / L) and (Dipel 2X + molasses 10%; 0.085 gm / L) (Table, 9 and Fig. 6). While on the contrary, treatment by (Xentari) led to the highest value (0.286%) indicating the least efficacy followed by Diazinox (0.232), Xenatri + K_2CO_3 1% (0.221) and Xenatri + *S.* (LC_{50} = 0.219). The remaining preparations could be considered intermediately effective, including Dipel 2X + *S. carpocapsae.* (LC_{50} 0.168 gm / liter) and Xentari + molasses 10% (0.186). Comparing the two entomopathogenic nematode species, data of LC_{50}'s indicated the *S. carpocapsae* was more virulent showing LC_{50} after 6 days from treatment = 260 IJ / ml than *S. riobravae* which showed higher LC_{50} = 356.29 IJ / ml distilled water (Table, 9 and Fig. 6).

Bioassay tests clearly demonstrated that *S. carpocapsae* proved to be the best treatment among all the assayed treatments as the shortest LT_{50} for the three tested larval instars of *S. cretica* and also the lowest LC_{50}'s were realized after feeding the *S.*

Table (9): LC_{50} values of different assayed preparations, on *S. cretica* treated as 5th instar larvae after 6 days from treatment.

Treatments	LC_{50}	Slope	Confidence limits PO 0.05 LC_{50}
1- Dipel 2X	0.08	0.608	0.033 : 0127
2- Dipel 2X + molasses 10%	0.085	0.455	0.021 : 0.152
3- Dipel 2X + K_2CO_3 1%	0.052	0.528	0.012 : 0.095
4- Xentari	0.286	0.565	0.181 : 0.545
5- Xentari + molasses 10%	0.186	0.505	0.1 : 0.329
6- Xentari + K_2CO_3 1%	0.221	0.42	0.108 : 0.513
7- *Steinernema carpocapsae*	260.06	0.745	110.10 : 412.5
8- *Steinernema riobravae*	356.29	0.705	166.92 : 545.0
9- Dipel 2X + *S.carpocapsae* LC_{50}	0.168	0.683	0.108 : 0.248
10- Dipel 2X + *S.riobravae* LC_{50}	0.027	0.289	– : –
11- Xentari + *S.carpocapsae* LC_{50}	0.076	0.487	0.02 : 0.134
12- Xentari + *S.riobravae* LC_{50}	0.219	0.474	0.119 : 0.435
13- Diazinox	0.232	0.542	0.141 : 0.419

N.B. LC_{50}'s were calculated after 6 days from treatment for the 5th instar

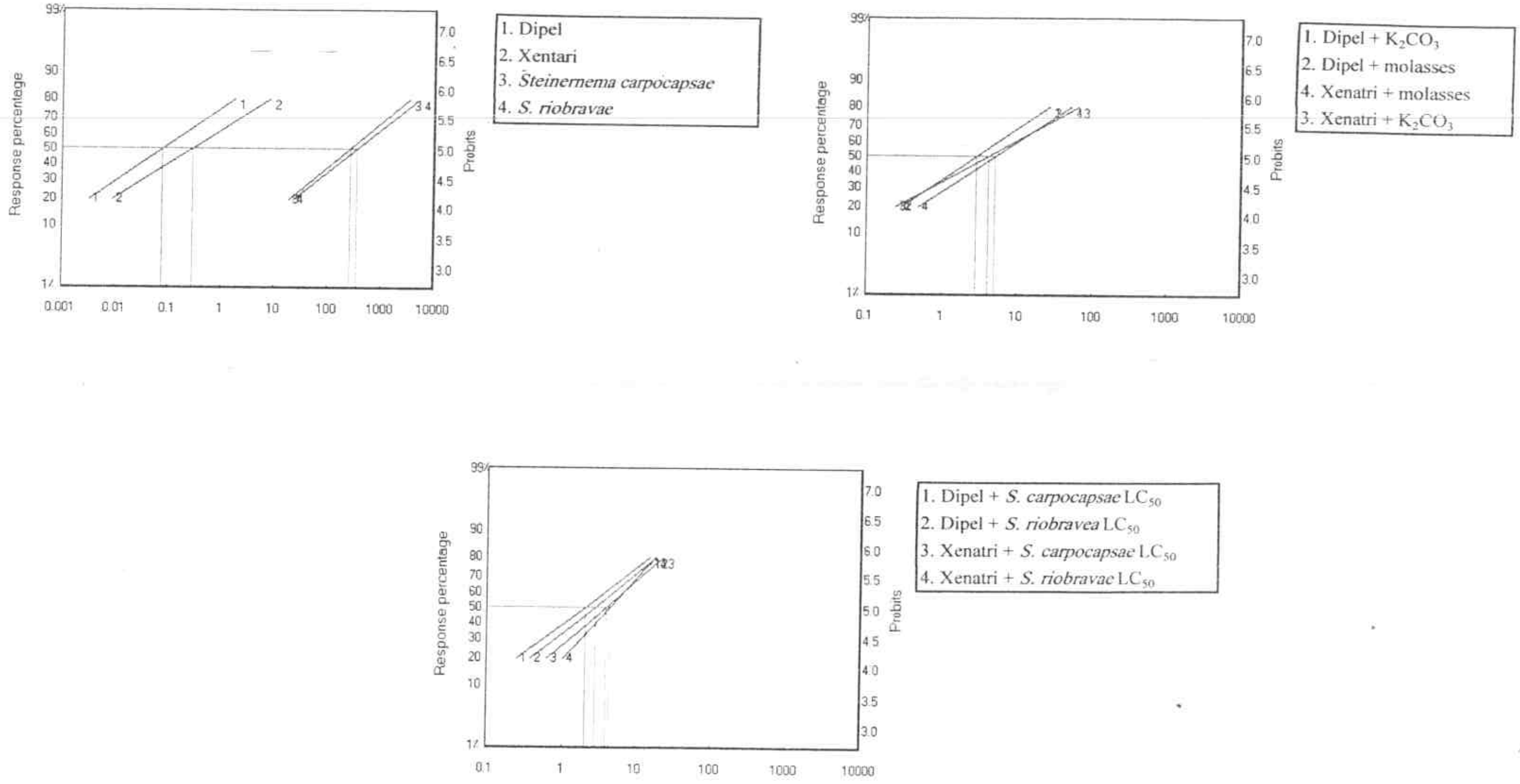


Fig (6): Log concentration probit lines showing response of 5th instar *S. cretica* larvae, 6 days after feeding on tender pieces of maize stems treated with different materials.

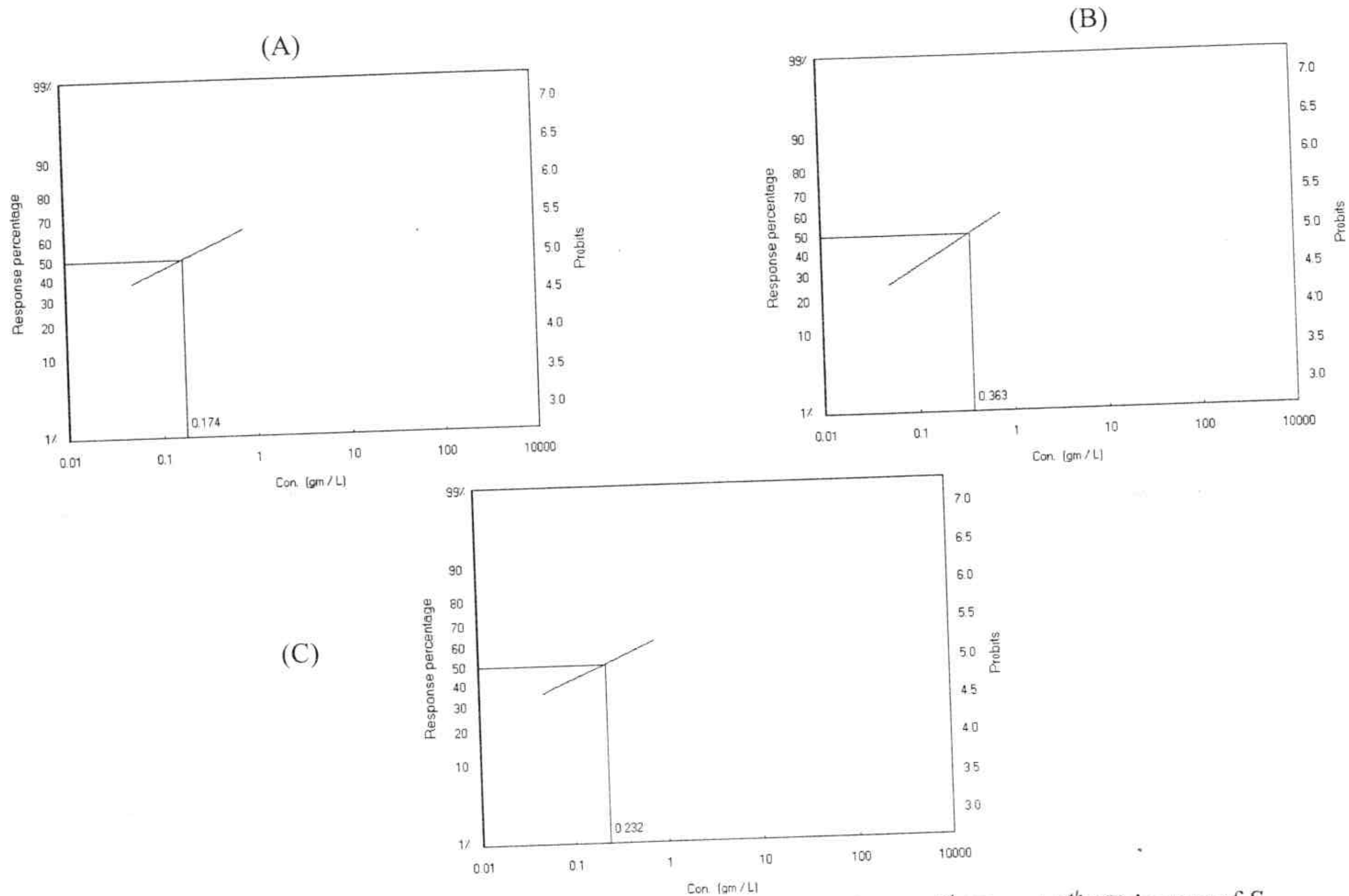


Fig (7): Log concentration probit lines showing response of 1st (A), 3rd (B) and 5th (C) instars of *S. cretica* larvae fed on tender pieces of maize stems treated with Diazinox.

cretica larvae on maize treated with this nematode. While in case of LC_{50}'s treatments with Xenatri + *S.* LC_{50}, Xenatri at lower concentration + *S. carpocapsae* and Dipel at lower concentration + *S.* LC_{50} caused the lowest LC_{50} values for *S. cretica larvae*, respectively.

All the results of laboratory bioassay experiments against different instars of *S. cretica* larvae with different instars are considered in harmony with those obtained by **Sosa *et al.* (1993)** who evaluated *S. carpocapsae* in the control of *Diatraea saccharalis*, by applying 5000 individuals / ml of *S. carpocapsae* to the diet of *D. saccharalis* resulted in 100% mortality of 3^{rd} and 4^{th} instar larvae. *S. carpocapsae* also caused 95% mortality of larvae tunneling inside pieces of sugarcane stem.

El-Sebay and El-Bishry (1994) studied the efficacy of *S. carpocapsae and S. glaseri and* a commercial preparation *of B. thuringiensis* against the subterranean termite *Anacanthotermes ochroceous* under laboratory conditions by subjecting termites to contaminated diet. Their results revealed that mortality rates ranged from 58.49 to 100%. *S. carpocapsae* alone was the most effective bioagent followed by *S. glaseri.* The lowest mortality rate was obtained in case of *B. thuringiensis* treatment. Mixing *B. thuringiensis* with *S. glaseri* enhanced the mortality. The opposite was evident with *S. carpocapsae*. Coating the diet with agar as a moistening material increased the efficacy of *B. thuringiensis* and *S. glaseri*, while *S. carpocapsae* was negatively affected. Nematode development inside dead termites was detected only in case of *S. glaseri*, while *S. carpocapsae* failed to complete its life cycle. **Khlibsuwan and Wirote (1996)** studied the pathogenicity of *S. carpocapsae* on *S. litura* on filtered paper bioassay. It was found that infection of 4^{th} instar larvae by *S. carpocapsae* was greater than those of 5^{th} instar larvae while for the 3^{rd} instar, it was the lowest. For determining the LC & LT $_{50}$' s, **Cheng *et al.* (1998)** found that the *S. carpocapsae* were highly pathogenic recording LC_{50} values to 3^{rd}, 4^{th} and 5^{th} instar larvae 7.5, 8.7 and 16.3 IJ / ml, respectively, and the LT_{50}'s were 1.4, 2.4 and 4.9 hrs for the same instars, respectively.

