RESULTS AND DISCUSSION

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I- Studies on resting larvae of the pink bollworm (*Pectinophora gossypiella*) :

The diapaused larvae of the pink bollworm *Pectinophora gossypiella* (Saunders) were obtained from the duple cotton seeds and classified into two groups; the 1st group was dead larvae and the 2nd one was alive larvae. The obtained dead larvae were thoroughly inspected under a stereomicroscope for detection of any pathological symptoms then classified into groups based on the cause of death; the number and percentage of each category was recorded. On the other hand, the obtained alive larvae were kept individually and inspected throughout the rest period until either pupation and emergence of adult or death; then the number and percentage of the dead pink bollworm (either as rest larvae or pupae) and the causatives of death were recorded. The experiment was carried out for the two successive seasons of 1994/95 and 1995/96.

I.1. The excluded diapaused larvae during 1994/95 and 1995/96 rest period :-

As shown in Table (1) the number of excluded diapaused larvae of *P. gossypiella* obtained from 26 kg of the cotton seeds during the first rest period (1994/95 season) was 406 larvae; this number consisted of 266 dead larvae (65.52%) and 140 alive larvae (34.48%). The dead larvae were classified into groups up to the causatives of death, furthermore a group of dead pupae.

As shown in Table (1) the normal death, Bacterial infection, the parasitoides *Pymotes herfsi* and *Pimpla raborator* are responsible for death of 104, 19, 139 and 3 resting larvae of pink bollworm, respectively. These numbers were represent 25.6%, 4.68%, 34.24% and 0.74%, respectively of the total number of the excluded resting larvae (406). In addition, there were dead pupae (0.25%) was found in the duple cotton seeds.

Table (1) : Numbers and percentages of pink bollworm resting larvae as affected by different mortality factors during 1994-1995 rest period.

Months of inspection	No. of excluded resting larvae	No. of resting larvae/ 26 kg cotton seeds	Number of dead larvae					No. of dead pupae	Total mortality		No. of alive pupae
			Normal death	Bacteria	Virus	Parasites					
						P.herfsi	*P.robarator*		No.	%	
December	406	Dead 266 (65.52%)	**104 (25.6 %)**	**19 (4.68 %)**	**0.0**	139 (34.24%)	**3 (0.74 %)**	**1 (0.25 %)**	**266**	**65.52**	**0.0**
		Alive 140 (34.48%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
January	-		0.0	2	0.0	0.0	-	0.0	2	-	0.0
February	-		2	4	0.0	0.0	-	0.0	6	-	17
March	-		1	7	0.0	0.0	-	0.0	8	-	17
April	-		2	2	0.0	1.0	-	3.0	8	-	75
May	-		0.0	0.0	0.0	0.0	-	6.0	6	-	1.0
Total	-	140	5	15	0.0	1.0	-	9.0	30	-	110
%	-	100%	3.57	10.71	0.0	0.71	-	6.43	21.43	-	78.57

During 1995/96 rest season, the number of excluded diapaused pink bollworm larvae obtained from 23 kg of the cotton seeds was 277; these larvae were grouped into dead and alive larvae. The numbers of dead and alive larvae were 108 and 169, respectively; these numbers ~~represnt~~ represent 39% and 61% of the total number of the excluded resting larvae (**Table, 2**).

The obtained dead larvae were classified based on the causatives of death to groups. As shown in **Table (2),** the normal death, bacterial infection, viral infection, the parasitoides *P. herfsi* and *P. raborator were* responsible for death of 42, 41, 1.0, 9 and 15 *P. gossypiella* resting larvae, respectively. These numbers equivalent 15.2%, 14.8%, 0.36%, 3.25% and 5.4%, respectively of the total excluded diapaused larvae.

It could be concluded that, the death of diapaused pink bollworm present inside the duple cotton seeds were due to various causatives (namely, normal death, bacterial and virus infections, and the parasitoides *P. herfsi* and *P. raborator.*

Similar observatiols were recorded by **Farrag (1976).** In addition, **Rashad** *et al.* (1993) noted that, *P. herfsi* appeared as an important mortality, factor against the resting larvae. However, the present study indicated that the highest percent of parasitism with *P. herfsi* on PBW resting larvae (34.2% and 3.25%) occurred during the second week of December and late of January. In this respect, **Hussien (1990)** found that the parasitism of *P. herfsi* on the diapaused larvae reached the maximum (17.03%) during the second week of February and that level continued until 10th March, then decreased gradually to zero on 2nd of April.

1.2. Following up of the obtained alive diapaused larvae during 1994/95 and 1995/96 seasons:

As shown in **Tables (1 and 2)** continuity of inspection of the excluded alive resting larvae (apparently healthy larvae) obtained from cotton seeds during both years (1995 and 1996) revealed that some of these larvae reach the adult stage during 1995 and 1996 (78.57% and 55.03%, respectively). On the

Table (2) : Numbers and percentages of pink bollworm resting larvae as affected by different mortality factors during 1995-96 rest period.

Months of inspection	No. of excluded resting larvae	No. of resting larvae/23 kg cotton seeds	Number of dead larvae					No. of dead pupae	Total mort-ality	No.of alive pupae
			Normal death	Bacteria	Virus	Parasites				
						P.herfsi	P.roberator			
January	277	Dead 108 (39%)	42 (15.2%)	41 (14.8%)	1 (0.36%)	9 (3.25%)	15 (5.4%)	0	108	0.0
		Alive 169 (61%)	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0
February			13	25	2	3	0	1	44	8.0
March			3	4	4	0	0	3	14	43.0
April			1	3	6	0	0	5	15	28.0
May			0	2	0	0	0	1	3	14
Total		169	17	34	12	3	0.0	10	76	93
%		(100%)	10.06	20.12	7.1	1.7	0.0	5.92%	44.97 %	55.03 %
Total	277								184	93
%	100 %								66.43	33.57%

other hand, 21.43% and 44.97% of the obtained alive resting larvae during 1995 and 1996, respectively dead either as larvae or pupae due to different reasons; these are 1- normal death (unfavorable ambient condition), 2- the possibility of carrying the larvae inside their body some pathogenic agents (bacteria or virus); and 3- parasitism of the ecto-parasite (*P. herfsi*).

I.2.1. Normal death :

Data in **Tables (1 & 2)** revealed that normal death was responsible for death of 5 (3.57%) and 17 (10.06%) of obtained alive larvae during rest period (from February until May) of years 1995 and 1996, respectively. However, normal death of diapausing pink bollworm larvae may attributed to the unfavorable ambient condition (e.g. temperature). In this respect **Rashad *et al.* (1993)** attributed the increasing of dead resting larvae with a progressive of diapause period to the increase of temperature.

I.2.2. Bacterial infection :-

As shown in **Tables (1 & 2)** the numbers and percentages of dead *P. gossypiella* resting larvae due to dueto bacteria infection during 1995 and 1996 years were 15 (10.71%) and 34 (20.12%), respectively of obtained alive resting larvae.

In this respect, **Farrag (1976)** explained the death of apparently healthy PBW larvae early in rest season by the possibility of larval carry in within their body pathogenic agents that may kill them latter during rest period. Also, **Cheema and Muzaffar (1981)** found that 9% of diapausing larvae were found to be infested with *Bacillus cereus*, but infection occurred irregularly and the pathogen became virulent only under warm humid conditions.

I.2.3. Virus infection :

With regard of viral infection, no viral infection was recorded between resting PBW larvae in the 1st year (1995), but in the 2nd year (1996) virus was responsible for death of 12 (7.1%) of obtained alive resting larvae **(Tables, 1 & 2)**.

Data indicated that, some of the obtained alive resting larvae during 1996 incubated virus within their body early in rest period where these larvae have normal appearance and suddenly, the larval body became soft then it render to opaque and they died in 3 - 7 days later, then body of dead larvae became swollen, dry and a hole appear in posterior of thorax and enterior of abdomen. However, the obtained results indicated that the mortality (%) due to virus infection was zero% and 7.1% of total obtained alive larvae during 1995 and 1996 season, respectively, i.e. viral infection occurred irregularly. This result agree with **El-Gemiey (1983)** who determined the viral infection between PBW at different districts of Fayoum Governorate during 1980 and 1981 and her study indicated that, infection of PBW with virus ranged between 3.85% and 34.09% of dead PBW larvae during 1980, while it ranged between zero% to 23% during 1981.

I.2.4. *Pyemotes herfsi* :-

As shown in **Tables (1 & 2)**, the ecto-parasite *P. herfsi* was responsible for death of one and 3 individual which equivalent 0.71% and 1.77% of obtained alive larvae during 1995 and 1996 years, respectively.

The slight parasitism (%) may due to the contamination with the active parasite during handling of diapausing larvae in lab.; consequently, this cause did not indicate the role of *P. herfsi* as a mortality factor in the nature This result coincides with the findings of **Fahmy (1976)** who noted that, the handling of alive resting larvae and equipment must be much more refined to exclude any possible contamination of the larvae maintained in lab. by this minute and active parasite.

In addition, some resting larvae [9 (6.43%)] and [10 (3.6%)] gain the end of their diapause and transferred to pupal stage, but fall to reach adult stage, meanwhile the remained numbers of resting larvae [110 (78.57%)] and [93 (57.05%)] of the obtained alive larvae in 1994/95 and 1995/96 rest season, respectively, reach the adult stage.

However, the total mortality of diapausing larvae obtained from 26 kg and 23 kg of cotton seeds during 1994/95 and 1995/96 was 296 and 184 larvae and these equivalent 72.9% and 66.42% of the number of the excluded resting larvae during 1994/95 and 1995/96 rest season, respectively.

1.3. Spring emergence of *P. gossypiella* :-

As shown in Table (3) the numbers of *P. gossypiella* resting larvae which get to the end of their diapause stage and transferred to normal pupae and emerged as adult during the period from February till May are 110 larvae equivalent 27.1% of the excluded resting larvae (406) from cotton seeds during 1994/95 rest season. The corresponding numbers during 1995/96 rest season are 93 larvae equivalent 33.57% of excluded resting larvae (277) (Table, 4). This result agree with **Sidhu and Dhawan (1978)** who reported that only 30.2% of resting PBW had emerged as adults.

As shown in Table (3), during 1995 the adults emergence of PBW took place from 9th March to 14th May. Apparently, present results show that only one peak of the adult emergence of PBW occurred on 2nd April during 1995 year with 42.27% of total emerged moths during the emergence period (of 75 days). However, the percentage of ♀ :♂ adults at the 4th March, (2nd, 9th, 16th, 19th, 26th and 30th) April, 7th May and 14th May were as follows : (40:60), (38.5:61.5), (50:50), (20:80), (10:90), (40:60), (30:70), (80:20) and (66.7:33.3), respectively. These results indicate that the percentages of emerged males were more than females during the period from 9th March until 30th April. Regardless the sex ratio during this period, the spring emergence of *P. gossypiella* does not form any importance because of the absence of the plant parts respitors for the infestation. Contrarily, the percentages of female became more than males during May; so this result may define the presence of PBW infestation on the squares of cotton plants early in cotton season.

In 1996 year, two main peaks of emergence were observed on April 8th with 21.5% of the total emergence and the second peak of emergence occurred on 5th May with 20.43% of total emergence PBW.

Table (3) : Resting larvae reach the adult stage during 1995 year.

Months	Date of emerg-ence	Emerged moths				% Adult emergence	
		Normal		Malformed			
		Female	Male	Female	Male	Female	Male
March	*9th*	2	3	0	0	40.0	60.0
April	*2nd*	20	32	0	0	38.5	61.5
	9th	9	9	0	0	50.0	50.0
	16*th*	2	8	0	0	20.0	80.0
	19*th*	1	1	0	0	10.0	90.0
	26*th*	2	3	0	0	40.0	60.0
	30*th*	3	7	0	0	30.0	70.0
May	*7th*	4	1	0	0	80.0	20.0
	14*th*	2	1	0	0	66.7	33.3
Total		45	65	0	0		
		110					
%		78.57*		0			
		27.10**		0			

* % of alive obtained resting larvae (140)

** % of alive excluded resting larvae (406)

The period between the two main peaks was 27 days. Emergence period was extended from March 3^{rd} to May 26^{th}, (i.e. 82 days). However, data in **Table** (4) show the percentage of ♀ : ♂ adults at the (5, 11 & 17^{th}) March, (1, 8, 14 & 21^{st}) April, (5, 13 & 20^{th}) May and 26^{th} May were as follows : (80:20), (0:100), (50:50), (62.5:37.5), (52.4:47.6), (46.2:53.85), (25:75), (36.8:63.2), (66.7:33.3), (100:0) and (0.0:2.0), respectively, i.e. percentages of female were more than males during the period from 5^{th} March until 8^{th} April and ves versa from 14^{th} April until 5^{th} May then percentage of superior the males.

Also, data in **Table (4)** show that, there are some emerged adult (6 moths equivalent 6.25% of emerged PBW moth) are found to be malformed during 1996 year. In contrast, during 1995 year, all emerged *P. gossypiella* moth are normal in their appearance (**Table,** 3).

Results in both years (1995 & 1996) revealed that, few moths of *P. gossypiella* emerged from resting larvae at the beginning of March and no increase of moth emerged until beginning of April where majority of pink bollworm spring emergence (i.e. peak of emergence). **Abd El-Megeed *et al.*** (1979) found that the highest percent of pupation and adult emergence of resting PBW larvae occurred during March-April and April-May, respectively.

Awaknavar *et al.* (1982) found that, the maximum emergence of adults of *P. gossypiella* from pupae collected as diapausing larvae at various times from January to June in 1975 occurred in July-August, when the humidity was high due to rainfall and was not related to the time of larval collection. Also, they indicated that diapause could be terminated in shortest time 21.5-22 days at 25°C and 92% RH or 35°C and 92%RH.

In 1994/95 season only one major peak of emergence was observed from diapaused PBW. Whereas, two such peaks occurred from diapaused PBW in 1995/96.

During April-May, maximum relative humidity ranged between 100-73%, while minimum RH ranged between 49 - 20% for the first year. On the

Table (4) : Resting larvae reach the adult stage during 1996 year.

Month	Date of emerg-ence	Emerged moths				% Adult emergence	
		Normal		Malformed			
		Female	Male	Female	Male	Female	Male
March	*5th*	4	0	0	1	80	20
	11th	0	1	0	0	0	100
	17th	0	0	1	1	50	50
April	*1st*	5	3	0	0	62.5	37.5
	8th	11	9	0	1	52.4	47.6
	14th	5	6	1	1	46.2	53.85
	21st	2	6	0	0	25.0	75.0
May	*5th*	7	12	0	0	36.8	63.2
	13th	6	3	0	0	66.7	33.3
	20th	5	0	0	0	100.0	0.0
	26th	0	2	0	0	0.0	100
Total		45	42	2	4		
		93					
%		55.03*		6.25*			
		33.00**					

*** % of alive obtained resting larvae (169)**
**** % of alive excluded resting lairvae (277)**

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other hand, maximum and minimum R.H. ranged between 100-61% and 42 - 17%, respectively for the 2nd year of 1996.

During the same period of the two years degree-days during April and May in 1995 were lower than that of 1996 year. However, it was indicated that one major peak of emergence might be expected from infested bolls with below normal temperature in April, accompanied by frequent periods of heavy rainfall during April 15th to May 15th (Fife, 1961).

1.4. Forecasting of timing of PBW spring emergence on the basis of degree-days (dd's) (or AHU) during 1994/95 and 1995/96 seasons:-

Data in **Tables** (5 & 6) show that the accumulative no of PBW spring emergence, started in 9 and 5th of March and nearly completed in 14 and 26th of May for 1st and 2nd season, respectively.

Accumulated heat units from January 1st to the first emergence, peak and complete of spring emergence of PBW were (444 and 423), (698 and 890) and (1382 and 1946) with corresponding averages of 433.5, 794 and 1664 AHU for both years 1995 and 1996 years, respectively. Also, data in **Tables** (5 & 6) show the accumulative numbers of PBW moths were positively correlated with the AHU, where r = (0.93 and 0.958), b =(0.01 and 0.66) for the 1st and 2nd season, respectively.

However, present results indicate that the PBW spring emergence was initialized when about 444 dd's and 423 dd's in 1995 and 1996, respectively, with average of 433.5 AHU. It could concluded that the ambient temperature may be similar during the period between the beginning of larval rest and the beginning of spring emergence. On the other hand, the AHU for peak of spring emergence occur in 2nd April and 8th April in 1994/95 and 1995/96 seasons, when 698 dd's and 821 dd's were accumulated, respectively. However, emergence peak during 1996 year delayed to 8th April that may due to the beginning of diapause in 1st season was earlier than in 2nd season. On the other hand, during May the spring in 1994/95 season was cooler than spring in

Table (5) : *P. gossypiella* spring emergence related to degree-days in 1995 year.

Date	Emerged moth (Accum. No.)	Degree-days (dd's)
March, 9*th*	5	444
April, 2*nd**	57	698
9*th*	75	779
16*th*	85	882
19*th*	87	931
26*th*	92	1043
30*th*	102	1130
May, 7*th*	107	1235
14*th*	110	1382

* Peak emergence date

r = 0.93 r = Correlation Coefficient

b = 0.01 b = Regression,

a = -19.86 a = Intercepte

A.H.U. for spring emergence = 444

A.H.U. for peak emergence = 698

A.H.U. for last emergence = 1382

A. H. U. = accummulated heat unit

Table (6) : *P. gossypiella* spring emergence related to degree-days in 1996 year.

Date		Emerged moth (Accum. No.)	Degree-days (dd's)
March,	*5th*	**5**	**423**
11*th*		**6**	**465**
17*th*		**8**	**546**
April,	1*st*	**16**	**711**
8*th* *		**37**	**821**
14*th*		**50**	**890**
21*th*		**58**	**988**
May,	*5th*	**77**	**1263**
13*th*		**86**	**1502**
20*th*		**91**	**1769**
26*th*		**93**	**1946**

* Peak emergence date

r = 0.95

b = 0.01

a = -19.86

A.H.U. for spring emergence = 423

A.H.U. for peak emergence = 821

A.H.U. for last emergence = 1946

1995/96 season and consequently, moth emergence continued for about 12 weeks in 1995/96 seasons, but shortened to about 9 weeks in the first season (1994/95), where a number of six pupae were suddenly dead at the period of 7th May to 14th May. These results agree with the findings of **Rashad *et al.* (1993)** who indicated that the low rate of heat units accumulation worked as a mortality factor on the diapausing *P. gossypiella* larvae.

Depending on the former results, AHU is an important factor for timing and determining size of pink bollworm spring emergence (1st generation).

II- Effect of different concentrations of Xentari (*B. thuringiensis* var. *aizawai*) against neonate larvae of the spiny bollworm :

Percentages of mortality among first instar larvae of *E. insulana* fed for 2 days on artificial diet treated with different concentrations of Xentari were estimated.

Data in **Table (7)** indicated that as the concentration of Xentari increased the percentages of larval mortality also, increased. The highest percentage of larval mortality was 87.5% at 1.25 g/L. concentration of Xentari, while the lowest percentages of larval mortality were 12.5 and 15.0% at 0.04 and 0.08 g/L. concentration, respectively.

The obtained data also, revealed that the neonate larvae of the spiny bollworm are sensitive to *B. thuringiensis* var. *aizawai*. These results are in agreement with the findings of **El-Husseini and Afifi (1981)** and **Moawad *et al.* (1983)** who found that, mortalities of neonate larvae of the spiny bollworm increased as the concentration of bioinsecticide increased.

From the above data, the different concentrations of Xentari and percentages of larval mortality were subjected to a computer program of **Noack and Reichmuth (1978)** to estimate the LC_{50} and LC_{90} of the bioinsecticide (Xentari).

Table (7): Mortality percentages of neonate larvae of *E. insulana* fed for 2 days on artificial diet treated with different concentrations of Xentari (40 larvae/conc.)

Xentari concentrations* (g/L.)	1.25	0.63	0.31	0.16	0.08	0.04
Mortality (%)	87.5	80.0	65.0	37.5	15.0	12.5

* Xentari concentrations equivalent 4.4 x 10^7, 2.2 x 10^7, 1.1 x 10^7, 0.55 x 10^7, 0.28 x 10^7 and 0.14 x 10^7, diamond-back moth units/L., respectively.

After 2 days from larval treatment, the LC_{50} of Xentari against *E. insulana* neonate larvae was 0.23 g/L. (equivalent 0.81 x 10^7 diamond back moth unit/L.), with upper and lower confidence limits 0.29 and 0.18 g/L. (equivalent 1.02 x 10^7 and 0.63 x 10^7 diamond back moth unit/L, respectively). While LC_{90} was 1.39 g/L. with confidence upper and lower limits 1.96 and 0.85 g/L. (equivalent 4.87 x 10^7, 6.86 x 10^7 and 2.98 x 10^7 diamond back moth unit/L, respectively) **(Table, 8)**.

Table (8): Lethal concentrations (LC_{50} and LC_{90}) of Xentari against the neonate larvae of *E. insulana*.

Lethal concentrations of Xentari and their 95% confidence limits			Slope ± SD	" r "
	Upper	Lower		
LC_{50} 0.23 g/L.	0.29	0.18	1.71±134	0.985
LC_{90} 1.30 g/L.	1.96	0.86		

SD = standard deviation

"r" = correlation coefficient of regression line

II.1. Effect of feeding of neonate larvae on diet treated with LC_{50} of Xentari on larval, pupal and adult stages :

II.1.1. Effect on larval stage :

Percentages of mortality among newly hatched larvae of *E. insulana* fed on artificial diet treated with LC_{50} were calculated in **Table (9).** These results indicated that, the mortality percentages (corrected with Abbot's formula) among 1st instar larvae of *E. insulana* were 51.1%, 55.26%, 57.9% and 57.14% after 2, 7, 14 and 21 days from treatment, respectively. These data indicated that, the most mortality of *E. insulana* larvae treated with *B. t.* var. *aizawai* occurred after 2 days. This result coincides with **El-Husseini and Afifi (1981)** who found that, the most of larval mortality of neonate larvae of *E. insulana* was recorded after 2 days from treatment with different concentrations of Entobackterin-3 *B. t.* var. *galleria.*

II.1.2. Latent effects of Xentari (*B. t.* var. *aizawai*) on pupal and adult stage of spiny bollworm :

Larvae of *E. insulana* fed on LC_{50} of Xentari for 2 days, after that, these larvae transferred on untreated fresh diet until pupation. The effect of *B. t.* var. *aizawai* on pupal and adult stage were recorded.

Data in **Table (9)** show the number and percent of surviving larvae either normal and/or malformed of both treatment and control. Also, the present study show the number and percent of formulated pupae as well as the resulting adults. However, the results reveal that, there was a great decrease in larval survivors as a result of larval feeding as young on contaminated food with LC_{50} of Xentari, where the number of surviving larvae was 15 (31.91% of initial number of treated larvae), whereas the number of surviving untreated larvae was 35 (74.46% of initial number of untreated larvae). On the other hand, the treatment of neonate larvae of *E. insulana* with LC_{50} of Xentari didn't induce any malformation in subsequent full grown larvae and pupal stage, where the number of formulated pupae was 15 normal pupae.

Table (9) : Effect of LC_{50} of *B. thuringiensis* var. *aiziwai* on larval, pupal and adult stages of *E. insulana.*

Treatment	Days after treatment	Xentari	Control
Number of initial larave used		47	47
Accumulated number and percentage of mortality	2 days	25(51.10)	2(4.25)
	7 days	30(55.26)	9(19.50)
	14 days	31(57.90)	9(19.50)
	21 days	32(57.14)	12(25.53)
Number of surviving larvae	Normal	15 (31.9)	35 (74.46
	Malformed	0	0
Weight of 15 larvae/g		0.696gm	0.910gm
Number and percentage of formulated pupae	Normal	15(100%)	33(94.3%)
	Malformed	0	2(5.7%)
Weight of 15 pupae/gm		0.563gm	0.695gm
Number and percentage of resulting adults	Normal	15(100)	32(96.97%)
	Malformed	0	1(3.03%)

Meanwhile, the untreated larvae induced two malformed pupae (5.7% of the number surviving larvae) and 33 normal pupae (94.3%).