Also **Ignoffo (1981)** found that the LC_{50} and the slope rate mortality time for *B.t. kurstaki* against *Trichoplusia ni* were 15.9 µg /ml and 1.97 $\pm$ 0.2, respectively.

El-Gemeiy (1983) found that the effect of Bactospeine increased with the increase of its concentration and the decrease in *P. gossypiella* larval age. The LC_{50} values were 87.1 and 61.4 IU / gr diet for the 2^{nd} and 4^{th} instar larvae, respectively. **Mattar *et al.* (1999)** investigated the susceptibility of the 2^{nd}, 3^{rd} and 4^{th} instar larvae of the semi looper *Autographa gamma* to Delfin (formulation of *B.t. krustaki*). It was concluded that susceptibility to *B.t. krustaki* decreased with the development of larvae. The LC_{50} value for 4^{th} instar larvae was 2.42 while, LC_{50} was 1.98 fold higher than that of 2^{nd} instar. Also, it was found that survivors from exposure in the 2^{nd}, 3^{rd} instars to LC_{25} and LC_{50} concentrations had significantly prolonged larval and pupal duration. For example the larval duration of 2^{nd} instar exposed to the LC_{25} concentration was 32 days, compared to 22 days in the untreated control. Up to 33% of pupae were malformed following exposure of 2^{nd} or 3^{rd} instars to the LC_{50} concentrations. Adults derived from treatment of different larval instars had, significantly, reduced longevity and fecundity.

Hafez *et al.* (2003) determined the LC_{50} value after 48 hours from treating *S. cretica* 1^{st} instar larvae by Delfin (a commercial product of *B. thuringiensis*) and NaCl 1% on being 5.2 X 10^4 IU.

II. Evaluation of bacterial biopesticides application in maize fields on *S. cretica* infestations:

II.1. On *S. cretica* eggs & egg-masses:

Under field conditions, in 2003 & 2004 maize seasons, at Moshtohor (Qalubiah governorate) two bactericides were applied (alone or with additives) on maize plants to evaluate their efficacy on infestations by *S. cretica* eggs. As shown in Table (10), five days after first spray (May, 4^{th} 2003 & 7^{th} 2004), all treatments caused significant reductions in *S. cretica* egg-masses & number of egg counts on maize leaf sheaths. Highest egg counts (two year averages of 9 ± 0.4 egg-masses, showing 104 ± 9.6 eggs / 30 plants) were recorded on the untreated plants.

Highest efficacy was recorded from treatment by **Xenatri** applied at the lower concentration (2.9 gm / L) as the two years average of egg-masses, 5 days after treatment, was 1.3 ± 0.1 egg-masses and that of eggs was 12.7 ± 1.7 eggs / 30 plants, indicating 85.6 and 87.8% reductions, respectively than control (Table, 10). That was, insignificantly, followed by treatments of **Dipel** at higher concentration (17.1 gm / L) which led to infestation by the same average of egg-masses (1.3 ± 0.1 / 30 plants) showing 13.4 ± 1.2 eggs / 30 plants, **Xenatri** at 2.9 gm / L + molasses (1.4 ± 0.2 egg-masses; 14.7 ± 1.6 eggs), **Dipel at 11.4 gm / liter + molasses** (1.5 egg-masses & 14.9 eggs), **Dipel 2X at 11.4 gm / L of water**

Table (10): Averages number of *S. cretica* egg-masses and eggs counts on maize plants after 5 days from 1st sampled from maize plants treated with some *B. thuringiensis* products with additives throughout two successive maize seasons (2003 & 2004).

Treatments	Average counts / 30 plants						% Reduction than control	
	Egg-masses			No. of eggs				
	2003	2004	Two years	2003	2004	Two years	Egg-masses	Total eggs
1- D [I]	1.8 (1-2)	1.5 (1-2)	1.7 ± 0.2 (1.-2)	11.8 (7-18)	18.5 (13-22)	15.2 ± 2.4 (7-22)	81.1	85.4
2- D [II]	1.5 (1-2)	1	1.3 ± 0.1 (1-2)	11.5 (7-16)	15.8 (10-22)	13.4 ± 1.2 (7-22)	85.6	85.9
3- D [I] + molasses	1.5 (1.2)	1.5 (1.2)	1.5 ± 0.2 (1.2)	12.8 (9-16)	17 (13-21)	14.9 ± 1 (9-21)	83.3	85.7
4- D [I] + K_2CO_3	1.8 (1-3)	1.8 (1-2)	1.8 ± 0.3 (1-3)	15.3 (9-19)	21.5 (12-34)	18.4 ± 1.5 (9-34)	80	82.3
5- X [I]	1	1.5 (1-2)	1.3 ± 0.1 (1-2)	9.5 (6-13)	15.8 (8-24)	12.7 ± 1.7 (6-24)	85.6	87.8
6- X [II]	2.3 (1-4)	2 (1-3)	2.2 ± 0.3 (1-4)	16.5 (10-24)	22.5 (15-20)	19.5 ± 2.1 (10-30)	75.6	81.3
7- X [I] + molasses	1.3 (1-2)	1.5 (1-2)	1.4 ± 0.2 (1-2)	11.5 (7-15)	17.8 (14-23)	14.7 ± 1.6 (7-23)	84.4	85.9
8- X [I] + K_2CO_3	3.8 (3-5)	4.3 (3-5)	4.1 ± 0.3 (3-5)	25 (18-32)	33 (24-40)	29 ± 2.2 (18-40)	54.4	72.1
9- Diazinox	6.8 (6-8)	7 (5-9)	6.9 ± 0.5 (5-9)	66 (60-71)	69.3 (48-93)	67.7 ± 4.9 (48-93)	23.3	34.9
10- Control	8.5 (7-10)	9.5 (8-11)	9 ± 0.4 (7-11)	100 (58-132)	108 (82-140)	104 ± 9.6 (58-140)	–	–
F. Value	Egg-masses: 35.4			Total no. of eggs: 24.3				
L.S.D. =	Egg-masses: 0.89			Total no. of eggs: 12.1				

D [I] = Dipel at 11.4 gm / L — X [I] = Xenatri at 2.9 gm / L

D [II] = Dipel at 17.1 gm / L — X [II] = Xenatri at 5.7 gm / L

(1.7 egg-masses; 15.2 eggs) and **Dipel 2X at lower concentration + K_2CO_3** which led to maize plants infested at rate 1.8 egg-masses; 18.4 eggs / 30 plants indicating 80% reduction in egg-mass counts and 82.3% reduction in egg counts than control (Table, 10).

Lower rates of reduction in egg-mass and egg counts than control were recorded from treatments by **Xentari at higher concentration** (5.7 gm / L) and by **Xentari at lower concentration (2.9 gm / liter) + K_2CO_3** as the treated plants harboured the averages of 2.2 ± 0.3 and 4.1 ± 0.3 egg-masses; 19.5 ± 2.1 and 29 ± 2.2 eggs / 30 plants, respectively. Counts from these two later treatments indicated 75.6 & 54.4% reductions in egg-mass counts and 81.3 & 72.1% reductions in egg counts, respectively than control (Table, 10). While, the lowest efficacy in reducing the egg-mass and egg counts on maize plants was recorded from the application of the recommended chemical insecticide **Diazinox** which led to infestation at averages of 6.9 ±

0.5 egg-masses (23.3% reduction); 67.6 ± 4.9 eggs / 30 plants indicating 34.9% reduction than control.

II.2. On *S. cretica* larval infestation:

II.2.1. after 5 days from first spray:

Data presented in Table (11) show that the untreated maize plants harboured an average of 65.3 & 64 larvae / 20 plants in 2003 & 2004 seasons, respectively, with average 50 ± 1.9 *S. cretica* larvae / 20 plants, which was, significantly, higher than either of those recorded in treated maize plants. Among the applied 15 treatments, the highest efficacy on *S. cretica* larval infestation rate resulted after treatment by **Dipel at low concentration 11.4 g/L + molasses** (15; 13 – 17 larvae in 2003 and 10 larvae / 30 plants in 2004 seasons, with two seasons' average 12.5 ± 0.6 larvae) showing 75% reduction in larval count than control, followed, insignificantly, by treatments; **Dipel [II] at high concentration 17.1 g / L** (13.6 ± 0.9 larvae, as an average for the two successive years showing 72.8% reduction than

Table (11): Percentages reduction and averages count of *S. cretica* larvae / 20 plants 5 days from the 1st spray with different assayed materials.

Treatments	Counts of larvae / 20 plants		Two years	% Reduction than control
	2003	2004		
1- D [I]	18.8 (16-22)	12.5 (10-16)	15.7 ± 0.9 (10-22)	68.6
2- D [II]	16.3 (14-21)	11 (8-12)	13.6 ± 0.9 (8-21)	72.8
3- D [I] + molasses	15 (13-17)	10 (7-11)	12.5 ± 0.6 (7-17)	75
4- D [I] + K_2CO_3	17.3 (8-20)	12.3 (9-15)	14.8 ± 0.9 (8-20)	70.4
5- X [I]	25 (20-28)	14 (12-16)	19.5 ± 0.9 (12-28)	61
6- X [II]	20 (17-22)	11.5 (9-14)	15.8 ± 0.7 (9-22)	68.4
7- X [I] + molasses	18.5 (16-20)	13.8 (10-14)	16.1 ± 1.1 (10-20)	67.8
8- X [I] + K_2CO_3	18.3 (16-22)	15.3 (12-21)	16.8 ± 1.1 (12-22)	66.4
9- Diazinox	26.5 (17-32)	34.5 (30-41)	21 ± 1.8 (15-30)	58
10- Control	65.3 (1-2)	64 (15-81)	50 ± 1.9 (43-56)	–
F. Value	28.4*			
L.S.D. =	5.3			

control, **Dipel [I] + K_2CO_3 (*i.e.*** 14.8 ± 0.9; *i.e.* 70.4% reduction), **Dipel at 11.4 g/L** (*i.e.*15.7 ± 0.9; *i.e.* 68.6%), **Xenatri** at concentration 5.7 g / L (15.8 ± 0.7 larvae / 20 plants; *i.e.* 68.4% reduction than control), **Xenatri [I] + molasses** which caused 67.8% reduction (16.1± 1.1 larvae) and **Xenatri [I] + K_2CO_3** that caused 66.4% reduction in *S. cretica* larval number (16.8 ± 1.1 larvae) than control (50 ± 1.9 larvae). As the differences in larval counts from these treatments were, statistically, insignificant (Table, 11). Accordingly these treatments could be considered of good effect in reducing *S. cretica* larval infestation in maize plants.

As seen in Table (11), the lowest efficacy resulted from treatment by the chemical insecticide **Diazinox** (21± 1.8; 15 – 30 larvae / 20 plants; indicating 58% reduction than control).

II.2.2. One day after the second treatment:

As shown in Table (12), the untreated maize plants harboured, significantly, the highest infestation rate with *S. cretica* larvae, being 55 & 33 larvae / 20 plants in 2003 & 2004 maize seasons, respectively (two seasons average, 30.4 ± 1.9 larvae / 20 plants). **Dipel at low concentration + molasses 10%** was the highest effective showing the highest reduction percentage (59.2%) in the number of *S. cretica* larvae, 12.4 larvae / 20 plants as an average for the two seasons.That was followed, insignificantly, by **Xenatri [I] + molasses** (58.9% reduction than control; 12.5 ± 0.5 larvae / 20 plants), **Dipel [II] at (higher concentration), Xentari [II] at 5.7 g / L high concentration**, the recommended chemical insecticide **Diazinox** and **Dipel [I] + K_2CO_3** and **Dipel [I] (lower concentration) + K_2CO_3** which led to maize plants infested by means of 12.7, 14.6, 14.9 & 15 *S. cretica* larvae / 20 plants, respectively, indicating 58.2, 51.9 50.9 & 50.7% reductions in mean larval count / 20 plants, respectively, Table (12): Percenatges reduction and averages count of *S. cretica* larvae / 20 plants after 24 hours from the 2^{nd} spray with different bactericides.