As for the resulting adult, data in **Table (9)** indicate that all formulated pupae of treated larvae (15 pupae) resulted 15 normal adult (i.e. there was no malformed adult), while the normal formulated pupae of control (33 pupae) resulted 32 (96.97%) normal adult, and only one of adult (3.03%) was malformed.

It could be concluded from the above results that *B. t.* var. *aizawai* was more active for controlling neonate larvae of *E. insulana*. In this respect, **Salama and Foda (1984)** found that some cultures belonging to *B. t.* subsp. *aizawai* have high level of activity against *E. insulana* larvae.

Moreover, the results in present study indicate that, although the treatment with LC_{50} of Xentari against neonate larvae of *E. insulana* caused great decrease in larval survivors, Xentari didn't induce any malformation in subsequent larvae, pupae and adults. However, **El-Gemaiey (1992)** reported that although the bacterial formulations (Dipel-2X, Florbac, Delfin and Bactospeine) showed high virulent action against the spiny bollworm larvae, only slight effect was reported on pupation and adult emergence from surviving larvae. Also, she noted that, the delayed effects of *B. thuringiensis* extended to the adults resulting from treated larvae, but some concentration of former biocides hadn't effect on percent pupation and adult emergence.

II.1.3. Latent effects of Xentari on durations of *E. insulana* immature stages and adults longevity at 28±1°C and 70±5 RH.

II.1.3.1. Effect on durations of immature stages :

As shown in **Table (10)** data indicated that the larval and pupal duration of *E. insulana* treated with LC_{50} were 21.20±0.65 and 9±0.46 days, respectively. While, the larval and pupal duration of *E. insulana* resulted from untreated larvae were 17.3±0.31 and 8.2 ±0.24 days, respectively. From these results it is clear that the larval and pupal durations of *E. insulana* treated ones with Xentari are longer than in untreated.

Table (10) : Larval and pupal periods and adult longevity of *E. insulana* larvae surviving after Xentari treatment at LC_{50} on artificial diet.

Treatment	Larval period±SE (days)	Pupal period±SE (days)	Adult longevity±SE (days)	
			Female	Male
Xentari	18-26 (21.2±0.65)	7-14 (9.0±0.46)	11-16 (13.3±0.8)	11-16 (13.3±0.8)
Control	15-22 (17.3±0.31)	6-10 (8.2±0.24)	14-16 (15.5±0.05)	14-17 (16.5±0.34)
T-value	6.1**	8.48**	1.78	2.39**
C.V.	0.1	0.17	0.16	0.16

On the other hand, statistical analysis show that there are significant differences between larval and pupal duration of treated and untreated larvae. The present results agree with **El-Gemaiey (1992)** who found that the larval and pupal duration's of treated SBW larvae with the biocides (Dipel-2X, Bactospeine, Delfin and Florbac) seem to be longer than that of untreated larvae.

II.1.3.2. Effect on adult's longevity :

Data in **Table (10)** indicate that, longevity of female and male of *E. insulana* emerged from treated neonate larvae with LC_{50} of Xentari were 13.3±8 days for both male and female, wherever the longevity of female and male of emerged from untreated larvae were 15.5±0.5 and 16.5±0.34 days, respectively.

However, the present study indicated that, the longevity of female and male of *E. insulana* emerged moth from treated neonate larvae with LC_{50} of Xentari were shorter than that emerged from untreated neonate larvae.

Statistical analysis using T-test indicated that, there was significant differences between adult's longevity of the males resulted from treated neonate larvae with Xentari and those resulted from untreated larvae. Contrarily, the differences between adult's longevity of the females resulted from treated and untreated larvae were non-significant. In this respect, **Abdel-Hameed (1995)** found that, the life-spans of moths that resulted after larval feeding on *B. thuringiensis* preparations were shorter than that estimated for the control adults of pink bollworm *P. gossypiella*.

II.1.3.3.Effect of feeding *E. insulana* larvae on artificial diet treated with LC_{50} of Xentari on reproductive capacity of females :

The resulted moths of spiny bollworm from treated larvae with Xentari and untreated larvae were paired and the number of eggs laid/female daily were estimated until death of female.

The mean pre-oviposition and oviposition periods were recorded and presented in **Table (11)** as well as the average of deposited eggs/female. The

Table (11) : Effect of feeding *E. insulana* larvae on artificial diet treated with LC_{50} of Xentari on reproductive capacity of resulted adult females.

Treatment	Average no. of deposited eggs/ female	Average no. of hatched larvae	% Hatchability	Pre-oviposition period (days)	Oviposition period (days)
Xentari	35-193 (119.83)	38-183 (112.50)	93.88	1-5 (3.0)	7-12 (10.33)
Control	184-317 (238.83)	182-137 (237.83)	99.58	1.2 (1.83)	10-13 (12.5)
T-value	3.97**	5.35**		1.30	2.26*
C.V.	0.29	0.23		0.65	0.14

deposited eggs were left until hatching. The number of hatched larvae and percentage of hatchability were recorded and presented in **Table (11)** too.

However, as shown in **Table (11)**, the neonate larvae of *E. insulana* fed on artificial diet treated with LC_{50} of Xentari increased the pre-oviposition period of female and decreased the oviposition period than these females resulted from larvae fed on untreated diet, where the pre-oviposition periods were 3 and 1.83 days for females resulted from treated and untreated larvae, respectively. While, the oviposition period of females resulted from treated and untreated larvae was 10.33 and 12.5 days, respectively.

The mean number of eggs/female obtained from females resulted from treated and untreated larvae were 119.83 and 238.83 eggs, respectively. Therefore, the percentage of eggs hatching was also, estimated where data in **Table (11)** cleared that percentage of eggs hatching in control was higher (99.58%) than in case of treated larvae (93.88%). Statistical analysis of the obtained data indicated that, the number of deposited eggs and hatched larvae obtained from female which resulted from treated young larvae were significantly lower than control. Also, statistical analysis cleared that is no significant differences between pre-oviposition period of females resulted from tested and untreated larvae. While, oviposition period were significantly shorter in the treatments than the control.

In summary, feeding neonate larvae of *E. insulana* on the contaminated diet with LC_{50} of Xentari for 2 days reduced oviposition period of female, the number of eggs deposited by its and percentage of eggs hatching. On the other hand, pre-oviposition period didn't affected by larval treatment with Xentari. In this respect, **Abdel-Hameed (1995)** who tested the LC_{50} of Flobac, Bactospeine and Delfin against neonate larvae of pink bollworm and found that the average of total number of eggs laid by a single female from treated diet was significantly fewer than that recorded from females of control as well as the percentage of hatched eggs. She also indicated that there was significant difference in the oviposition period, where the longest was in the control. She added that, there was no significant differences between the pre-oviposition period in the treatment and control.

In general, the present results of the toxicity and biological effects of Xentari (*B. t.* var. *aizawai*) against the larvae of *E. insulana* reveal that, the neonate larvae of *E. insulana* are sensitive to Xentari and the mortality percentage of treated larvae was concentration dependent.

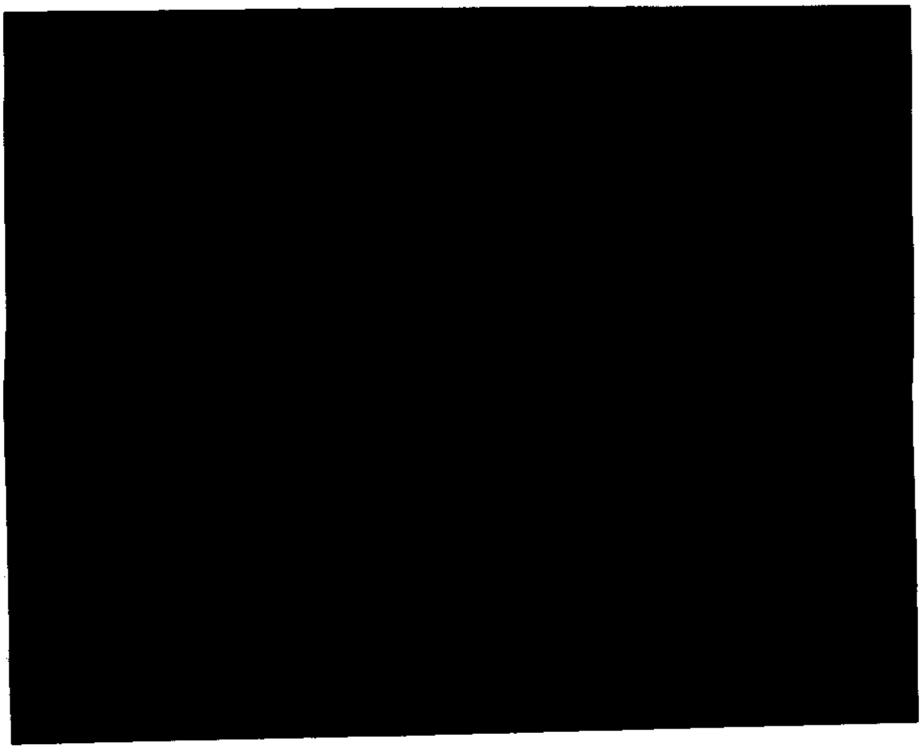
The latent effects of LC_{50} of Xentari against neonate larvae of *E. insulana* extended to the subsequent pupae and adults; where it caused significant increase in the duration of larval and pupal stages; but it didn't cause any male formation of larvae and pupae stage also it hadn't effects against pupation and adult emergence. On the other hand, LC_{50} of Xentari against neonate larvae of *E. insulana* reduced the adult's longevity and fecundity.

III- Histological effects of Xentari (*Bacillus thuringensis* var. *aizawai*) on larvae of *E. insulana* :

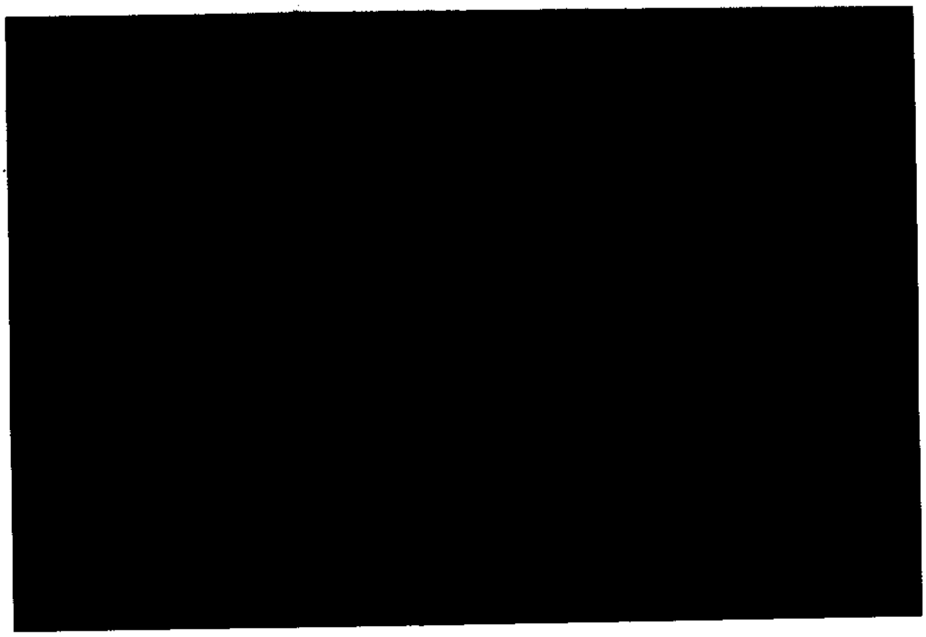
Histological studies revealed that, the spiny bollworm [(*E. insulana* (Boisd.)] larvae are susceptible to Xentari (*Bacillus thuringensis* var. *aizawai*), where Xentari caused many pathological effects as well as any bactiricide derived from *Bacillus thuringensis*.