Treatments	Counts of larvae / 20 plants		Two years	% Reduction than control
	2003	2004		
1- D [I]	21 (18-25)	20.8 (17-26)	20.9 $\pm$ 1.3 (17-26)	31.3
2- D [II]	14 (10-19)	11.3 (11-18)	12.7 $\pm$ 1.3 (10-19)	58.2
3- D [I] + molasses	13 (12-15)	11.8 (10-12)	12.4 $\pm$ 0.5 (10-15)	59.2
4- D [I] + K_2CO_3	17.5 (12-22)	12.5 (9-15)	15 $\pm$ 1.2 (9-22)	50.7
5- X [I]	28.8 (25-35)	27.3 (20-37)	28.1 $\pm$ 2.2 (20-37)	7.6
6- X [II]	17.8 (12-28)	11.3 (10-14)	14.6 $\pm$ 1.7 (10-28)	51.9
7- X [I] + molasses	15.5 (14-17)	9.5 (8-11)	12.5 $\pm$ 0.5 (8-17)	58.9
8- X [I] + K_2CO_3	21.3 (17-25)	14.5 (13-16)	17.9 $\pm$ 0.9 (13-25)	41.1
9- Diazinox	15.8 (12-21)	14 (11-18)	14.9 $\pm$ 1.2 (11-21)	50.9
10- Control	55 (31-81)	33 (28-41)	30.4 $\pm$ 1.9 (24-39)	–
F. Value	5.9*			
L.S.D. =	7.9			

than control. As the differences, in two season means of larval counts, between these six treatments were found, statistically, insignificant, those could be considered as of higher effect in reducing *S. cretica* larval infestation in maize plants.

On the other side, **Xentari [I] (lower concentration)** was the least effective material on *S. cretica* larval infestation (28.1; 20 - 37 larvae / 20 plants indicating only 7.6% reduction than control. Also the treatments of **Xenatri [I] + K_2CO_3** and **Dipel [I]** were, also, considered of lower effect as the treated maize plants harboured 17.9, and 20.9 larvae / 20 plants indicating 41.1 and 31.3% reductions, respectively than control (Table, 12).

II.2.3. Five days after the second treatment:

Data presented in Table (13), show that adding molasses to the bacterial bioinsecticide **Dipel** (used at its lower concentration 11.4 gm / L) increased its efficacy in reducing larval infestation to maize plants, showing highest efficacy than all the remaining 8 treatments (66.5% reduction in larval count than control two seasons mean of 13.4 ± 1.2 larvae / 20 plants opposed to 40 ± 3.2 larvae in case of the control plants). The mean larval count from this treatment was, insignificantly, higher than the two season means counted 5 days after second treatment by **Dipel [I] + K_2CO_3** (16.6 larvae; 58.5% reduction), **Diple [II]** (17.1 gm / L) that led to 17 larvae / 20 plants (57.5% reduction) and **Xentari** at 2.9 gm **+ molasses 10%** (17.4 ± 1.1 larvae; 56.5% reduction). Accordingly, these 4 treatments were considered the highest effective **Xenatri [I] + K_2CO_3, Xenatri** at 5.7 gm / L and **Dipel** at lower concentration (11.4 gm / L) were considered moderately effective leading to plants infested at rates 18.7 ± 1.3 larvae (53.3% reduction), 21.5 larvae (46.3% reduction and 21.7 ± 1.6 larvae / 20 plants (45.8% reduction in mean larval count than control). While **Xenatri** at its lower concentration (2.9 gm / L) and the chemical insecticide **Diazinox** proved at the least effective leading to 43.3 and 32% reductions in mean counts (22.7 ± 1.8

Table (13): Averages count of *S. cretica* larvae / 20 plants after 5 days from the 2[nd] spray throughout two successive maize seasons (2003 & 2004).

Treatments	Counts of larvae / 20 plants		Two years	% Reduction than control
	2003	2004		
1- D [I]	23.8 (19-28)	19.5 (12-25)	21.7 ± 1.6 (12-28)	45.8
2- D [II]	17 (13-20)	17 (15-20)	17 ± 1.1 (13-20)	57.5
3- D [I] + molasses	13.8 (10-18)	13 (9-17)	13.4 ± 1.2 (9-18)	66.5
4- D [I] + K_2CO_3	16.8 (13-20)	16.3 (11-22)	16.6 ± 1.5 (11-22)	58.5
5- X [I]	22.3 (19-26)	23 (17-33)	22.7 ± 1.8 (17-33)	43.3
6- X [II]	22.5 (17-31)	20.5 (15-27)	21.5 ± 1.9 (15-31)	46.3
7- X [I] + molasses	18.8 (15-23)	16 (13-19)	17.4 ± 1.1 (13-23)	56.5
8- X [I] + K_2CO_3	18.3 (11-22)	19 (16-23)	18.7 ± 1.3 (11-23)	53.3
9- Diazinox	29.3 (23-36)	25 (20-32)	27.2 ± 1.9 (20.-36)	32
10- Control	79 (69-92)	75.3 (66-86)	40 ± 3.2 (35-49)	-
F. Value	50.1*			
L.S.D. =	5.1			

and 27.2 ± 1.9larvae / 20 maize plants, respectively than control (40 ± 3.2 larvae / 20 plants; Table, 13).

II.2.4. One day after the third treatment:

The highest efficacy on *S. cretica* larval infestation rates resulted after treatment by **Dipel** at lower concentration **[I]** + **molasses 10%**, a two seasons average of 10.5 ± 1larvae was recorded / 20 plants opposed to 27.1 ± 1.8 larvae in the control plants, indicating 61.3% reduction in larval count than control (Table, 14). That was followed, insignificantly, by **Dipel** at lower concentration + **K_2CO_3** (12.1 ± 1.1 larvae; 55.4% reduction), **Dipel [II]** at higher concentration (12.7 ± 1.4 larvae; 53.1% reduction).Accordingly, these 3 treatments were considered highly effective against *S. cretica* larvae. **Xenatri [I]** at lower concentarion + **molasses 10%** and **Diazinox** ranked the 4^{th} in efficacy (16.4 ± 1 larvae; 39.5% reduction), followed by **Dipel [I]** (18.1 ± 0.7 larvae; 33.2%) and **Xentari [I] + K_2CO_3** (18.8 larvae; 30.6% reduction). While, the least efficacy preparation was

Table (14): Percentage reductions than control and averages count of *S. cretica* larvae / 20 maize plants in two seasons (2003 & 2004) sampled after 1 day from 3rd spray with the assayed materials.

Treatments	Counts of larvae / 20 plants		Two years	% Reduction than control
	2003	2004		
1- D [I]	19.3 (16-20)	16.8 (13-19)	18.1 ± 0.7 (13-20)	33.2
2- D [II]	14 (9-19)	11.3 (7-15)	12.7 ± 1.4 (7-19)	53.1
3- D [I] + molasses	11 (6-15)	10 (8-12)	10.5 ± 1 (6-15)	61.3
4- D [I] + K_2CO_3	12.8 (8-17)	11.3 (8-14)	12.1 ± 1.1 (8-17)	55.4
5- X [I]	25 (15-32)	20.3 (13-27)	22.7± 2.2 (13-32)	16.2
6- X [II]	21.3 (12-28)	17.8 (10-23)	19.6 ± 2 (10-28)	27.7
7- X [I] + molasses	17.3 (11-21)	15.5 (12-20)	16.4 ± 1.3 (11-21)	39.5
8- X [I] + K_2CO_3	19.5 (13-24)	18 (17-20)	18.8 ± 1.1 (13-24)	30.6
9- Diazinox	18.3 (15-21)	14.5 (11-18)	16.4 ± 1 (11-21)	39.5
10- Control	47.3 (42-54)	43.8 (39-50)	27.1 ± 1.8 (22-35)	-
F. Value	15.23			
L.S.D. =	5.04			

Xenatri at lower concentration (2.9 gm / liter) as the treated plants were infested at a rate of 22.7 ± 2.2 larvae / 20 plants, showing 16.2% reduction in larval count than control, followed by **Xenatri [II]** (19.6 ± 2 larvae; 27.7% reduction). Counts from these two later treatments were, insignificantly, lower than that recorded from the control plants (27.1 larvae; Table, 14).

II.3. Effect of *B. thuringiensis* preparations and *B.t.* + additives on number of dead hearted plants:

One day after third spray (38 day after sowing), 50 maize plants were inspected / treatment to find out the numbers and subsequently percentages of dead hearted plants. As shown in Table (15), the untreated maize plants had significantly the highest numbers of dead heart cases, as result of infestation by *S. cretica* larvae (two seasons average 30.9 ± 1.6 plants indicating 61.8% dead hearts).

Among the applied preparations, the highly efficacy in reducing dead heart cases resulted from treatment by **Dipel** at low

Table (15): Effect of bacteria and additives on averages number of maize plants having dead hearted symptomes as a result of *S. cretica* larvae infestation, 24 hours after the 3rd spray with different traetments during early maize summer season.

Treatments	Counts of dead heart cases/ 50 plants		Average	% Reduction than control
	2003	2004		
1- D [I]	9.2 (5-11.7)	6.7 (6.6-11.7)	8 ± 0.8 (5-11.7)	74.1
2- D [II]	7.1 (5-8.3)	6.3 (3.3-10)	6.7 ± 0.8 (3.3-10)	78.3
3- D [I] + molasses	5.4 (5-6.7)	3.3 (3.3-10)	4.4 ± 0.6 (3.3-10)	85.8
4- D [I] + K_2CO_3	7.5 (5-10)	6.3 (5-8.3)	6.9 ± 0.7 (5-10)	77.7
5- X [I]	13.7 (13.3-15)	10.4 (8.3-13.3)	12.1 ± 0.8 (8.3-15)	60.8
6- X [II]	11.3 (10-13.3)	7.9 (6.6-10)	9.6 ± 0.8 (6.6-13.3)	68.9
7- X [I] + molasses	12.1 (8.3-15)	7.9 (3.3-11.7)	10 ± 1.4 (3.3-15)	67.6
8- X [I] + K_2CO_3	10 (5-11.7)	7.5 (5-10)	8.8 ± 1 (5-11.7)	71.5
9- Diazinox	13.7 (13.3-15)	11.3 (8.3-15)	12.5 ± 0.8 (8.3-15)	59.5
10- Control	30.9 (26.7-36.7)	30.8 (25-38.3)	30.9 ± 1.6 (25-38.3)	-
F. Value	22.6*			
L.S.D. =	3.0			

concentration 11.4 g / L + **molasses** (85.8% reduction in dead hearted plants than control; dead hearts / 50 plants), **Dipel** at higher concentration 17.1 gm / L of water (78.3%; 6.7 ± 0.8 / 50 plants) and **Dipel + K_2CO_3** treatment from which average of 6.9 ± 0.7 dead hearted plants / 50 plants were discerned indicating 77.7% reduction than control (Table, 15). The moderately effective preparations included **Dipel [I], Xentari** at 2.9 gm / liter + **K_2CO_3, Xentari** at 5.7 gm and **Xentari** at 2.9 gm + **molasses.** The two season averages in numbers of dead hearted plants were 8 ± 0.8, 8.8 ± 1, 9.6 ± 0.8 and 10 ± 1.4 plants / 50 plants with insignificant differences between these mean counts indicating 74.1, 71.5, 68.9 and 67.6% reductions than control, respectively (Table, 15). On the contrary, the chemical insecticide **Diazinox** and **Xentari [I]** at 2.9 gm / liter of water were the least effective preparations (12.5 ± 0.8 and 12.1 ± 0.8 dead hearted plants / 50 plants showing 59.5 and 60.8% reductions than the 30.9 dead hearts / 50 plants recorded from the control treatment (Table, 15).

II.4. Maize yield after treatment by *B.t.* preparations and *B.t.* + additives:

At the end of 2003 & 2004 maize seasons, the dry maize ears were weighed to estimate the effect of treatments on the weight of ears / plot was transferred to represent that of a feddan. Data in Table (16) confirmed that all *B. thuringiensis* treatments and also the chemical insecticide **Diazinox** which caused reductions in *S. cretica* infestation rates (Tables , 10 – 15), that resulted in significant increases in the weight of obtained ears / plot than control (7.5 – 9.6 kg) opposed to 4.9 kg *i.e.* from the control treatment).

The heaviest weight of ears in 25 plants (two season mean of 9.6 ± 0.1 kg *i.e.* 16 ardab / feddan resulted from 3 sprays of **Dipel [II]** at 11.4 gm / liter + **molasses 10%** = 17.1 ardab / feddan, indicating 95.9% increase than control. That was, insignificantly followed by treatments by **Dipel [II]** (higher concentration of 17.1 gm / liter of water, resulting 9 ± 0.1 kg *i.e.*

Table (16): Calculated dry ears yield ardab / feddan in different biopesticide treatments throughout 2003 & 2004 maize early summer plantation.