However, the fourth instar larvae of spiny bollworm fed on artificial diet treated with Xentari at concentration of 1.25 g/L. (equivalent 4.4×10^7 diamond-back moth unit/mg).

After 24 hrs. from treatment, the treated larvae became sluggish and a dark colour appeared on its body. The microscopic examination of treated and untreated larvae mid-gut sections (**Figs., 1 & 2**) indicate that there were differences between the mid-gut sections of treated and untreated larvae, where Xentari (δ-endotoxin) produces apparent conditions to the mid-gut epithelium and preitrophic membrane.



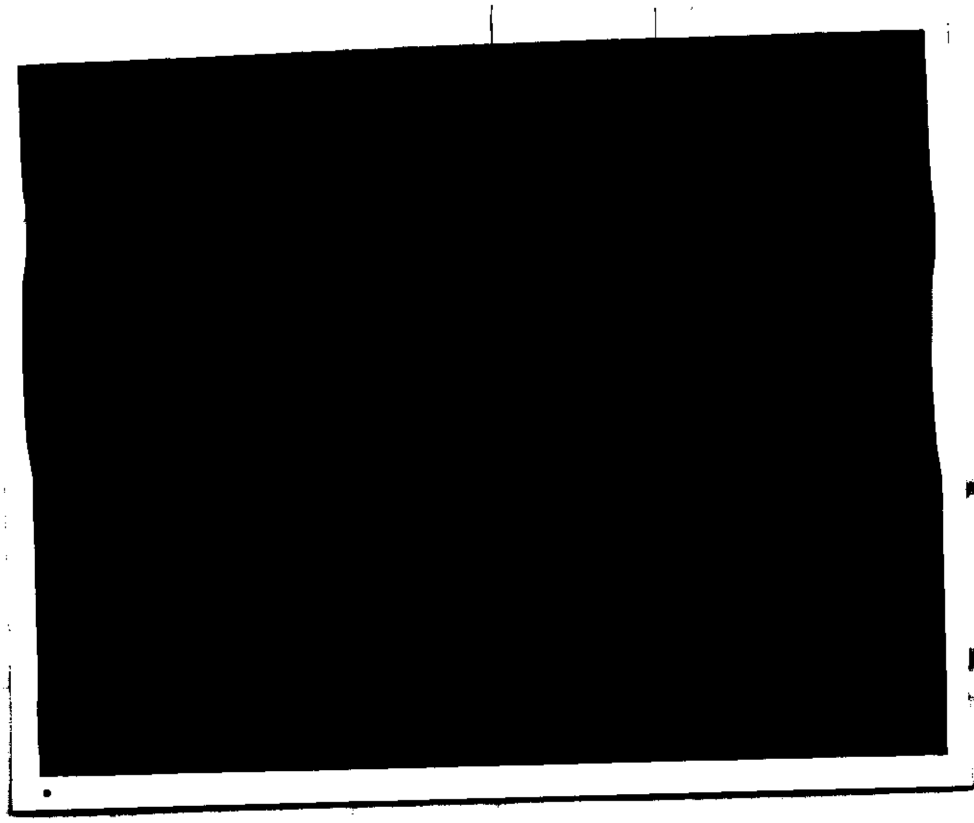
Magnification 100X



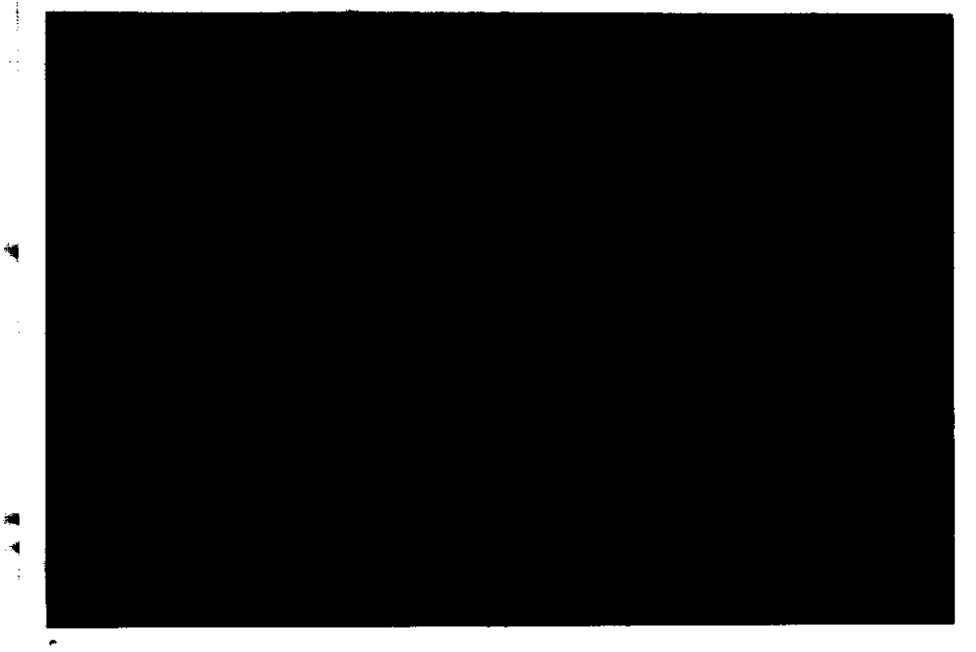
Magnification 40X

Fig. (1) : Cross section in the mid-gut of untreated 4*th* instar of larvae of the spiny bollworm *E. insulana*.

1- Basement membrane 2- Epithelium layer 3- Lumen



Magnification 100X



Magnification 40X

Fig. (2) : Cross section in the mid-gut of Xentari- treated 4*th* instar larvae of the spiny bollworm *E. insulana*.

1- Basement membrane 2- Epithelium layer 3- Lumen

As shown in **Fig. (2)**, the histopathological effects caused by Xentari on the mid-gut of 4th instar larvae are involved, separation of epithelial cells from basement membrane; moreover, elongation, vacuolization and breakdown of the larvae mid-gut epithelium. Also, Xentari caused disorganization and disintegration of preitrophic membrane.

The histological effects of Xentari on larvae mid-gut found during this study are as a great similar as those found by **Hamed (1979)** who mentioned that, Bactospeine (*B. t.* var. *thuringiensis*) caused disorganization of epithelial cells of *S. littoralis* larvae after 24 hrs. of infection and after 48 hrs. these epithelial cells became ditched from the basement membrane and disintegrated.

Also, in this respect, **Awad (1983)** mentioned that, Bactospeine caused the deattachment and separation of the peritrophic membrane of pink bollworm larvae.

IV- Evaluation of certain control programs against cotton bollworms :

Cotton boll worms i.e. pink bollworm (PBW)-*Pectinophora gossypiella* (Saunders) and spiny bollworm (SBW)-*Earias insulana* (Boisd.) are considered as key pests affecting cotton yield in Egypt.

Chemical pesticides are useful and powerful tool for the management of the two pests. Microbial control is considered as a new approach offers high potential against several pests. There is now abundant evidence to show that integrated pest control has proved to be a better approach to the solution of many cotton pest problems than a total reliance on pesticides. Thus, the main goal of the present work was to evaluate the efficiency of different control programs including insecticides and bio-agents separately or in conjunction with the conventional insecticides against bollworms, taking into consideration the reduction rates of young larvae and the total number of all counted larvae during inspections as well as the rates of boll infestation to find an adequate control program.

Content of bolls from young larvae in relation to total number of bollworms larvae could be a more reliable parameter for control decisions and evaluation of efficacy of the applied control programs.

During this work, different control programs were tested against cotton bollworms during 1994, 1995 and 1996 cotton seasons.

Experimental design for evaluating the tested programs during various cotton seasons was randomized complete block with 3-4 replicates each of 38-44 m^2.

Plants received the 1st spray in July 24th, August 2nd and 7th during 1994, 1995 and 1996 season, respectively. The following sprays in each program were performed when the correlation between small larvae (1st instar) and all counted larvae in infested bolls proved to be significant. In this respect, the method of calculation was adopted after **Abd El-Salam *et al.* (1991)** who mentioned that the relation between young larvae (1st and 2nd instar) and the total counted larvae in infested bolls seemed to be more reliable parameter for starting the chemical control program and helpful criterion for evaluating bollworms control programs.

The tested control programs during this study are given in **Table (12).** The obtained data were subjected to analysis of variance and combined statistical analysis.

The efficacy of the investigated programs was detected against small larvae and all counted larvae of PBW and SBW.

IV.1. Efficacy of the bio-insecticides and pesticides included in various control programs against cotton bollworms larvae and reduction percentages in cotton boll infestation on basis of each spray :

IV.1.A. Season 1994 :

Efficiency of Dipel-2X (program A), binary mixtures of Dipel-2X plus chemical insecticides (program B) and chemical insecticides (program C) against small and all counted bollworms larvae and reduction percentages in boll infestation at various inspections are presented in **Table (13).** The 1st, 2nd

Table (12) : Evaluated control programs against the cotton bollworms (pink and spiny bollworm) during 1994, 1995 and 1996 cotton seasons.

Season	Program	Applied insecticides and rate/feddan					Group
		1st spray	2nd spray	3rd spray	4th spray	5th spray	
1994	A	Dipel-2X (400 g)	Dipel-2X (400 g)	Dipel-2X (400 g)	Dipel-2X (400 g)	-	1
	B	Dipel + Dursban (0.5 l.)	Dipel + Cutabron (375 ml)	Dipel + Bulldock (82.5 ml)	-	-	
	C	Dursban (1 l).	Cutabron (750 ml)	Bulldock (165 ml)	-	-	
1995	D	Xentari 500 g	Xentari 500 g	Xentari 500 g	Xentari 500 g	-	2
	E	Xent. + Cyanox (0.5 l.)	Xent. + Cutabron (375 ml)	Xent. + Bulldock (82.5 ml)	Xentari + Cyanox (0.5 l.)	-	
	F	Cyanox (1 l.)	Cutabron (750 ml)	Bulldock (165 ml)	-	-	
1996	A	Dipel-2X (400 g)	Dipel-2X (400 g)	Dipel-2X (400 g)	Dipel-2X (400 g)	Dipel-2X	
	B	Dipel + Dursban (0.5 l.)	Dipel + Cutabron (375 ml)	Dipel + Bulldock (82.5 ml)	-	-	
	C	Dursban (1 l).	Cutabron (750 ml)	Bulldock (165 ml)	-	-	
	D	Xentari 500 g	Xentari 500 g	Xentari 500 g	Xentari 500 g	-	
	E	Xent. + Cyanox (0.5 l.)	Xent. + Cutabron (375 ml)	Xent. + Bulldock (82.5 ml)	Xentari + Cyanox (0.5 l.)	-	
	F	Cyanox (1 l.)	Cutabron (750 ml)	Bulldock (165 ml)	-	-	

Table (13) : Efficiency (%) of insecticides included in different control programs against the cotton bollworm larvae and reduction percentages in boll infestation at various inspection dates during 1994 cotton season.

Programs	Efficiency (%) of insecticides against small and all counted bollworms larvae and reduction (%) of infested cotton bolls at various inspection dates																	
	1/8			8/8			16/8			23/8			30/8			6/9		
	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)
Program "A"	54.8*	35.76	29.4	0.0 **	0.0	13.95	26.53 ***	0.0	30.3	5.39 ***	0.55	24.4	31.7 ****	25.8 ****	25.0	3.24	0.0	3.3
Program "B"	63.1 *	44.5	47.1	0.0 **	17.0	37.2	0.0 ***	0.0	57.57	57.5 ***	57.2	70.73	0.0 ***	27.3 ***	46.43	0.0	0.0	24.2
Program "C"	79.68 *	75.8	52.94	0.0 **	0.0	51.16	55.1 ***	0.0	45.45	90.0 ***	51.1	70.73	72.0 **	34.8 ***	62.5	0.0	2.11	43.9

s : Small larvae   a : All counted larvae   Red. (%) : Reduction (% in infested cotton bolls).

* : Efficiency and reduction (%) after 1*st* spray

** : Efficiency and reduction (%) after 2*nd* spray

*** : Efficiency and reduction (%) after 3*rd* spray

**** : Efficiency and reduction (%) after 4*th* spray and 3rd spray dates were conducted on 24/7, 1/8 and 8/8.1994, respectively for the various control programs. Only control program A included a fourth spray which applied on 23th of August.

Data showed that one week after the 1st spray, efficiency (%) of Dipel-2X (400 g/fed.) Dipel-2X + Dursban (½ L./fed.) and Dursban (1 L./fed.) against small and all counted bollworm larvae were (54.8 & 35.76%), (63.1 & 44.5%) and (79.68 & 75.8%), respectively. This result indicated that Dursban was the most effective followed by the mixture of Dipel-2X with Dursban at half of the recommended rate/fed., while Dipel-2X was the least effective compound.

This result coincides with the findings of **Sheta *et al.* (1979)**, who mentioned that, Dursban averaged the best reduction in the total pink and spiny bollworm larvae followed by the mixture of Dipel-2X + Dursban (at half of the used rate).

In addition, Dursban gave the highest reduction rate of boll infestation with bollworms followed by the mixture, while Dipel-2X alone ranked the 3rd position. Whereas, the reduction rates were 52.94%, 47.1% and 29.4%, respectively.

After the 2nd spray, the comparison between the insecticides on basis of the efficiency was difficult because of lower larval level in untreated check than the former inspection and this might be due to the effect of the natural enemy rover beetle (*Paederus alferii*).

On the other hand, comparison between the tested insecticides after the 2nd spray revealed that, Cutbron (750 ml/fed.) showed the highest reduction percentage (51.16%) followed by mixture of Dipel-2X + Dursban (375 ml/fed.), (37.7%), while Dipel-2X alone induced the least reduction percentage of infested bolls (13.95%). These results are in coincidence with the findings of **El-Gemaiey (1992)** who reported that, combinations of *B. t.* and the insecticide IKI were less effective than the insecticide alone, but higher than *B. t.* alone (Dipel & Delfin).

After one week of the 3rd spray comparison based on percentage reduction of infestation, revealed that mixture of Dipel plus Bulldock (400 g + 82.5 ml/fed.) caused 57.57% reduction, whereas Bulldock (165 ml/fed.) ranked the second (45.45%) and Dipel resulted in only 30.3% reduction of infestation. On the other hand, after two weeks of the 3rd spray, Bulldock showed the highest efficiency against small bollworm larvae (90%) followed by mixture of Bulldock with Dipel (57.5%), while Dipel caused only 5.39% reduction.

As far as the all counted larvae inside bolls, it is evident that, mixture of Dipel + Bulldock was more effective against bollworms larvae (57.2%) than Bulldock (51.1%), separately.

Meanwhile, effectiveness of Dipel after 2 weeks of the 3rd spray was 0.55%. Measuring the protective efficiency against boll infestation, treatment with mixture of Dipel + Bulldock and Bulldock alone showed equal protective efficiency against the boll infestation where % reduction of infested bolls was 70.7% for both program larvae, while the reduction rate resulted with Dipel alone was 24.39% **(Table, 13)**.

After the 3rd spray, correlation coefficient (r) between small and all counted bollworms larvae was not significant for both treated plots with the chemical insecticides and their mixtures with Diple. Because of the significance of (r) value after Dipel treatment, 4th spray with Dipel-2X was conducted.

The efficiency of Dipel-2X after 1 week and 2 weeks of application was (31.7 & 3.2%) and (25.8 & 0.0%) against small and all counted bollworms larvae, respectively. Meanwhile, the reduction values of infested bolls were 25% and 3.3%, respectively.

At the end of the evaluation, data in **Table (13)** clearly indicated that 3 and 4 weeks after 3rd spray in the chemical control program Bulldock showed the highest activity against small and all counted larvae and boll infestation. Where its efficiency was (72 & 0.0%), (34.8 & 2.11%) and (62.5 & 43.94%), respectively, compared with (0.0 & 0.0%), (27.3 & 0.0%) and (46.43 & 24.24%) activity of binary mixture against small, all counted bollworms and boll infestation, respectively.

During 1994 cotton season, results indicated clearly that sequence of 3 sprays with Dursban, Cutabron and Bulldock at the recommended rates was more effective than their mixtures (at half of the recommended rates) with Dipel (400 g/fed.) and/or sequences of 4 sprays with Dipel alone against bollworms under field conditions.

The same control programs were experimentally repeated during 1996 cotton season. Evaluation of the insecticides involved in each program was presented in **Table (14).** The 1st spray of Dipel program, mixture program and chemical program was applied on 7th August. The second spray was applied after 1st spray by 2, 3 and 3 weeks, for the respective programs based on the calculated values of (r) between the small and all counted larvae for each treatment. However, one week after the 1st spray the comparison between the tested insecticides showed that Dursban was the most effective against small and all counted bollworms and induced the highest reduction rate of boll infestation followed by Dipel-2X alone or in combination with chemical insecticides, where the efficiency of Dursban against small and all counted larvae was 69.4% and 67%, respectively. Furthermore, it resulted in 60.53% reduction of boll infestation. The corresponding values of Dipel were 65.62%, 45% and 52.63%, respectively. These values were 45%, 39.9% and 47.37%, respectively for the mixture of Dipel with Dursban.

It was evident that efficacy of Dipel-2X mixture with Dursban against small and all counted bollworms larvae during 1996 season was less than in season, 1994, this difference might be due to the mastery of the pink bollworm at the first spray during 1994, whereas pink and spiny bollworms were recorded during 1996. This finding may confirmed by the obtained reduction percentage in both experimental seasons, where it was 47% after the 1st spray during both 1994 and 1996 seasons. Besides, the increase in activity of Dipel

Table (14) : Efficiency (%) of insecticides included in different control programs against the cotton bollworm larvae and reduction percentages in boll infestation at various inspection dates during 1996 cotton season.

Programs	Efficiency (%) of insecticides against small and all counted bollworms larvae and reduction (%) of infested cotton bolls at various inspection dates																				
	14/8			21/8			28/8			4/9			11/9			18/9			25/9		
	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)
Program "A"	65.62 *	45.0	52.63	0.0 *	8.68	23.26	11.76 **	10.04	32.56	37 ***	2.45	37.0	12.5 ****	8.9	41.93	0.0	6.24	16.95 *****	0.0	2.4	34.52
Program "B"	45.0 *	39.9	47.37	41.3 *	43.5	48.8	15.6 *	30.17	34.9	27.3 **	0.0	24.1	67.3 **	12.68	32.3	0.0 **	0.0	5.08	53.1 ***	7.2	29.76
Program "C"	69.4 *	67.0	60.5	0.0 *	47.7	32.6	0.0 *	46.7	25.6	30.4 **	17.4	48.2	78.6 ***	0.0	32.3	74.3	24.4	40.68	0.0	26.7	52.4

s : Small larvae a : All counted larvae Red. (%) : Reduction (% in infested cotton bolls.

* : Efficiency and reduction (%) after 1*st* spray
** : Efficiency and reduction (%) after 2*nd* spray
*** : Efficiency and reduction (%) after 3*rd* spray
**** : Efficiency and reduction (%) after 4*th* spray
***** : Efficiency and reduction (%) after 5*th* spray

in reducing boll infestation may be due to decline in infestation rate during season 1996 compared to 1994 season. Two weeks after the 1^{st} spray efficiency of Dipel against small and counted larvae was 0.0% and 8.68%, respectively, and the corresponding reduction rate of boll infestation was only 23.26%. Meanwhile, efficiency of Dipel-Dursban mixture against small and all counted bollworms larvae and % reduction of boll infestation were 41.3%, 43.5% and 48.84%, respectively. The corresponding values for Dursban were 0.0, 47.7 and 35.56%.

Three weeks after the 1^{st} spray, efficiency of Dipel-Dursban mixture against small & all counted larvae and boll infestation were (15.6%, 30.17% and 34.9%), while it was (0.0%, 46.7% and 25.6%) for Dursban alone. One week after the 2^{nd} spray efficiency of Dipel-2X was 11.76%, 10.04% and 30.56%, against small, all larvae and reduction of infestation, respectively.

One and two weeks after the 2^{nd} spray efficiency of Dipel-Cutabron mixture (program B) against small, all counted bollworms and boll infestation ranged (27.3% & 67.3%), (0.0 & 12.68 %) and (24.1% & 32.26%), respectively. After 3 weeks of 2^{nd} spray, Dipel-Cutabron mixture loss its activity. The corresponding values for cutabron against samll larvae and all larvae were (30.4 & 78.6) , (17.4 & 0.0) and (48 & 32.3) , respectively.

The 3^{rd} spray of programs A, B and C was applied on 28^{th} August, 18^{th} September and 4^{th} September, respectively.

One week after the 3^{rd} spray, efficiency of Dipel (program A) and Dipel-Bulldock mixture (program B) against small, all counted bollworms and boll infestation were (37%, 2.45% and 37%) and (53.1%, 7.2% and 29.76%), respectively.

Meanwhile, the corresponding efficacy for Bulldock ranged 74.3% - 78.6%, 0.0 - 24.4% and 32.26 - 40.68%, respectively against small, all counted bollworms and boll infestation for 2 weeks after spray with Bulldock; while it's efficiency after three weeks of spray, was 0.0, 26.7% and 52.38% against small, all counted bollworms and boll infestation, respectively.

Dipel-2X was applied in 4^{th} and 5^{th} spray up to the calculated (r) value in the experimental plots. Efficiency values were (12.5% & 0.0%), (8.9% & 6.24%) and (41.93% & 16.95%) in the fourth spray against small, all counted bollworms and boll infestation, respectively. The corresponding values following the 5^{th} spray was 0.0%, 2.4% and 34.5%.

IV.1.B. Season 1995 :

During this season the bioinsecticide Xentari (500 g/fed.) alone or in mixture with half of the recommended dose of the chemical insecticide and/or the chemical insecticides (at the recommended dose) were evaluated against bollworms.

Small and all counted bollworms larvae after each spray and inspection as well as reduction percentages of infested bolls are summarized in Table (15). During this season, 3-4 sprays were applied.

Results revealed that, efficiency of the control programs against small bollworms larvae during the whole season ranged (3.53% - 94%), (13.7% - 78%) and (20% - 78%) for **Xentari** program, binary mixture (program E) and chemical insecticide (program F), respectively. The corresponding efficiency against all counted bollworms larvae was (0.0% & 50%), (5.5% & 42.8%) and (2.8% & 52.64%), respectively. Analysis of variance of the achieved numbers of bollworms post treatment during the whole season revealed that there was no significant differences between the population of bollworms (*P. gossypiella* and *E. insulana*) in plots treated with Xentari alone and that treated with the mixture, but a significant differences between the two control programs and the chemical program was obtained. Accordingly, the tested control programs could be arranged in ascending order as follows : microbial control program (Xentari), control program of Xentari plus chemical insecticide and the control program of the chemical insecticides.

Reduction values of Xentari (program D) as well as of the mixture program were (0.0% & 43%), while these values were from (0.0% -36%) for the chemical control program.

Table (15) : Efficiency (%) of insecticides included in different control programs against the cotton bollworm larvae and reduction percentages in boll infestation at various inspection dates during 1995 cotton season.