Treatments	Averages weight (kg) of dry ears / plot			Calculated dry ears yield ardab / feddan in two years	% Increase than control
	2003	2004	two years		
1- D [I]	7.5 (7.1 - 8)	8 (7.4 - 8.4)	7.8 $\pm$0.2 (7.1 - 8.4)	13.9	59.2
2- D [II]	9.1 (8.4 - 9.6)	9 (8.8 - 9.2)	9.0 $\pm$0.1 (8.4 - 9.2)	16	83.7
3- D [I] + molasses	9.6 (9.4 - 9.8)	9.5 (9 - 9.8)	9.6 $\pm$0.1 (9 - 9.8)	17.1	95.9
4- D [I] + K_2CO_3	8.1 (7.4 - 8.8)	8.6 (7.6 - 9.1)	8.3 $\pm$0.2 (7.4 - 9.1)	14.8	69.4
5- X [I]	7.3 (6.8 - 8)	8.1 (6.4 - 9.4)	7.7 $\pm$0.3 (6.4 - 9.4)	13.7	57.1
6- X [II]	7.7 (7 - 8.4)	7.9 (7.4 - 8.8)	7.8 $\pm$0.2 (7 - 8.8)	13.8	59.2
7- X [I] + molasses	8.3 (7.8 - 8.8)	7.9 (7 - 8.8)	8.1 $\pm$0.2 (7 - 8.8)	14.4	65.3
8- X [I] + K_2CO_3	7.3 (7 - 7.6)	7.8 (7.2 - 8.4)	7.6 $\pm$0.1 (7 - 8.4)	13.5	55.1
9- Diazinox	7.1 (5.9 - 9.1)	7.9 (7 - 8.8)	7.5 $\pm$0.4 (5.9 - 9.1)	13.3	53.1
10- Control	4.7 (3.8 - 5.4)	5 (4 - 5.9)	4.9 $\pm$0.2 (3.8 - 5.9)	8.7	–
F. Value	12.04*				
L.S.D. =	0.7				

An ardab = 140 kg. Dry weight of ardab = 225 kg. 4 plots (replicates) = 30.24 m^2

showing 83.7% increase than control. Accordingly these two treatments may be fairly considered the best than either of the remaining 7 treatments (Table, 16). Treatments of **D [I] + K_2CO_3** and **Xentari [I] + molasses** may be considered as moderately effective preparations (8.3 ± 0.2 and 8.1 ± 0.2 kg of dry ears *i.e.* 14.8 & 14.4 ardab / feddan, respectively, indicating 69.4 and 65.3% reduction than control, respectively. While, the remaining 5 treatments were of lower effect as those led to lighter dry ears yields ranging between 7.8 kg = 13.9 ardab / feddan (**Dipel** at 11.4 gm / L) to 7.5 ± 0.4 kg = ardab / feddan (**Diazinox** treatment; reduction percentages ranging from 59.2 to 53.1% than the dry ears weight of the control treatment (Table, 16).

III. Latent effect of biopesticides and additives in 2003 & 2004 season:

III.1. Effect of field applications of bacterial preparations without and with additives on *S. cretica* pupal weight:

It was found that the field applications of **Xentari** or **Dipel 2X** at two concentration each, with or without additives (molasses or K_2CO_3) resulted in significant reductions in weights of pupae collected from plants in the treated plots than those collected from the control plots (Table, 17). Mean weight of pupa from treated plots ranged 0.119 – 0.197 and 0.119 – 0.163 gm for 2003 & 2004, respectively opposed to 0.214 & 0.209 gm / pupa from control plots for 2003 & 2004, respectively. The two seasons average of pupal weight ranged between 0.119 – 0.179 gm from treatments and 0.212 gm / pupa from control (Table, 17).

Among *S. cretica* pupae collected from different treatments, the severest reduction in pupal weight than control resulted from plants treated with **Dipel at 11.4 g / L [I] + K_2CO_3)** showing the lightest weight of pupa (0.119 gm; two seasons' mean; Table, 17). That was followed, insignificantly by **Dipel 2X at 17.1 gm / liter** (weight of pupa 0.128 gm), **Xentari at 2.9 gm / L +K_2CO_3 1%** (0.136 gm / pupa) and **D [I] + molasses** (0.146 gm / pupa). Accordingly, these 4 preparations were considered as highly effective in causing high reductions in the weight of *S. cretica*

Table (17): Averages in weight of *S. cretica* pupa collected from maize field treated with bacterial bioinsecticides throughout 2003 & 2004 maize seasons.

Treatments	Average weight of pupae (gm)			% Reduction than control
	2003	2004	average	
1- D [I]	0.197	0.16	0.179	15.5
2- D [II]	0.126	0.13	0.128	39.39
3- D [I] + molasses	0.143	0.148	0.146	30.97
4- D [I] + K_2CO_3	0.119	0.119	0.119	43.56
5- X [I]	0.166	0.163	0.165	22.29
6- X [II]	0.152	0.146	0.149	29.49
7- X [I] + molasses	0.151	0.158	0.155	26.84
8- X [I] + K_2CO_3	0.137	0.134	0.136	35.89
9- Diazinox	0.152	0.153	0.153	28
10- Control	0.214	0.209	0.212	
F. Value	**3***			
L.S.D. =	**0.28**			

pupae than control (43.56, 39.39, 35.89 and 30.97%, respectively, Table, 17).

On the contrary, the lowest effect on pupal weight resulted from treatment of maize plants with **Dipel at lower concentration (D [I])** as the pupa from treatment weighed 0.179 gm showing 15.5% reduction than the weight of pupa from control, followed insignificantly by **Xenatri at 2.9 gm** (0.165 gm / pupa). These 2 treatments could be fairly considered of lowest efficacy (Table, 17). The remaining 3 treatments were considered intermediately effective. These could be arranged in descending order as **Xentari** at higher concentration (5.7 gm / liter) from which the mean weight of pupa was 0.149 gm (29.49% reduction), the chemical insecticide **Diazinox** (0.153 gm / pupa; 28% reduction) and **Xenatri [I] + molasses** (0.155 gm / pupa; 26.84% reduction than control (Table, 17).

From all the 9 treatments either the entomopathogenic bactericides alone or with additives, Dipel at lower concentration

+ molasses, Dipel at higher concentration and Dipel at lower concentration + K_2CO_3, were considered the best treatments as for the application on the maize fields the mentioned treatments proved to be good tools for insect control as those had the highest reduction percentages in most of the parameters which were taken for evaluation in the field.

The obtained results on the toxicity of bactericides and their additives against *S. cretica* may be considered in harmony with those obtained by **Schmidt and Antonin (1977)** observed that the addition of sugar to the preparation of *B. thuringiensis* increased its effectiveness by about 20%. In field tests, *B. thuringiensis* sugar, was effective within 9 days on contrary to the bacterial preparation alone. Also, **Salama *et al.* (1990 a)** tested Dipel 2X (*B. t. kurstaki)* as a biological insecticide against *S. littoralis* larvae infesting soybean plants, either alone or combined with potassium carbonate as an adjuvant. The materials were applied either through spraying or dusting. Results showed that potassium carbonate (K_2CO_3) enhanced and significantly increased the effect of Dipel 2X. The authors recommended the use of combination of Dipel 2X at 250 gm / feddan and potassium carbonate at a rate of 150 gm /feddan, to obtain significant larval reduction. The results obtained were 96.6% and 92.11% reduction than control with an increase of 1.6 fold in yield after spraying and dusting applications, respectively. The data also suggested that combination of Dipel 2X and K_2CO_3 may be effective component of the future *S. littoralis* Integrated Pest Management (IPM) on soybean.

The same authors **(1990 c)** indicated in another investigation the enhancement of bactericide by adding calcium sulfate ($CaSO_4$); also the rate for field application was mentioned as 250 gm / feddan for Dipel 2X. **Ebaid (2001)** also, used Delphin (a bacterial bioinsecticide) to control *S. cretica* under field conditions. It was found that addition of NaCl at 1% concentration, as an additive for the Delphin, reduced the number of perforated leaves by 66.51%

and 38.84% in years 1998 and 1999, respectively. Also, there was a reduction in the mean larval counts / 10 infested plants and caused % reduction than control by 47.39 and 27.01% in 1998 and 1999 seasons, respectively.

IV. Evaluation of different biopesticides applications in maize fields on *S. cretica* infestation:

Under field conditions, in 2004 maize season, at Moshtohor (Qalubiah governorate) some bactericides and entomopathogenic nematodes for *S. cretica* maize pest were evaluated.

IV.1. On *S. cretica* egg-masses and total number of eggs:

Five days after spraying the two bacterial insecticides, Dipel 2X & Xentari, two entomopathogenic nematodes and their mixtures on maize plants, significant reductions in *S. cretica* egg-mass and total egg counts on sheathes of maize leaves were recorded (Table, 18). Averages of egg-mass counts ranged from 1

± 0.3 to 3.3 ± 0.6 / 30 plants, opposed to 7.3 ± 0.7 egg-masses / 30 control plants (Table, 18).

The least number of egg-masses (one / 30 plants) was recorded from treatments by ***S. carpocapsae* at (1000 J / ml)** and also by the mixture of **Dipel [I] (17.1 g / L) + *S. carpocapsae* at 2000 J / ml**. Severe effect in reducing the number of egg-masses on maize leaves resulted also from treatment by **Dipel [I] (lower concentration) + *S.* 2000 J / ml** as, after 5 days of this treatment, an average of only 1.3 ± 0.4 were recorded / 30 plants. That was followed by treatments of ***S.* 1000, Xenatri [II] (5.7 g / L), X [I] + *S.r.* 2000** and **X [I] (11.4 gm / L) + *S. carpocapsae* at 2000 J / ml**, which showed almost the same efficacy (1.5 egg-masses / 30 plants). These treatments could be, fairly, considered of severe effect, causing high reduction in egg-mass counts by 79.5 – 86.3% than control (Table, 18). On the contrary, the least effective treatment on egg-mass counts, was the recommended chemical insecticide **Diazinox**, as 5 days after treatment by this pesticide, Table (18): Averages in *S. cretica* egg-mass and egg counts on maize plants after 5 days from 1[st] spray by different assayed treatments in 2004 early summer season.

Treatments	Average counts / 30 plants		% Reduction than control	
	Egg-masses	Total no. of eggs	Egg-masses	Total no. of eggs
1-D [II]	**1.8** ± 0.4 (1 - 3)	**19** ± 3.2 (9 - 31)	75.3	76.4
2-X [II]	**1.5** ± 0.3 (1 - 2)	**15.8** ± 2.6 (9 - 23)	79.5	80.3
3- *S.c.* 1000	**1** ± 0.3 (0 - 2)	**9** ± 1.8 (0 - 16)	86.3	88.8
4- *S.c.* 2000	**2.3** ± 0.6 (1 - 5)	**21.3** ± 3.8 (11 - 39)	68.5	73.5
5- *S.r.* 1000	**1.5** ± 0.3 (1 - 2)	**16.3** ± 2.0 (9 - 25)	79.5	79.8
6- *S.r.* 2000	**1.8** ± 0.5 (1 - 3)	**15.3** ± 2.7 (4 - 29)	75.3	81
7- D [I] + *S.c.* 1000	**2** ± 0.4 (1 - 3)	**16.3** ± 2.0 (10 - 21)	79.8	79.8
8- D [I] + *S.c.* 2000	**1** ± 0.3 (0 - 2)	**10.8** ± 1.3 (0 - 22)	86.3	86.6
9- D [I] + *S.r.* 1000	**3** ± 0.4 (2 - 4)	**29** ± 4.0 (19 - 38)	58.9	63.9
10- D [I] + *S.r.* 2000	**1.3** ± 0.4 (1 - 2)	**11.8** ± 1.6 (8 - 18)	82.2	85.3
11- X [I] + *S.c.* 1000	**3** ± 0.7 (1 - 5)	**28** ± 3.6 (11 - 43)	58.9	65.2
12- X [I] + *S.c.* 2000	**1.5** ± 0.2 (1 - 2)	**16.3** ± 2.0 (9 - 23)	79.5	79.8
13- X [I] + *S.r.* 1000	**2.3** ± 0.9 (1 - 5)	**18.8** ± 2.2 (10 - 34)	68.5	76.6
14- X [I] + *S.r.* 2000	**1.5** ± 0.7 (1 - 3)	**13.3** ± 2.0 (8 - 23)	79.5	83.5
15- Diazinox	**3.3** ± 0.6 (2 - 5)	**32.8** ± 4.3 (21 - 41)	54.8	59.6
16- Control	**7.3** ± 0.7 (6 - 9)	**80.5** ± 7.9 (68 - 91)	–	–
F. Value	Egg masses 4.9*		Total no. of eggs 13.9*	
L.S.D. =	Egg masses 1.9		Total no. of eggs 12.9	

an average of 3.3 ± 0.6 egg-masses / 30 plants were counted. This treatment was followed by **Dipel at the lower concentration + *S.* 1000** and **Xenatri [I] + *S. r.* 1000 J / ml** which were almost equally effective showing an average of 3 egg-masses / 30 plants. These 3 latter compounds were categorized of lower efficacy as those led to 54.8 and 58.9% reductions in the average number of egg-masses, respectively (Table, 18).