Programs	Efficiency (%) of insecticides against small and all counted bollworms larvae and reduction (%) of infested cotton bolls at various inspection dates																				
	9/8			16/8			23/8			30/8			6/9			12/9			20/9		
	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)
Program "D"	86.66 *	58.97	36.4	94.44 *	57.4	27.3	51.1 *	22.0	0.0	79 **	62.5	43.3	10.16 ***	0.0	23.1	3.53 ****	0.0	31.14	35.7	11.4	38.5
Program "E"	42.8	5.5	0.0	78.57	12.8	0.0	60.0	42.85	7.7	50.5 **	15.4	20.0	37.3 ***	4.0	7.7	74.0 ****	20.5	26.23	13.7	33.4	43.1
Program "F"	52.0	26.66	0.0	60.0	13.84	0.0	20.0	2.8	0.0	78.8 **	52.64	36.7	64.63	17.64	0.0	49.1 ***	16.25	24.6	34.0 ***	22	20.0

s : Small larvae   a : All counted larvae   Red. (%) : Reduction (% in infested cotton bolls.

* : Efficiency and reduction (%) after *1st* spray
** : Efficiency and reduction (%) after *2nd* spray
*** : Efficiency and reduction (%) after *3rd* spray
**** : Efficiency and reduction (%) after *4th* spray
***** : Efficiency and reduction (%) after *5th* spray

Analysis of variance of infested bolls after all treatments during the whole season showed no significant differences between the chemical and mixture control program. Contrarily, significant differences between the microbial program and the previous control programs were found. This result indicated that sequence of 4 sprays with Xentari was more effective against cotton bollworms than mixture program (Xentari 500 g/fed. + half dose of the chemical insecticide). Meanwhile, the chemical control program (Cyanox 50% EC l./fed, Cutabron 750 ml/fed and Bulldock 165 ml/fed.) was the least effective program under study.

Results showed also that the bioinsecticide Xentari was more effective against bollworms for two weeks after the 1st spray than both of chemical insecticide Cyanox and the mixture of Xentari plus the insecticide. Xentari continued superior the chemical insecticide (Cutabron) and its mixture (Xentari + Cutabron) one week after the 2nd spray. In addition, one week after 3rd spray (at 6th September) with both Xentari and the mixture and 2 weeks after 2nd spray with Cutabron the efficiency of Cutabron against small and all counted bollworms was higher than that of the others. Meanwhile, Xentari showed the highest reduction rate of infested bolls followed by the mixture and then Cutabron. At 12th September (i.e. one week after 4th spray with both Xentari and the mixture and 3rd spray with the chemical insecticide Bulldock, respectively) the efficiency of the mixture against small and all bollworms larvae (74% and 20.5%, respectively) was the highest followed by Bulldock (49.1% and 16.25%, respectively) and Xentari (3.53 and 0.0%, respectively).

Concerning the reduction rates of infested bolls, Xentari ranked the 1st (31.14%)mixture , the 2nd (26.23%), while Bulldock the 3rd (24.59%). The differences between treatment at this date (6th inspection) was not significant. After 2 weeks of the 4th spray with both Xentari alone and mixture and the 3rd spray with the chemical insecticide (Bulldock) (the last inspection week) the efficiency of Xentari, mixture and Bulldock against small and all bollworms larvae was (35.69% & 11.39%), (13.7% & 33.39%) and (34% & 22%), respectively. However, the differences were not significant. On basis of percentage reduction of infestation, the mixture ranked the 1st (43.1%), Xentari the 2nd (38.46%) and Bulldock the 3rd (20%). Also, the differences between the number of infested bolls were not significantly in the various treatments.

Data obtained during 1995 season based on efficiency of the tested insecticides showed that, the biocide, Xentari was more effective against bollworms followed by the mixture. The chemical insecticide was the least effective. The obtained data are in harmony with the findings of **Abul-Nasr *et al.*** (1979) who evaluated the effectiveness of 2 sprays (applications at an interval of 2 weeks) of *B. t.* subsp. *thuringiensis* and/or *B. t.* subsp. *finitimus*. They found that, the two bacterial treatments reduced the number of infested bolls by 42% - 45%, whereas treatment with the chemical insecticide Leptophos reduced the number by only 34%. They added that, the application of microbial pesticides may be an important factor in an integrated control program of bollworms.

During 1996 cotton season the control programs of 1995 were tested again. The efficiency of insecticides involved in each program are presented in **Table (16).** During this season 3-4 sprays were applied. The first spray of *B. t.* program (Xentari 500 g/fed.), mixture program and chemical program was applied on August 7th. The 4th spray was applied only with mixture program on 18th September.

Three weeks after 1st spray the efficiency of Xentari against small bollworm ranked the 1st (78.2%, 61.4% and 52.3% in 1st, 2nd and 3rd week, respectively). The second rank was the mixture of Xentari with Cyanox (71.3%, 0.0 and 0.0, respectively) and the chemical insecticide ranked the later (37%, 6.7% and 0.0, respectively).

Concerning the efficiency against all counted bollworm, Xentari showed also the first rank after 1st spray by 1, 2 and 3 weeks (54.7%, 53% and 36%, respectively). Cyanox recorded the second rank (62.7%, 58.2% & 22.3%, respectively). Although Xentari-Cyanox mixture ranked the 3rd

Table (16) : Efficiency (%) of insecticides included in different control programs against the cotton bollworm larvae and reduction percentages in boll infestation at various inspection dates during 1996 cotton season.

Programs	Efficiency (%) of insecticides against small and all counted bollworms larvae and reduction (%) of infested cotton bolls at various inspection dates																				
	14/8			21/8			28/8			4/9			11/9			18/9			25/9		
	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)	s	a	Red. (%)
Program "D"	78.2 *	54.7	42.1	61.4 *	53.0	34.9	52.3 *	38.4	16.3	7.9 **	17.7	35.2	29.1 **	20.5	30.6	0.0 **	6.6	3.4	20.0 ***	16.0	30.1
Program "E"	71.3	60.2	60.5	0.0	36.6	30.2	0.0	0.0	20.9	0.0	13.5	25.9	57.1 ***	39.0	48.4	5.7 ***	36.7	28.8	65.9 ****	19.3	48.8
Program "F"	37.5	62.7	50.0	6.7	58.2	39.5	0.0	22.3	0.0	44.9	38.6	37.0	67.8 ***	15.2	46.8	65.7 ***	26.3	35.6	3.6 ***	45.1	60.7

s : Small larvae   a : All counted larvae   Red. (%) : Reduction (% in infested cotton bolls).

* : Efficiency and reduction (%) after 1*st* spray

** : Efficiency and reduction (%) after 2*nd* spray

*** : Efficiency and reduction (%) after 3*rd* spray

**** : Efficiency and reduction (%) after 4*th* spray

(60.2%, 36.6% & 0.0%, respectively), it caused the highest reduction rates of boll infestation (60%, 30.2% & 20.9%, respectively) followed by Xentari (42.1%, 34.9% & 16.3%) whereas Cyanox ranked the later (50%, 39% & 0.0%, respectively).

The efficacy of Xentari, mixture and chemical insecticide (Cutabron) against small, all bollworm and boll infestation a week after the 2nd spray was (7.9%, 17.7% & 35.19%), (0.0%, 13.5% & 25.93%) and (44.9%, 38.6% & 37%), respectively. Efficiency of Xentari against small, all bollworm and boll infestation (after 2 weeks of 2nd spray) on September 11th was 29.1%, 20.5% and 30.64%, respectively. The corresponding values after 3 weeks were 0.0%, 6.6% and 3.39%, respectively. One week after the 3rd spray of mixture and chemical program (spray with Xentari-Bulldock mixture and Bulldock alone) these values were (57.19% & 67.8%), (39% & 15.2%) and (48.38% & 46.77%), respectively.

The corresponding values after 2 weeks were (5.7% & 65.7), (36.7% & 26.3%) and (28.8% & 35.6%) for Xentari-Bulldock mixture and Bulldock alone, respectively.

On 29th September i.e. after 1 week of the 3rd spray with Xentari and 4th spray with the mixture (Xentari + Cyanox) and after 3 weeks of 3rd spray with chemical insecticide (Bulldock) (the last inspection week); efficacy against small bollworm larvae was (20%, 65.9% and 3.6%, respectively) for Xentari, mixture and Bulldock, respectively. The corresponding values of all bollworms and boll infestation were (16% & 30.1%), (19.3% & 48.8%) and (45.1% & 60.71%), respectively.

IV.2- Efficacy of Various Control Programs Against Small Larvae of *P. gossypiella* :

Data presented in **Tables (17 & 18)** summarize results obtained during 1994, 1995 and 1996 seasons. Mean numbers of *1st* instar larvae of PBW during the whole season of 1994 were 6.44, 4.33 and 2.94 for the bio-insecticide (Dipel-2X), binary mixture (Dipel-2X + insecticides), and insecticides program, respectively, whereas the tested compounds were applied 3-4 times. On the other hand, mean number in untreated check was 9.22. **(Table, 17).**

The corresponding values of PBW larvae during 1995 season were 1.85, 2.33, 3.09 and 5.38 for the bio- insecticide (Xentari), binary mixture (Xentari + insecticides), the recommended insecticides and untreated check, respectively. **(Table, 18).**

During 1996 season, the evaluation of the tested programs of 1994 and 1995 seasons was repeated. Mean number of the PBW small larvae in the tested six control programs and untreated check amounted 1.64, 1.39, 1.46, 1.25, 1.14, 1.64 and 1.93, respectively **(Tables, 17 & 18).**

Mean numbers of PBW neonate during 1994 season were higher than in 1995 and 1996 seasons and these values of 1995 were also greater than of 1996. This could be due to cotton varieties tolerance to PBW infestation as achieved by **Gill and Sidhu (1989),** and/or might be attributed to the vigor vegetative growth of the planted cotton in addition to the microclimate conditions in the field.

However, analysis of variance of data obtained during 1994 and 1995 seasons showed significant differences between numbers of small PBW larvae of various control programs and untreated check. Contrarily, no significant differences were found during 1996 season.

As shown in **Table (17)** and the use of Dipel-2X (400 g/fed.) for 4 sprays during 1994 season resulted in 30.15 % reduction of PBW 1*st* instar larvae. For combination of Dipel-2X + recommended insecticides (at half recommended rate) in recommended sequence, reduction of PBW neonate after 3 sprays increased to 53.04 %. Co-toxicity value of combination of the bio-insecticide plus chemical insecticides reached +22.11, indicating that addition of the insecticide to the bio-agent resulted in a potentiated action (After **Zidan *et al.*, 1981).**

Table (17) : Average numbers of 1*st* instar larvae and (%) reduction of PBW *P. gossypiella* in cotton bolls after treatments by certain control programs during 1994 & 1996 seasons.

Program	Average number of 1*st* instar larvae of PBW/replicate/inspection																		
	1994									1996									
	Weeks of inspection							Mean	% Reduction	Weeks of inspection							Mean	% Reduction
	1*st*	2*nd*	3*rd*	4*th*	5*th*	6*th*	7*th*			1*st*	2*nd*	3*rd*	4*th*	5*th*	6*th*	7*th*		
A	6.33	11.00	2.66	5.00	6.00	7.66	-	6.44 b	30.15	0.75	2.75	3.50	1.00	1.25	1.25	1.00	1.64	15.00
B	4.33	4.33	5.66	1.00	2.00	8.66	-	4.33 c	53.04	1.75	0.75	2.00	1.25	0.50	2.75	0.75	1.39	27.98
C	4.33	6.00	1.00	0.33	1.00	5.00	-	2.94 d	68.10	1.00	2.75	2.75	1.75	0.25	0.50	1.25	1.46	24.35
Untreated check	15.66	11.66	4.00	6.33	8.66	9.00	-	9.22 a	-	3.50	2.25	2.75	1.50	2.00	1.25	0.25	1.93	-
Relative co-toxicity									+22.11									-14.9
"F" value								20.7**									0.76	
L.S.D.								1.047									N.S.	

- Means followed by the same letter are not differ significantly
- N.S. : Not significant

Table (18) : Average numbers of 1*st* instar larvae and (%) reduction of PBW *P. gossypiella* in cotton bolls after treatments by certain control programs during 1995 & 1996 seasons.