The remaining 5 treatments could be categorized as intermediately effective as those caused 68.5 – 75.3% reductions in the averages in numbers of eggs-masses (2.3 – 1.8 egg-masses / 30 plants, respectively; (Table, 18).

Regarding the total *S. cretica* egg counts, 5 days after treatments, those averaged 80.5 ± 7.9 eggs / 30 control plants being, significantly, higher than those recorded from either of the remaining treatments. The fewest number of eggs (9 / 30 plants) was recorded 5 days after treatment by ***S. carpocapsae* at 1000 J / ml**, showing the highest efficacy, followed by the mixture **of**

Dipel [1] + ***S. carpocapsae* 2000** (10.8 eggs), **Dipel [I]** + ***S.* at 2000 J / ml** (11.8 eggs) and **Xentari [I] at lower concentration** + ***S. carpocapsae* 2000** (13.3 eggs / 30 plants). The mentioned 4 treatments may be considered highly effective, as those caused 88.8, 86.6, 85.3 and 83.5% reductions in total eggs counted / 30 plants than control, respectively (Table, 18). On the contrary, the chemical insecticide **Diazinox** appeared as the least effective material, as the treated plants harboured 32.8 ± 4.3 eggs / 30 plants, being, insignificantly, higher than those recorded from treatments by **Dipel [I]** + ***S.r.* 1000** (29 ± 4.0 eggs), **X [I]** + ***S.c.* 1000** (28 ± 3.6 eggs / 30 plants) and ***S. carpocapsae* at 2000 J / ml** (21.3 eggs / 30 plants).. These latter treatments were considered of lower efficacy as those caused 63.9, 65.2 and 73.5% reductions in total egg counts, respectively than control.

The remaining 5 treatments may be considered of intermediate effect, as the averages of total eggs ranged from 15.3 ± 2.7 (***S. riobravae* at higher concentration**) to 19 ± 3.2 eggs / 30 plants (**Dipel at higher concentration**) indicating 81 – 76.4% reduction in total eggs than control, respectively; (Table, 18).

IV.2. On *S. cretica* larval infestation:

IV.2.1. after 5 days from first spray:

As shown in Table (19), the untreated plants harboured, significantly, the highest infestation rate with *S. cretica* larvae (72 ± 1.8; 68 -79 larvae / 20 plants) in 2004 season, compared to the larval counts recorded from either of the applied treatments.

Among the different treatments, (**Dipel [I] + *S.c.*2000**) was the most effective, as it caused the highest reduction percentage (84.7%) in the number of *S. cretica* larvae [11 ± 1.1 (8 – 13) larvae / 20 plants] than control. The four treatments (**X [I] + *S.r.* 2000**), (***S. carpocapase* 1000**), (**D [I] + *S.r.* 2000**) and (***S.* 1000 J / ml**) came, insignificantly, after D [I] + *S.c.* 2000, leading to maize plants infested by 13 ± 0.9 (10 – 15), 14.5 ± 1.3 (12 -18), 15 ± 2.7 (11 – 23) and 18.5 ± 1.7 (15 -23) larvae / 20 plants, respectively indicating reduction percentages in *S. cretica* larval counts by 81.9, 79.9, 79.2 and 74.3%, respectively than control (Table, 19). These treatments could be considered as highly effective in reducing *S. cretica* larval infestation in maize plants.

On the other side, treatment by **Xenatri [I] + *S. carpocapsae* 1000 J / ml** was the least effective preparation on *S. cretica* larval infestation [32.5 ± 3.2 (23 -36) larvae / 20 plants indicating 54.9% reduction than control; [Table, 19]. That was followed, insignificantly, by **X [I] + *S.r.* 1000 & *S. carpocapsae* 2000 J** / ml which were of similar efficacy (30 ± 2.4 larvae; 58.3% reduction than control), the chemical insecticide **Diazinox** (29.5 larvae; 59.7% reduction) and ***S. riobravae* at 2000 J / ml** (23.5 ± 2 larvae showing 67.4% reduction than control). Accordingly, these 5 treatments were considered of lower efficacy against *S. cretica* larvae. While, the remaining 5 treatments led to larval counts of *S. cretica* that ranged from 18.8 larvae (73.9% reduction) from treatment by **Dipel at higher concentration to** 22 ± 1.7 larvae / 20 plants (69.4% reduction than control from

Table (19): Averages in numbers of *S. cretica* larval counts / 20 maize plants after 5 days from 1[st] spray by different biocontrol preparations (2004 maize season).

Treatments	**Mean count of *S. cretica* larvae / 20 plants**	**% Reduction than control**
1-D [II]	**18.8** ± 1.8 (14 - 22)	73.9
2-X [II]	**22** ± 1.7 (17 - 25)	69.4
3- S.c. 1000	**14.5** ± 1.3 (12 - 18)	79.9
4- *S.c.* 2000	**30** ± 3.2 (24 - 39)	58.3
5- *S.r.* 1000	**18.5** ± 1.7 (15 - 23)	74.3
6- *S.r.* 2000	**23.5** ± 2 (20 - 29)	67.4
7- D [I] + *S.c.* 1000	**20** ± 1.6 (16 - 23)	72.2
8- D [I] + *S.c.* 2000	**11** ± 1.1 (8 - 13)	84.7
9- D [I] + *S.r.* 1000	**19** ± 1.9 (14 - 23)	73.6
10- D [I] + *S.r.* 2000	**15** ± 2.7 (11 - 23)	79.2
11- X [I] + *S.c.* 1000	**32.5** ± 3.2 (23 - 36)	54.9
12- X [I] + *S.c.* 2000	**23** ± 3.1 (19 - 29)	60.1
13- X [I] + *S.r.* 1000	**30** ± 2.4 (24 - 35)	58.3
14- X [I] + *S.r.* 2000	**13** ± 0.9 (10 - 15)	81.9
15- Diazinox	**29.5** ± 2.9 (23 - 37)	59.7
16- Control	**72** ± 1.8 (68 - 79)	-
F. Value	10.8 *	
L.S.D. =	9.6	

treatment by **Xenatri at higher concentration (5.7 g / L)** may be, fairly, considered intermediately effective for *S. cretica* larval control (Table, 19).

IV.2.2. One day after the second treatment:

Among the applied 15 treatments, the highest efficacy on *S. cretica* larval infestation rates resulted after treatment by the mixture of **Xenatri at lower concentration + *S. riobarvae* at 2000 J / ml**, as an average of 6 larvae was recorded / 20 plants, showing 79.3% reduction in larval counts than control (Table, 20). That was followed, insignificantly, by the mixture of **Dipel at lower concentration (2.9 gm / L) + *S. carpocapsae* 2000** (7 ± 1.6 larvae; 75.9% reduction), the nematode ***S. carpocapsae* 1000** & the mixture **D [I] + *S.r.* 2000** (8 ± 1.6 & 8 ± 2.1; larvae; respectively, 72.4% reduction), **Xentari [I] + *S. carpocapsae* 2000** (8.3 ± 0.8 larvae; 71.4% reduction), ***S.* 1000** (9 ± 1.9 larvae; 69% reduction) and **Xenatri at higher concentration (5.7g/L)** &

Table (20): Averages of *S. cretica* larval counts / 20 maize, one day after second treatment by *B. thuringiensis* products and *Steinernema* spp. and their mixtures.

Treatments	**Mean count of *S. cretica* larvae / 20 plants**	**% Reduction than control**
1-D [II]	**10** ± 1.4 (6 - 13)	65.5
2-X [II]	**9.5** ± 0.6 (8 - 11)	67.2
3- S.c. 1000	**8** ± 1.6 (3 - 10)	72.4
4- *S.c.* 2000	**10** ± 0.4 (9 - 11)	65.5
5- *S.r.* 1000	**9** ± 1.9 (6 - 14)	69
6- *S.r.* 2000	**13.8** ± 1.9 (10 - 19)	52.6
7- D [I] + *S.c.* 1000	**9.5** ± 1.3 (6 - 12)	67.2
8- D [I] + *S.c.* 2000	**7** ± 1.6 (3 - 10)	75.9
9- D [I] + *S.r.* 1000	**12** ± 1.1 (12 - 15)	58.6
10- D [I] + *S.r.* 2000	**8** ± 2.1 (3 - 12)	72.4
11- X [I] + *S.c.* 1000	**12** ± 1.1 (10 - 15)	58.6
12- X [I] + *S.c.* 2000	**8.3** ± 0.8 (7 - 10)	71.4
13- X [I] + *S.r.* 1000	**11.5** ± 0.6 (10 - 13)	60.3
14- X [I] + *S.r.* 2000	**6** ± 1.1 (4 - 9)	79.3
15- Diazinox	**10** ± 0.7 (9 - 12)	65.5
16- Control	**29** ± 0.4 (28 - 30)	-
F. Value	16.3 *	
L.S.D. =	3.7	

D [I] + *S.c.* 1000 (9.5 ± 1.3 larvae; 67.2% reduction). Accordingly, these 8 treatments were considered highly effective against *S. cretica* larvae. While, the lowest efficacy resulted from treatment by ***S.riobravae* 2000** (13.8 ± 1.9 larvae / 20 plants, indicating 52.6% reduction than control) followed, insignificantly, by treatments of **Xenatri [I] + *S. carpocapsae* 1000** & **Dipel [I] + *S.* 1000** which were of similar efficacy (12 ± 1.1 larvae; 58.6% reduction) and **Xenatri at lower concentration + *S.r.* 1000** from which 11.5 ± 0.6 (10 – 13) larvae were counted / 20 maize plants showing 60.3% reduction. These latter 4 treatments were, then, considered of low efficacy on *S. cretica* larvae.

The remaining 3 treatments (***S. carpocapsae* 2000, the chemical insecticide Diazinox** and **Dipel at higher concentration**, 11.4 g / L) were, almost, of the same efficacy as one day after treatment by either of these treatments, maize plants harboured *S. cretica* larvae at a rate of 10 ± 1.4 larvae / 20 plants, being of intermediate effect on this pest species (Table, 20).

IV.2.3. Five days after the second treatment:

Data presented in Table (21) show that the untreated maize plants harboured an average of 35 ± 2.2 *S. cretica* larvae) / 20 plants, being

significantly, higher than either of those recorded in maize plants from all treatments. The 15 applied treatments may be categorized according to their efficacies in reducing the rate of maize infestation by *S. cretica* and the reduction percentages of *S. cretica* larval counts than control as follows: **1-** Highly effective preparations: the included two mixtures; **Dipel at lower concentration (11.4 gm / L) + *S. carpocapsae* at 2000 J / ml** which showed the highest efficacy, leading to only 4 ± 0.7 larvae / 20 plants, indicating the highest reduction (88%)in larval count than control. That was followed insignificantly by **D [I] + *S.riobravae* 2000** from which 7 ± 1.5 larvae were counted / 20 plants; *i.e.*, 80% reduction in mean larval count than control (Table, 21).

2- Moderately effective preparations: this group involved 5 preparations; **Xentari [I] +** ***S. carpocapsae*** **2000** (11 ± 0.4), **Dipel [I] +** ***S. riobravae*** **2000** (11 ± 1.1), ***S. carpocapsae*** **1000, X [I] +** ***S. riobravae*** **1000** (15 ± 1.5) and **D [I] +** ***S. carpocapsae*** **1000** (15 ± 2.0). The first three preparations were of similar effect as those led to 68.6% reduction in *S. cretica* mean larval count than control (11 larvae / 20 maize plants). The remaining two preparations led to 15 larvae / 20 plants being, insignificantly, higher than the 11 larvae recorded from the former 3 treatments, and showing 57.1% reduction in mean larval count than control (Table, 21). **3-** Less effective preparations: involved another 5 treatments of which the 1st was **Dipel at lower concentration (11.4 gm / L),** as the treated maize plants by this preparation were infested at a mean rate of 16.5 ± 2.5 *S. cretica* larvae / 20 plants. The subsequent three preparations (***S.*** **1000, Dipel [I] +** ***S.riobravae*** **1000** and **Xenatri [I] +** ***S. carpocapsae*** **1000** were similar efficacy, causing 51.4% reduction in larval count (17 larvae / 20 plants) than control.