Program	Average number of 1*st* instar larvae of PBW/replicate/inspection																	
	1995									1996								
	Weeks of inspection							Mean	% Reduction	Weeks of inspection							Mean	% Reduction
	1*st*	2*nd*	3*rd*	4*th*	5*th*	6*th*	7*th*			1*st*	2*nd*	3*rd*	4*th*	5*th*	6*th*	7*th*		
D	1.00	0.33	0.66	3.66	4.00	2.66	0.66	1.85 d	65.61	1.50	1.50	2.00	2.00	1.00	0.50	0.25	1.25	35.23
E	3.33	0.66	1.66	4.00	5.00	0.66	1.00	2.33 c	56.69	1.25	2.25	1.50	1.75	0.75	0.50	0.00	1.14	40.93
F	2.00	0.66	3.33	2.66	9.33	2.33	1.33	3.09 b	42.57	2.25	1.25	5.25	1.75	0.50	0.50	0.00	1.64	15.00
Untreated check	1.66	0.66	1.33	7.66	15.30	7.00	4.00	5.38 a	-	3.50	2.25	2.75	1.50	2.00	1.25	0.25	1.93	-
Relative co-toxicity									+13.95									-16.18
"F" value								7.13**									0.78	
L.S.D.								0.914									N.S.	

- Means followed by the same letter are not differ significantly
- N.S. : Not significant

Results reveal also, that the chemical program including the recommended dose of Dursban, Cutabron and Bollduck in sequence was the most effective in reducing numbers of ***P. gossypiella*** small larvae (red., 68%). Generally, all tested programs were effective against PBW small larvae and could be arranged ascendingly as follows : bio- insecticide program, combination of bio-insecticide + recommended chemical insecticides program then chemical insecticides program.

Data in **Table (18)** revealed that, at the end of 1995 season, the bio-insecticide (Xentari) was the most effective in reducing PBW small larvae followed by program "E" (mixture of Xentari plus chemical insecticide at recommended sequence and half recommended dose), while the chemical insecticide programs was the least effective one. Co-toxicity value calculated after **Zidan *et al.* (1981)** was +13.95 for the mixture of Xentari (500 g/fed.) plus half dose of the recommended insecticides. This value showed that mixing insecticide with bio-insecticide resulted in an additive effect.

This result is in agreement with the findings of **Aboul-Nasr *et al.* (1979)** who reported that, the use of certain microbial insecticides in the field may be even more effective in controlling bollworms than some of the commonly used chemical insecticides.

During 1996 season, no significant differences were achieved between average numbers of PBW small larvae of the different control programs and untreated check. This may be attributed to the normal decrease of PBW larvae during this season. The tested programs through this season could be arranged ascendingly as follows : bio-insecticide program (Dipel-2X) and chemical insecticides program (including the recommended dose of Cyanox, Cutabron, and Bollduck in sequence), chemical control program (including the recommended dose of Dursban, Cutabron and Bollduck in sequence), combination of bio-insecticide (Dipel-2X) + recommended chemical insecticides program, bio-insecticide (Xentari) program and combination of bio- insecticide (Xentari) + recommended chemical insecticides program, whereby the reduction rates were 15 %, 15 %, 24.35 %, 27.98 %, 35.23 % and 40.93 %, respectively **(Tables, 17 & 18)**. In other words, Xentari alone or in combination with the recommended chemical insecticides (Cyanox, Cutabron and Bollduck in sequence and half dose) considered as effective compounds, while chemical insecticides program (Dursban, Cutabron and Bollduck in recommended sequence and dose) was moderately effective against pink bollworm during this season as well as the combination of bio-insecticide (Dipel-2X) + recommended insecticide at half application rate.

The number of small larvae of PBW obtained during the whole seasons of 1994 and 1996 for the same tested products were combined to evaluate their efficiency through these seasons. Data were statistically analysed by combined analysis of variance using the software program of statistical package MSTATE, Michigan Univ., U.S.A.

Data presented in **Table (19)** summarize the results. Mean number of small PBW larvae/program were 4.22, 2.97, 2.19 and 5.75 larvae for bio-insecticide program (Dipel-2X), combination of Dipel-2X with chemical insecticides program, chemical insecticides program and untreated check, respectively. There were highly significant differences between the numbers of small larvae of PBW in the control programs and untreated check. In addition, there was significant difference between program "A" Dipel-2X (400 g/fed.) and program "C" (including Dursban 1 l/fed., Cutabron 750 ml/fed. and Bollduck 165 ml/fed.) (in the respect of sequential system). On the other hand, there were no significant differences between program "C" and program "B" (including binary mixture of Dipel-2X + Dursban, Dipel-2X + Cutabron and Dipel-2X + Bollduck).

Reduction values amounted 26.6 %, 48.3 % and 61.9 % for programs "A", "B" and "C", respectively. Dipel-2X was the least effective one, while

Table (19) : Average numbers of small *P. gossypiella* larvae on cotton bolls as affected by certain control programs during 1994 & 1996 cotton seasons.

Programs	Average No. of *P. gossypiella* 1*st* instar instar larvae per replicate at various inspections							Reduc-tion
	1*st*	2*nd*	3*rd*	4*th*	5*th*	6*th*	Mean	(%)
Program "A"	3.66	6.83	3.49	3.17	3.83	4.33	4.22b	26.6
Program "B"	3.16	2.5	3.8	1.16	1.16	6.0	2.97c	48.3
Program "C"	2.83	4.66	1.66	0.66	0.66	2.66	2.19c	61.9
Untreated	9.5	7.3	3.66	4.0	5.16	4.83	5.75a	-
"F" value							24.4**	
L.S.D.							0.81	

- Means followed by the same letter did not differ significantly.

Dipel-2X mixed with the recommended sequential chemical insecticides at its half rate of application was moderately effective (48.3 %).

Program "C" including the recommended insecticides was highly effective against small larvae of PBW (61.9 %).

Similar results were obtained by **El-Gemeiy (1992)** who reported that combinations of ***B.t.*** and the chemical insecticides were less effective than the insecticide alone but higher than the ***B.t.*** formulation alone.

A combined analysis of variance of the obtained numbers of PBW small larvae at all inspections throughout the whole two seasons of 1995 and 1996 was statistically computed to determine the effective program directly during these season.

Table (20) includes average number of small PBW larvae in the infested cotton bolls/program at different inspections after treatment as well as the untreated check and reduction (%) of these numbers among different inspections. Data in this Table reveal the following :

Average numbers of small PBW larvae ranged between (0.33-2.83), (0.5-3.0), (0.66-5.0) and (1.83-8.5) larvae for bio-insecticide program (Xentari), binary mixture (Xentari + insecticide) program, insecticide program and untreated check, respectively.

Combined analysis of variance of the data revealed that there was a highly significant difference between the numbers of PBW small larvae in untreated check and the applied programs. Also, differences in numbers of program "D" (Xentari 500 g/fed.) and program "F" (including recommended insecticides) were significant, while they were not significant between program "D" and program "E" (including Xentari + recommended chemical insecticide at its half rate), and program "E" and program "F" (including chemical insecticides).

Table (20) : Average numbers of small *P. gossypiella* larvae on cotton bolls as affected by certain control programs during 1995 & 1996 cotton seasons.

	Average No. of *P. gossypiella* 1*st* instar larvae per replicate at various inspections								Reduc-tion
Programs	1*st*	2*nd*	3*rd*	4*th*	5*th*	6*th*	7*th*	**Mean**	**(%)**
Program "D"	1.33	1.16	1.33	2.83	2.66	1.5	0.33	1.59 c	56.9
Program "E"	2.33	1.50	1.5	2.83	3.0	0.66	0.5	1.76 cb	52.3
Program "F"	2.16	1.0	4.33	2.16	5.0	1.16	0.66	2.35 b	36.3
Untreated	2.5	1.83	2.33	4.66	8.5	3.83	2.16	3.69 a	-
"F" value								17.13**	
L.S.D.								0.646	

- Means followed by the same letter did not differ significantly.

Comparing the obtained results on basis of reduction percentages in small PBW larvae after three sprays, the tested programs induced the following reduction values : 56.94 %, 52.30 % and 36.30 % for program "D", "E" and "F", respectively.

These results indicated that the microbial control programs included 3-4 sprays with Xentari (500 g/fed.) alone or Xentari in a mixtures of recommended insecticides at the half rates of application was more effective than the chemical insecticides program "F".

These findings are in contrast with the results of 1994/1996 seasons, but in coincidence with those of **El- Gemeiy (1992)** who concluded that different treatments by bio-insecticide and chemical insecticides had various effects on cotton field. In addition, the present results are in agreement with those of **Abul- Nasr *et al.* (1979).**

IV.3- Effect of Certain Control Programs on suppression of All PBW Larvae in Cotton Bolls :

Data presented in **Tables (21& 22)** show average numbers of all PBW larvae obtained during 1994, 1995 and 1996 seasons after applying different control programs as well as those in untreated check.

IV.3.1- Season 1994 :

It is obvious that average number of PBW larvae/replicate/treatment at various inspections fluctuates between increasing and decreasing, while it takes the trend of increasing in the untreated check as a zigzag shape up to the development of the normal population of generations. Mean numbers were as follows : 18.44, 8.06, 7.0 and 21.78 larvae for program "A", "B", "C" and untreated check, respectively. Analysis of variance reveal that there was significant differences between numbers of PBW larvae in untreated check and all tested programs.

In addition, there was significant differences between program "A" (Dipel-2X, 400 g/fed.), program "B" (Dipel-2X + recommended insecticides at half application rates), and program "C" (insecticides at recommended dose). Meanwhile, mean numbers of PBW larvae did not differ significantly in program "B" and program "C".

When a comparison is done on basis of reduction values of PBW larval numbers after 3-4 sprays **(Table, 21)**, the chemical insecticide (program C) showed the highest effect against PBW larvae (67.86 %) followed by mixture of Dipel-2X plus chemical insecticide (program B) (62.99 %). Co-toxicity value of this mixture reached +7.18, indicating an additive effect.

The least effective product was Dipel-2X (400 g/fed.) (15.33 % reduction).

IV.3.2- Season 1995 :

Data presented in **Table (22)** show various numbers of PBW larvae of each tested program and untreated check through weeks of inspections.

Accordingly, estimation of efficacy of the tested programs can be explained by decreasing the total number of PBW larvae during the whole season. Mean numbers of PBW were 6.24, 6.76, 8.85 and 9.66 larvae for program "D" (Xentari), program "E" (mixture of Xentari + recommended insecticides at half rate), program "F" (recommended insecticides), and untreated check, respectively.

Reduction values in larval populations of PBW were 35.4 %, 30.02 % and 8.38 % for programs D, E and F, respectively **(Table, 22)**.

Accordingly, Xentari alone and/or Xentari in mixture with the recommended insecticides were effective against PBW larvae. However, mixtures of Xentari plus chemical insecticides showed an additive effect, in which the calculated co-toxicity value was +15.2.

IV.3.3- Season 1996 :

During season 1996 both programs tested through season 1994 and 1995 were repeated again to evaluate their efficacy against PBW larvae.

Table (21) : Average numbers of all counted larvae and (%) reduction of PBW *P. gossypiella* in cotton bolls after treatments by certain control programs during 1994 & 1996 seasons.

Program	Average number of all counted larvae of PBW/replicate/inspection																	
	1994									1996								
	Weeks of inspection							Mean	% Reduction	Weeks of inspection							Mean	% Reduction
	1st	2nd	3rd	4th	5th	6th	7th			1st	2nd	3rd	4th	5th	6th	7th		
A	9.66	17.00	10.33	15.66	18.33	39.66	-	18.44 b	15.33	4.50	7.50	6.75	5.75	8.75	7.25	7.00	6.78 b	34.25
B	5.66	8.66	7.66	4.00	5.66	16.66	-	8.06 c	62.99	5.50	5.00	4.25	8.25	7.50	9.00	12.25	7.39 b	28.39
C	5.66	8.00	6.33	4.00	6.33	11.66	-	7.00 c	67.86	4.00	6.50	5.00	5.25	9.75	8.00	7.50	6.57 b	36.34
Untreated check	17.00	20.33	11.00	19.66	27.33	35.33	-	21.78 a	-	9.75	9.50	9.00	10.75	13.00	9.25	11.00	10.32 a	-
Relative co-toxicity									+7.18									+21.88
"F" value									21.58**							6.89**		
L.S.D.									1.60							1.48		

- Means followed by the same letter are not differ significantly

Table (22) : Average numbers of all counted larvae and (%) reduction of PBW *P. gossypiella* in cotton bolls after treatments by certain control programs during 1995 & 1996 seasons.