Table (21): Averages in number of *S. cretica* larvae collected, 5 days from the 2nd spray, / 20 maize plants during 2004 season at Moshtohor.

Treatments	Mean count of *S. cretica* larvae / 20 plants	% Reduction than control
1-D [II]	**16.5** ± 2.5 (11 - 22)	52.9
2-X [II]	**21** ± 1.8 (17 - 25)	40
3- S.c. 1000	**11** ± 0.4 (10 - 12)	68.6
4- *S.c.* 2000	**19** ± 1.1 (17 - 22)	45.7
5- *S.r.* 1000	**17** ± 1.1 (14 - 18)	51.4
6- *S.r.* 2000	**29** ± 2.8 (24 - 36)	17.1
7- D [I] + *S.c.* 1000	**15** ± 2 (11 - 19)	57.1
8- D [I] + *S.c.* 2000	**4** ± 0.7 (2 - 5)	88.6
9- D [I] + *S.r.* 1000	**17** ± 1.1 (14 - 19)	51.4
10- D [I] + *S.r.* 2000	**11** ± 1.1 (9 - 14)	68.6
11- X [I] + *S.c.* 1000	**17** ± 1.1 (14 - 19)	51.4
12- X [I] + *S.c.* 2000	**11** ± 0.4 (10 - 12)	68.6
13- X [I] + *S.r.* 1000	**15** ± 1.5 (12 - 19)	57.1
14- X [I] + *S.r.* 2000	**7** ± 1.5 (4 - 10)	80
15- Diazinox	**25** ± 1.8 (9 - 12)	28.6
16- Control	**35** ± 2.2 (31 - 41)	—
F. Value	102.9 *	
L.S.D. =	4.5	

While, treatment by the 5th one, ***S. carpocapsae* 2000** lead to plants infested at a mean of 19 larvae / 20 plants indicating 45% reduction in larval count than control. The differences between means of larval counts recorded from these 5 treatments were, statistically, insignificant. **4-** Least effective preparations: those caused 17.1 – 40% reductions in means of *S. cretica* larval counts. The least effective was ***S. riobravae* 2000** from which the treated plants harboured 29 larvae / 20 plants, followed by the chemical insecticide **Diazinox** (25 ± 2.8 larvae) and the bacterial bioinsecticide **Xenatri at 2.9 gm / L** which the maize plants were infested at a rate of 21 ± 1.8 larvae / 20 plants (Table, 21).

IV.2.4. One day after the third treatment:

As shown in Table (22), the untreated maize plants showed infestation at a rate of 45.3 ± 2.3 (40 – 50) *S. cretica* larvae / 20 plants in 2004 season, showing, significantly, the highest

Table (22): Averages in number of *S. cretica* larvae / 20 maize plants, treated with different biopesticides, sampled 24 hours after the 3rd spray at Moshtohor throughout maize successive 2004 season.

Treatments	Mean count of *S. cretica* larvae / 20 plants	% Reduction than control
1-D [II]	**10.3** ± 1.7 (11 - 22)	77.3
2-X [II]	**16.5** ± 2.2 (17 - 25)	63.5
3- S.c. 1000	**11** ± 0.4 (10 - 12)	75.7
4- *S.c.* 2000	**13.8** ± 2.4 (17 - 22)	69.6
5- *S.r.* 1000	**15.3** ± 1 (14 - 18)	66.3
6- *S.r.* 2000	**17.8** ± 0.6 (24 - 36)	60.8
7- D [I] + *S.c.* 1000	**10.5** ± 0.6 (4 - 10)	76.8
8- D [I] + *S.c.* 2000	**3.5** ± 0.6 (2 - 5)	92.3
9- D [I] + *S.r.* 1000	**13.8** ± 0.6 (14 - 19)	69.6
10- D [I] + *S.r.* 2000	**7.3** ± 0.5 (9 - 14)	84
11- X [I] + *S.c.* 1000	**14.3** ± 1.7 (14 - 19)	68.5
12- X [I] + *S.c.* 2000	**9.3** ± 0.5 (10 - 12)	79.5
13- X [I] + *S.r.* 1000	**12** ± 0.7 (12 - 19)	73.5
14- X [I] + *S.r.* 2000	**6.5** ± 0.7 (11 - 19)	85.6
15- Diazinox	**18.3** ± 1.9 (18 - 22)	59.7
16- Control	**45.3** ± 2.3 (40 - 50)	–
F. Value	74.7 *	
L.S.D. =	3.1	

concentration (17.1 gm / L), Dipel at 11.4 gm / L + *S. carpocapsae* 1000 J / ml, *S. carpocapsae* 1000 J / ml and **Xenatri [I] (at 2.9 gm / L) + *S. riobravae* 1000** followed the formerly mentioned 4 preparations in the order of effectiveness against *S. cretica,* leading to maize plants infested at rates 10.3, 10.5, 11 and 12 larvae / 20 plants which are, insignificantly, different, showing 77.3, 76.8, 75.7 and 73.5% reductions in larval counts, respectively than control (Table, 22). Accordingly, these treatments could be categorized as effective.

The less effective preparations involved **Dipel [I] + *S.* 1000 J / ml, *S. carpocapsae* 2000 J / ml, Xentari [I] + *S. carpocapsae* 2000 J / ml, *S.* 1000 J / ml** and **Xenatri at 5.7 gm / L.** Maize plants from these treatments were found infested by 13.8, 13.8, 14.3, 15.3 and 16.5 larvae / 20 plants indicating 69.5, 69.5, 68.4, 66.2 and 63.6% reductions in larval counts, respectively than control. While, the least effective preparations were ***S.riobravae* 2000 J / ml** and the chemical insecticide

Diazinox which led to plants infested at rates 17.8 and 18.3 larvae / 20 plants showing 60.7 and 59.6% reductions in larval counts, respectively than control (Table, 22).

IV.3. Effect of bioinsecticidal treatments on number of dead hearted maize plants after one day of third spray:

One day after the 3[rd] spray, all treatments caused significant reductions in the number of dead hearted maize plants (29 – 87.5%) than control (Table, 23). The number of dead heart cases after treatments ranged from 2.5 to 14 plants / 50 plants, opposed to 20 plants among the control treatment.

From data in Table (23), highest efficacy was recorded from treatment by **Dipel [I] + *S. carpocapsae* 2000 J / ml.** Among plants treated by this preparation, a mean of only 2.5 dead hearted plants were counted / 50 plants. **Xenatri [I] + *S. carpocapsae* 2000 J / ml, Dipel at lower concentration +*S. carpocapsae* 1000 J / ml** and **Dipel at 11.4 gm / L + *S.* 2000 J / ml** caused 81.5, 80 and 77% reduction in the number of dead hearted plants (3.7, 4 and 4.6 plants / 50 plants), respectively than control. Accordingly, these 3 treatments were considered also, highly effective. The effective treatments involved ***S. carpocapsae* 1000 J / ml, Dipel at higher concentration (17.1 gm / L), Diazinox** and the mixture

Table (23): Impact of different assayed materials on number of plants containing dead hearted cases / 50 plants 24 hours after the 3rd spray 2004 season.

Treatments	**Mean count of maize plants containing dead heart cases / 50 plants**	**% Reduction than control**
1-D [II]	**5.8** ± 0.4 (5 - 6.7)	71
2-X [II]	**10.8** ± 1.1 (8.3 - 13.3)	46
3- S.c. 1000	**5.4** ± 1 (3.3 - 8.3)	73
4- *S.c.* 2000	**14.2** ± 1.1 (11.7 - 16.7)	29
5- *S.r.* 1000	**8.8** ± 1.4 (5 - 11.7)	56
6- *S.r.* 2000	**11.7** ± 0.7 (10 - 13.3)	41.5
7- D [I] + *S.c.* 1000	**4** ± 2.2 (5 - 10)	80
8- D [I] + *S.c.* 2000	**2.5** ± 0.5 (1.7 - 3.3)	87.5
9- D [I] + *S.r.* 1000	**9.6** ± 1.4 (6.7 - 13.3)	52
10- D [I] + *S.r.* 2000	**4.6** ± 1.1 (1.7 - 6.7)	77
13- X [I] + *S.c.* 1000	**12.1** ± 1.4 (5 - 8.3)	39.5
14- X [I] + *S.c.* 2000	**3.7** ± 1 (1.7 - 6.7)	81.5
11- X [I] + *S.r.* 1000	**11.3** ± 0.7 (10 - 13.3)	43.5
12- X [I] + *S.r.* 2000	**6.7** ± 1.2 (5 - 8.3)	66.5
15- Diazinox	**6.5** ± 0.6 (5 - 8)	67.5
16- Control	**20** ± 1.4 (16 - 23)	–
F. Value	42.4 *	
L.S.D. =	1.9	

Xenatri [I] + *S.* 2000 J / ml as those led to 5.4, 5.8, 6.5 and 6.7 dead heart cases / 50 plants (73, 71, 67.5 and 66.5% reductions than control), respectively.

Six treatments; ***S.* 1000 J / ml, Dipel (11.4 gm / L) + *S.* 1000 J / ml, Xentari (5.7 gm / L), *S.* 2000** and **Xentari [I] + *S. carpocapsae* 1000 J / ml** were considered less effective preparations (8.8, 9.6, 10.8, 11.3, 11.7 and 12.1 dead hearts / 50 plants indicating 56, 52, 46, 43.5, 41.5 and 39.5% reductions than control, respectively). While the remaining preparations of ***S. carpocapsae* 2000 J / ml** proved as the least effective, leading to 14.4 dead hearts, showing 29% reduction that the 20 dead heart cases / 50 plants recorded from the control treatment (Table, 23).

IV.4. Effect of different bioinsecticidal preparations used for *S. cretica* control on maize yield:

At the end of 2004 early summer season, the dry maize ears harvested from plots of different treatments by bioinsecticides were weighed and transferred, mathematically, to that of a feddan.

Data in Table (24) showed that the dry maize ears yield from the control plots weighed 7.1 ± 0.8; 5.6 – 9.3 Kg / plot (12.6 ardab / feddan), being significantly lighter than either of those

Table (24): Calculated dry ears yield ardab / feddan in different biopesticide treatments throughout 2004 maize early summer plantation.

Treatments	Averages weight (Kg) of dry ears	Calculated yield ardab / Feddan	% Increase than control
1-D [II]	**12.3** ± 0.6 (11.3 - 12.5)	21.9	73.2
2-X [II]	**10.7** ± 0.2 (10.3 - 11.1)	19	50.7
3- S.c. 1000	**12.5** ± 0.3 (12 - 13.4)	22.2	76.1
4- *S.c.* 2000	**10.3** ± 0.5 (9.3 - 10.7)	18.3	45.1
5- *S.r.* 1000	**10.6** ± 0.5 (9.5 - 11.7)	18.8	49.2
6- *S.r.* 2000	**10.3** ± 0.5 (9.3 - 11.6)	18.3	45.1
7- D [I] + *S.c.* 1000	**12** ± 0.5 (11 - 13)	21.3	69
8- D [I] + *S.c.* 2000	**12.9** ± 0.4 (12 - 13.5)	22.9	81.7
9- D [I] + *S.r.* 1000	**10.1** ± 0.6 (8.8 - 11.5)	17.9	42.3
10- D [I] + *S.r.* 2000	**12.4** ± 0.4 (11.6 - 13.2)	22	74.6
11- X [I] + *S.c.* 1000	**10.2** ± 0.3 (9.7 - 10.9)	18.1	43.7
12- X [I] + *S.c.* 2000	**12.9** ± 0.6 (12.1 - 14.6)	22.9	81.7
13- X [I] + *S.r.* 1000	**9.5** ± 0.2 (8.9 - 9.8)	16.9	33.8
14- X [I] + *S.r.* 2000	**11.7** ± 0.4 (11.3 - 12.8)	20.8	64.8
15- Diazinox	**11.3** ± 0.3 (10.7 - 11.9)	20.1	59.2
16- Control	**7.1** ± 0.8 (5.6 - 9.3)	12.3	-
F. Value	4.1 *		
L.S.D. =	2.4		

Dry weight of Ardab = 225 kg plot = 3 X 3.5 m^2

obtained from plots treated by the bioisecticide preparations (9.5 ± 0.2 – 12.9 kg *i.e.*, 16.9 – 22.9 ardab / feddan, idicating 33.8 – 81.7% increase than control). The increase in yield weight is normally attributed to the efficacy of the applied treatments in controlling *S. cretrica*. While, the heaviest yield (average 12.9 Kg representing 22.9 ardab / feddan, 81.7% increase than control) was recorded from **Xenatri at low concentration + *S. carpocapsae* 2000 and Dipel [I] + *S.carpocapsae* 2000** treatments, followed insignificantly, by yields from **D [II]** (12.3; 11.3 – 14 kg = 21.9 ardab / feddan), ***S.c.* 1000** (12.5; 11.9 – 13.4 Kg = 22.2 ardab / feddan), **D [I] + *S.* 2000** (12.4; 11.6 – 13.2 Kg = 22 ardab / feddan), **D [I] at low concentration + *S.c.* 1000** (12; 11 – 13 Kg = 21.3 ardab), **X [I] + *S.* 2000** (11.7; 11.3 – 12.8 Kg = 20.8 ardab) and **Diazinox** (11.3; 10.7 – 11.9 Kg = 20.1 ardab). These treatments led to 73.2, 76.1, 74.6, 74.6, 69, 64.8 and 59.2% increase in grain yields' weight, respectively.

While, on the contrary, the lowest grain yield (9.5; 8.9 – 9.8 Kg = 16.9 aradab / feddan), indicating 33.8% increase in grain yields' than control) was recorded from **X [I] + *S.* 1000 (9.5 ; 8.9 – 9.8; 33.8% increase)** treatment. That was followed, insignificantly, by **Xentari [I] + *S. c.* 1000** (10.2 ± 0.6; 9.7 – 10.9 Kg = 18.1 ardab / **feddan), D [I] +*S.* 1000** (10.1 ± 0.6; 8.8 – 11.5 Kg = 17.9 ardab), ***S. carpocapsae* 2000 J / ml** (10.3 ± 0.3; 9.3 – 11.6 Kg = 18.3 ardab), ***S.r.* 2000** (10.3 ± 0.5; 9.3 – 11.6 kg = 18.3 ardab / feddan), **X at high concentration** (10.7 ± 0.2; 10.1 – 11 Kg = 19 ardab / feddan) and ***S.* 1000** (10.6 ± 0.5; 9.5 – 11.7 kg = 18.8 ardab / feddan) showing 43.7, 42.3, 45.1, 45.1, 50.7 & 49.3% increase in grain yield than control, respectively, (Table, 24).

V. Latent effect of mixtures (bacteria & entomopathogenic nematodes:

V.1. Effect of bioinsecticidal field treatments on *S. cretica* pupal weight:

As shown in Table (25), the bioinsecticidal applications on maize plants for *S. cretica* control had a latent effect on the weight of pupae which were always lighter in weight (0.11 – 0.187 gm / pupa than the mean weight of pupa from control (0.201 gm)

The mixture of **Dipel at 11.4 gm / L + *S. carpocapsae* 2000 J / ml** had the severest effect on pupal weight (0.11 gm / pupa, showing 45.3% reduction than control). That was followed by **Dipel [I] + *S. carpocapsae* 1000 J / ml & Dipel at 17.1 gm / L** treatments from which *S. cretica* pupae were of equal mean weight, being 0.124 gm / pupa (38.3% reduction) and **Xenatri at 2.9 gm / L + *S.* 2000 J / ml** (0.125 gm / pupa; 37.8% reduction than control). This group of the mentioned 4 preparations were considered highly effective as latent effect on pupal weight. According to the reduction percentages in pupal weight, the second group of three preparations that was considered intermediately effective (33.8 – 31.1% reductions in pupal weight than control) included ***S. carpocapsae* 1000 J / ml, *S.* 1000** and the mixture **Xenatri [I] + *S. carpocapsae* 2000 J / ml** from which the means of pupal weight 33.8, 31.8 and 31.3 gm / pupa, Table (25): Averages weight of *S. cretica* pupa (15 pupae / treatment) after biopesticides treatments in early summer plantation.

Treatments	Average weight of pupae (gm / pupa)	% Reduction than control
1-D [II]	0.124	38.3
2-X [II]	0.148	26.4
3- *S.c.* 1000	0.133	33.8
4- *S.c.* 2000	0.15	25.4
5- *S.r.* 1000	0.137	31.8
6- *S.r.* 2000	0.145	27.9
7- D [I] + *S.c.* 1000	0.124	38.3
8- D [I] + *S.c.* 2000	0.11	45.3
9- D [I] + *S.r.* 1000	0.149	25.9
10- D [I] + *S.r.* 2000	0.148	26.4
11- X [I] + *S.c.* 1000	0.187	7
12- X [I] + *S.c.* 2000	0.138	31.3
13- X [I] + *S.r.* 1000	0.175	12.9
14- X [I] + *S.r.* 2000	0.125	37.8
15- Diazinox	0.153	23.9
16- Control	0.201	—
F. Value	9	
L.S.D. =	**0.02**	

respectively (Table, 25). The remaining 8 treatments were less effective than the formerly mentioned ones, the mean weight of pupa ranged from 0.145 gm showing 27.9% reduction than control (resulted from treatment by ***S.* 2000 J / ml**) to 0.187 gm showing only 7% reduction in pupal weight than control (from maize treatments by the mixture of **Xenatri at 2.9 gm / L + *S. carpocapsae* 1000 J / ml,** being the least effective preparation (Table, 25).

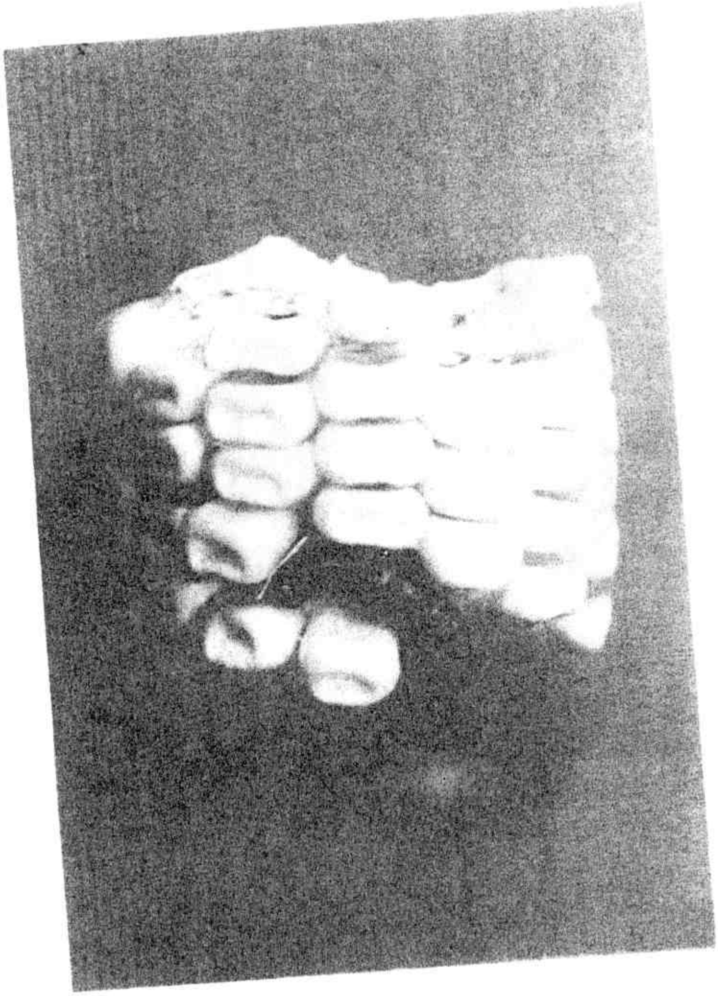
V.2.1. Malformations due to biopesticide applications on *S. cretica* larvae:

Bacterial infestation of *S. cretica* larvae was different than entomopathogenic nematodes infection. the former infestation clearly in immobility. darkening of the integument. body softening and shrinking and the appearance of brown colour of the integument (Fig. 8. 9). While. for the nematodes infection *S. cretica* larvae seem to be illness and shrinkness (Fig. 10) bright coloured. abnormal shaped (Fig. 11 & 12) stunted the growth. especially. in last larval instar (Fig. 13).

V.2.2. Malformations among pupae after biopesticides application in maize fields:

After 10 days of the third spray (about 8th June), some plants from different treatments were dissected and *S. cretica* pupae were collected. In addition, the fully grown larvae were kept in plastic cups 30°C ± 3 and 55% ± 5 R.H., allowed to pupate in the laboratory. All pupae were thoroughly inspected to determine the malformed ones and consequently the percentage of malformed pupae, from different treatments, could be calculated.

The malformed pupae appeared, in some cases, with the posterior half having the normal shape of pupae and the anterior half still in the shape of larvae (Fig. 14A), or the resultant pupae having flatten ventral side with darker colour at the ventrum of thorax and both sides of abdomen (Fig. 14B). Other appeared abnormal in shape and colour (Fig. 15) or the pupa may appear incomplete in shape, being raphed at the region between head and wings with the larval skin (Fig. 16).



General view

Fig (8): Bacterial infestation of *S. cretica* larva

- range from immobility
- darkening of the integument
- body softening & skrinkining
- the appearance of brown colour of the integument

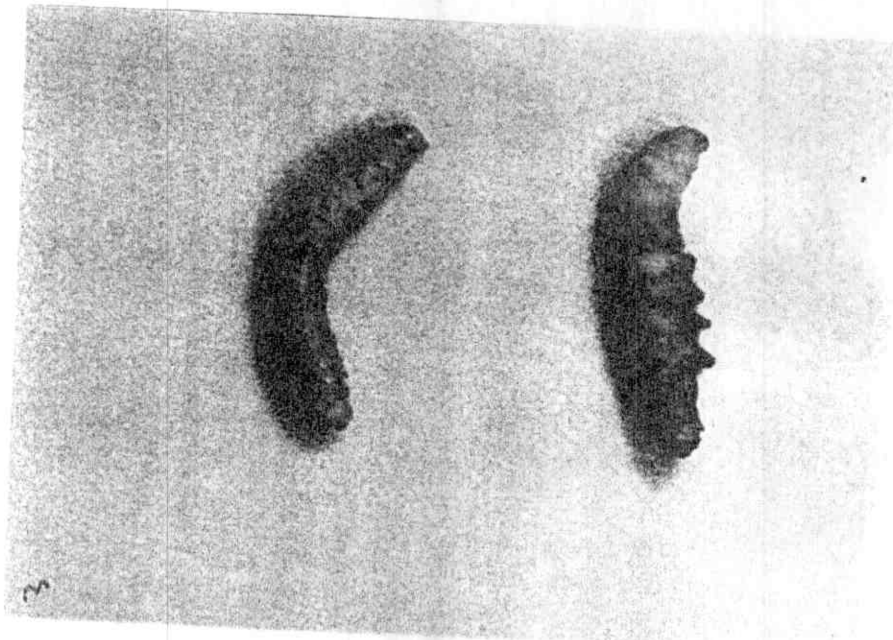


Fig (9): *S. cretica* larvae just after mortality, from maize plants treated by the mixture of Xenatri [I] + *S. carpocapsae* larvae are coloured black on most of the body with some bright yellow parts

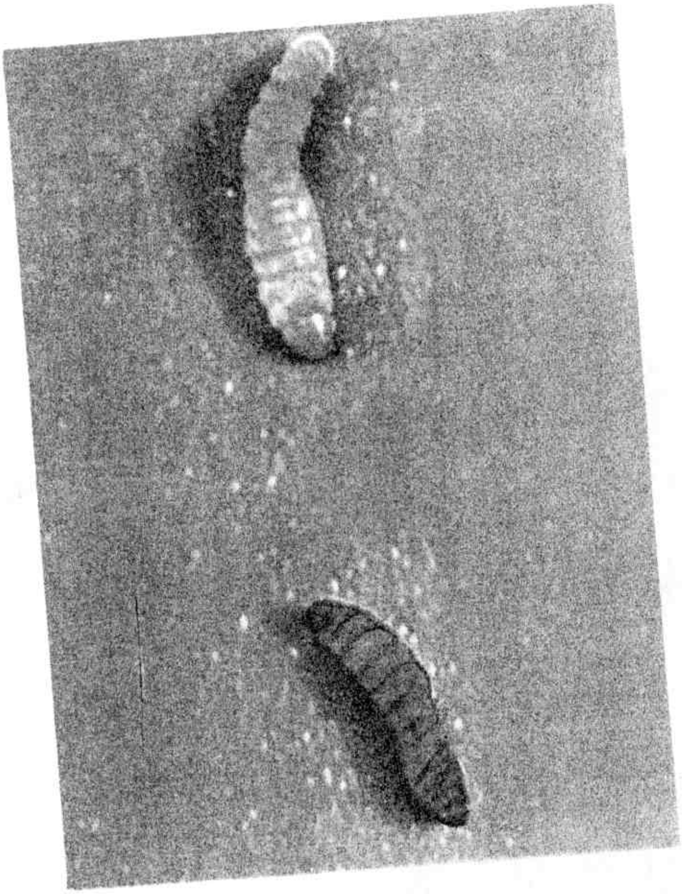


Fig (10): Last instar larvae seem to be illness and shrinkness by Xenatri + *S. carpocapsae* 2000 J / ml

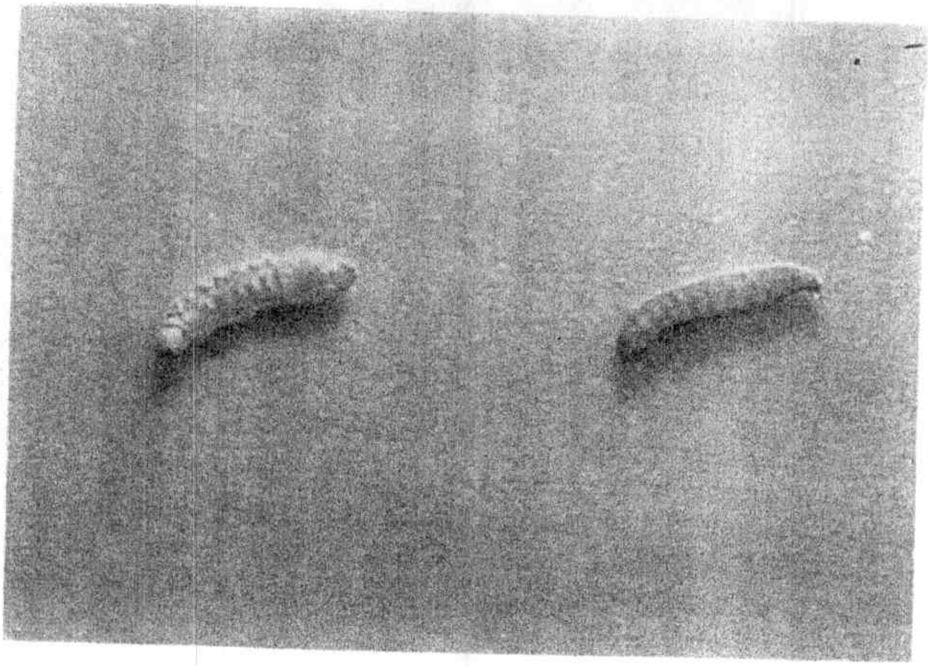


Fig (11): Bright coloured and abnormal [illegible] larval instar

I. *S. cretica* malformed larvae after treatment by *S. carpocapsae* 1000

II. *S. cretica* malformed larvae [illegible] treatment by *S. riobravae* 1000

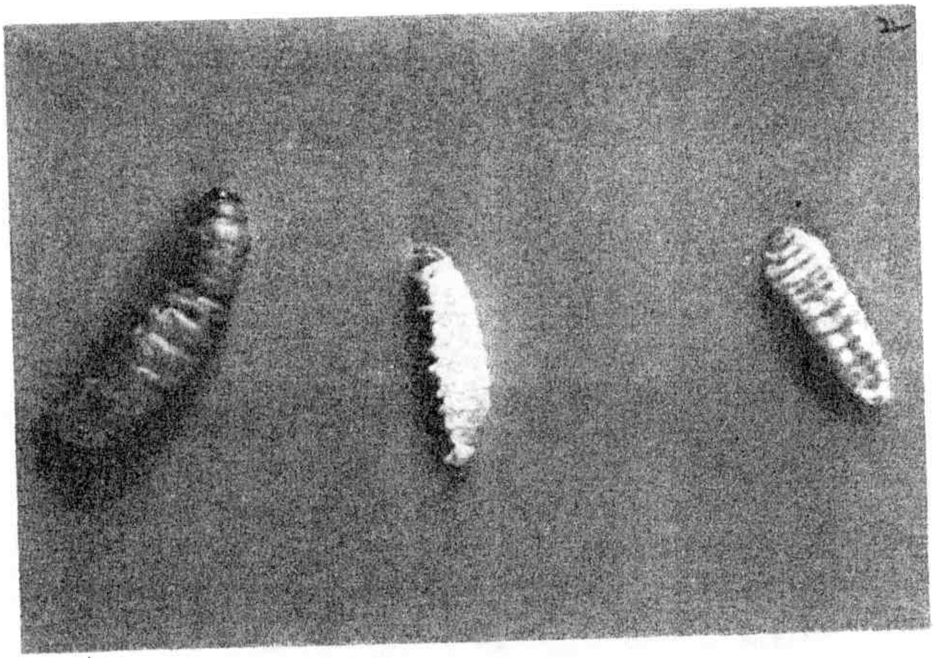


Fig (12): Shrinked *S. cretica* larvae and obvious abnormal coloured *S. cretica* larvae after treatment by Dipel + *S. riobravae* 1000 J /ml

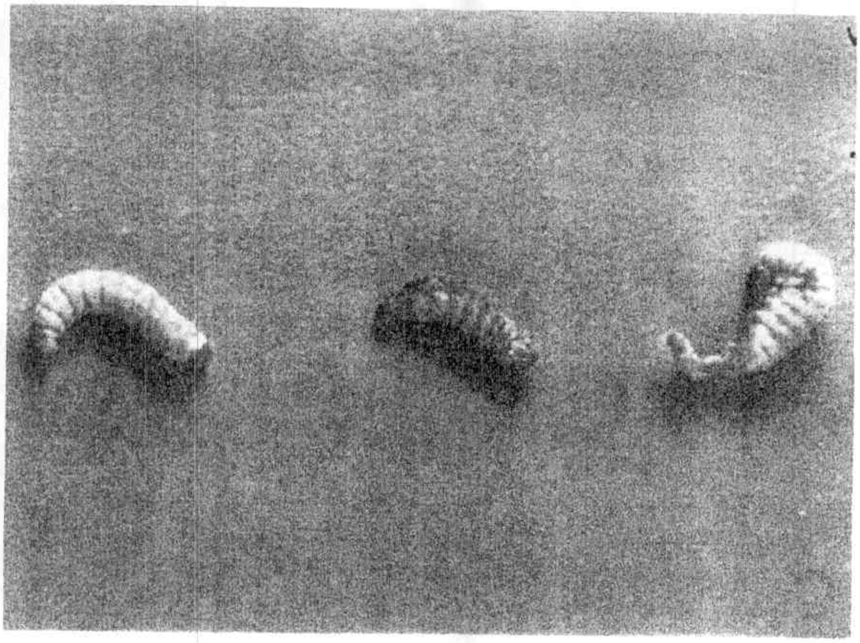


Fig (13): Moulting integument remain with pupa shrinked & stunted of *S. cretica* malformed prepupa after treatment by Dipel + *S.carpocapsae* 2000

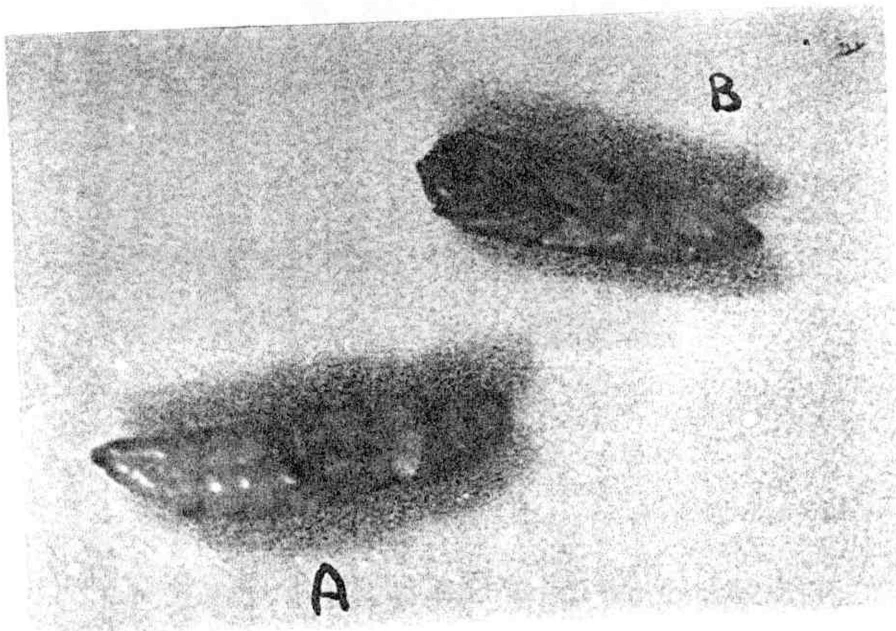


Fig (14): Flatten ventral side and moulting failure last instar of *S. cretica* larvae malformed pupa after treatment by Dipel + *S. carpocapsae* 1000

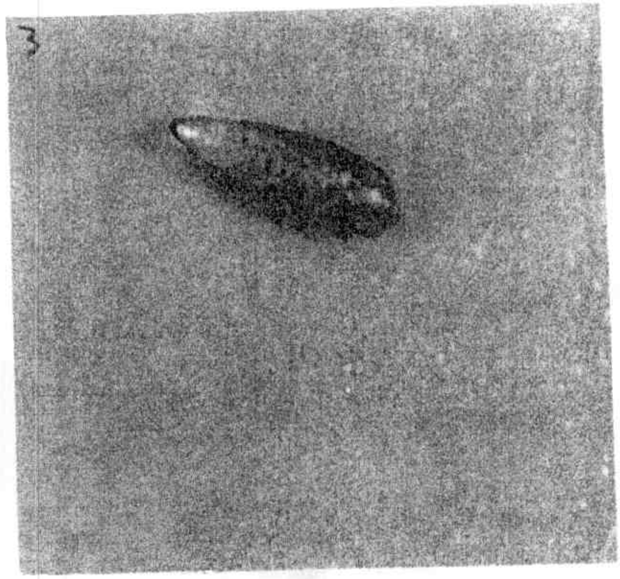


Fig (15): Abnormal colour and shape of *S. cretica* pupa after treatment by Xentari + *S. riobravae* 2000

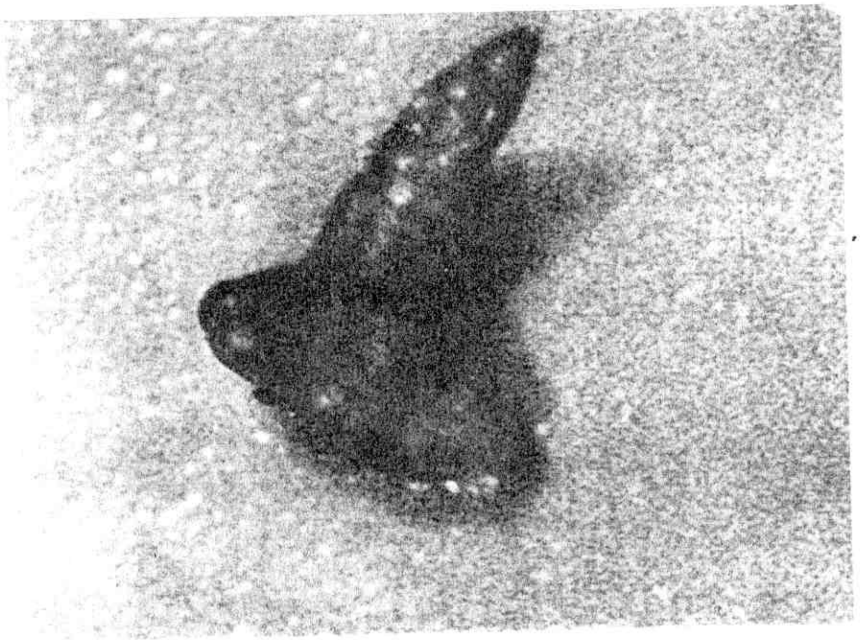


Fig (16): Malformed pupae and seem to be rahped on itself at ventral side between head and wing regions after treatment by Dipel + *S. riobravae* 2000