Program	Average number of all counted larvae of PBW/replicate/inspection																	
	1995									1996								
	Weeks of inspection							Mean	% Reduction	Weeks of inspection							Mean	% Reduction
	1st	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*			*1st*	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*		
D	2.66	1.33	3.66	4.33	6.66	12.66	12.33	6.24 b	35.40	6.25	5.50	5.50	7.25	10.75	8.00	7.25	7.21 b	30.14
E	4.66	2.66	2.66	5.00	9.66	8.66	14.00	6.76 b	30.02	3.75	5.00	5.25	7.50	8.00	7.50	7.75	6.39 b	38.08
F	3.66	1.66	3.66	3.33	14.66	15.66	19.33	8.85 a	8.38	4.75	4.25	9.00	5.25	9.00	8.50	6.75	6.78 b	34.25
Untreated check	3.00	2.33	2.33	10.00	15.33	14.00	20.66	9.66 a	-	9.75	9.50	9.00	10.75	13.00	9.25	11.00	10.32 a	-
Relative co-toxicity									15.2									-11.18
"F" value								2.77**									6.89**	
L.S.D.								1.875									1.48	

- Means followed by the sàme letter are not differ significantly

Data in **Tables (21& 22)** revealed that there were significant differences between numbers of PBW larvae in the applied programs and untreated check. On the other hand, there were no significant differences between mean numbers of the tested programs.

Mean numbers of the PBW larvae during this season were 6.78, 7.39, 6.57, 7.20, 6.39, 6.78 and 10.32 larvae for A, B, C, D, D, F programs, and untreated check, respectively. The corresponding reduction values in counted PBW larvae after treatment were 34.25, 28.39, 36.34, 30.14, 38.08 and 34.25%, respectively.

Co-toxicity of the binary mixtures included in programs "B" and "E" (mixtures of Dipel-2X plus chemical insecticides) indicated a potentiated action, while mixtures of Xentari plus chemical insecticides resulted in an additive effect.

Combination of numbers of counted PBW larvae post treatment/ replicate/treatment through inspection weeks during 1994 and 1996 seasons for the same directed programs were calculated to evaluate the efficiency of the investigated programs through the whole two seasons.

As shown in **Table (23)**, all tested programs reduced significantly numbers of *P. gossypiella* larvae in comparison to untreated check. Furthermore, both programs "B" & "C" induced significantly lower larval numbers than in program "A".

Meanwhile, combinations of Dipel-2X with the recommended insecticides had shown similar effect in reducing the larval population of *P. gossypiella* as the chemical insecticides. The bio-insecticide (Dipel-2X) alone was less effective against *P. gossypiella* larvae although it was applied in a sequence of 4 sprays.

Average numbers of *P. gossypiella* larvae resulted from the tested programs and statistical analysis of the data during the two cotton seasons of

Table (23) : Average numbers of all counted *P. gossypiella* larvae in cotton bolls as affected by certain control programs during 1994 & 1996 cotton seasons.

Programs	Average No. of *P. gossypiella* larvae per replicate at various inspections							Reduction (%)
	1st	*2nd*	*3rd*	*4th*	*5th*	*6th*	Mean	
Program "A"	7.33	12.66	9.33	10.66	14.16	23.16	12.88 b	19.5
Program "B"	5.33	6.83	6.0	6.5	6.66	13.33	7.44 c	53.5
Program "C"	5.5	8.0	5.5	4.5	8.83	10.16	7.08 c	56.25
Untreated	13.33	15.33	10.66	14.66	20.16	21.83	16.00 a	-
"F" value							39.44**	
L.S.D.							1.93	

- Means followed by the same letter did not differ significantly.

1995 and 1996 are presented in **Table (24)**. Results showed that all tested programs reduced significantly the larval number of ***P. gossypiella*** as compared to untreated check. However, there were no significant differences between the efficacy of the three programs (D, E and F).

The achieved reduction values in all counted *P. gossypiella* larvae were 21.75 %, 29.52 % and 32.97 % for the chemical insecticides program, the bio-insecticide (Xentari), and mixtures of the bio- insecticide plus insecticides at half recommended rates, respectively.

IV.4- Effect of Control Programs on the Numbers of Spiny Bollworm *E. Insulana* Small Larvae :

Results summarized in **Tables (25 & 26)** show the average number of small SBW larvae and percentages of reduction to evaluate the efficacy of the control programs against the numbers of SBW small larvae.

The mean numbers of SBW during the experimental seasons were very low, this may be due to the microclimate conditions in the field which affect the population fluctuations.

Mean number of 1*st* instar larvae of SBW during the whole season of 1994 were 1.83, 2.17, 1.44 and 1.94 for 1*st*, 2*nd*, 3*rd* programs and untreated check. **(Table, 25).**

Statistical analysis of the data showed that there was no significant difference between the three tested programs in all applied treatments (3-4 times) and untreated check.

Reduction values indicate clearly that, the chemical program "C" was more effective than binary mixture (program B) or bio-insecticide using Dipel-2X (program A).

Co-toxicity value of the binary mixture was (+57.6) that means combining of Dipel-2X with half dose of recommended insecticide resulted in a potentiated effect against SBW larvae. Similar trend was obtained during

Table (24) : Average numbers of all counted *P. gossypiella* larvae on cotton bolls as affected by certain control programs during 1995 & 1996 cotton seasons.

Programs	Average No. of *P. gossypiella* larvae per replicate at various inspections								Reduction (%)
	1st	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*	Mean	
Program "D"	4.83	3.66	5.0	6.5	9.0	11.0	10.16	7.16 b	29.52
Program "E"	4.66	4.16	3.5	6.5	9.0	8.66	10.83	6.81 b	32.97
Program "F"	4.33	3.33	6.33	4.16	12.5	12.16	12.83	7.95 b	21.75
Untreated	6.33	6.33	6.33	9.83	14.16	11.16	17.0	10.16 a	-
"F" value								10.21**	
L.S.D.								1.3259	

- Means followed by the same letter did not differ significantly.

Table (25) : Average numbers of 1*st* instar larvae and (%) reduction of SBW *E. insulana* in cotton bolls after treatments by certain control programs during 1994 & 1996 seasons.

Program	Average number of 1*st* instar larvae of SBW/replicate/inspection																	
	1994									1996								
	Weeks of inspection							Mean	% Reduction	Weeks of inspection							Mean	% Reduction
	1st	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*			*1st*	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*		
A	1.00	1.00	1.33	1.66	2.00	4.00	-	1.83	5.67	1.25	2.75	2.00	1.50	1.50	4.50	3.25	2.34	3.72
B	1.00	1.00	1.00	1.00	4.00	5.00	-	2.17	11.70	1.75	2.25	2.25	1.00	1.25	5.50	2.00	2.29	7.75
C	1.00	1.00	1.00	1.00	1.66	3.00	-	1.44	25.77	1.00	2.00	3.00	1.00	1.25	1.25	1.50	1.57	36.75
Untreated check	1.00	1.00	1.33	1.00	3.66	3.66	-	1.94	-	1.50	2.50	2.50	1.75	2.00	3.50	2.75	2.48	-
Relative co-toxicity									+57.6									+78.91
"F" value								2.71									1.27	
L.S.D.								N.S									N.S	

- Means followed by the same letter are not differ significantly
- N.S. : Not significant

Table (26) : Average numbers of 1*st* instar larvae and (%) reduction of SBW *E. insulana* in cotton bolls after treatments by certain control programs during 1995 & 1996 seasons.

Program	Average number of 1*st* instar larvae of SBW/replicate/inspection																	
	1995									1996								
	Weeks of inspection							Mean	% Reduction	Weeks of inspection							Mean	% Reduction
	1*st*	2*nd*	3*rd*	4*th*	5*th*	6*th*	7*th*			1*st*	2*nd*	3*rd*	4*th*	5*th*	6*th*	7*th*		
D	1.00	1.00	3.66	1.33	2.66	1.66	0.66	1.86	6.54	1.00	2.00	2.50	1.00	1.75	5.25	2.75	2.32	6.54
E	1.00	1.33	1.66	3.00	2.33	1.33	1.00	1.81	18.23	1.00	3.5	2.75	1.00	1.25	3.25	1.50	2.03	18.23
F	1.00	1.66	1.00	2.00	1.33	1.66	1.00	1.52	35.9	1.25	3.25	1.75	1.00	1.25	1.75	2.50	1.82	35.90
Untreated check	1.00	1.66	1.33	2.00	2.66	2.33	1.00	1.86	-	1.50	2.50	2.50	1.75	2.00	3.50	2.75	2.48	-
Relative co-toxicity									+86.1									+49.2
"F" value								0.26									1.27	
L.S.D.								N.S									N.S	

- Means followed by the same letter are not differ significantly
- N.S. : Not significant

1995 season **(Table, 26)**. Mean numbers of SBW small larvae were 1.86, 1.81, 1.52 and 1.86 for program "D" (bio-insecticide using Xentari, 500 g/fed.), program "E" (binary mixtures of Xentari, 500 g/fed. plus insecticides at half recommended rates in recommended sequence), program "F" (recommended insecticides at recommended rates), and untreated check, respectively. There were no significant differences between these values. In addition, the bio-insecticide program (Xentari) had a very low effect in reducing numbers of SBW small larvae after all treatments, whereby the reduction percentage was 6.54%.

The chemical control program (program F) was more effective in reducing of SBW small larvae than in mixture at half of the recommended dose plus Xentari (binary mixture, program E). Co-toxicity value of the mixture amounted +86.1, indicating that the addition of the insecticide to Xentari in the mixture potentiated its effect against SBW larvae.

During 1996 cotton season, six control programs were tested, including the 3 programs of 1994 and the other three programs of 1995. Number of treatments ranged between (3-5) for the 1^{st} 3 programs, while it was from 3-4 for the others.

Data presented in **Tables (25 & 26)** showed average numbers of counted SBW small larvae per replicate at various inspections. All counted numbers of small SBW larvae at the first inspection after the first application of all treatments (7*th* August) were very low. This case continued until the 5*th* inspection on 11*th* September, where (4, 2 and 3) sprays were applied for the programs of bio-insecticide (Dipel-2X), binary mixture (program B) and chemical insecticides (program C) of 1994 season and (2-3) sprays for the corresponding programs of 1995 season. Larval numbers increased in the experimental plots of programs "A", "B", "D", and program "E" after this date, so it was necessary to apply 2*nd*, 3*rd*, and 4*th* spray at the corresponding programs.

Mean numbers of ***E. insulana*** small larvae in the six tested programs and untreated check given in **Tables (25 & 26)** were 2.39, 2.29, 1.57, 2.32, 2.03, 1.82 and 2.48, respectively. However, analysis of variance of the obtained data indicated that during 1996 season no significant differences were found between counted numbers of small SBW larvae and untreated check in all programs.

Results revealed also that the application of Dipel-2X (400 g/fed.), Xentari (500 g/fed.), binary mixtures (Dipel-2X + recommended insecticides), (Xentari + recommended insecticides), chemical insecticides (program C) and chemical insecticides (program F) caused 3.72%, 6.54%, 7.75%, 18.23%, 36.75% and 35.9% reduction in small larvae of SBW, respectively.

This result indicates that, the chemical control programs (C and F) were more effective against ***E. insulana*** small larvae than binary mixtures of Xentari or Dipel-2X plus insecticides, while Xentari and Dipel- 2X were the least effective. Co-toxicity values (49.2 & 78.9) resulted from addition of the insecticides to the bio-insecticides, *i.e.* Dipel-2X or Xentari in the mixtures exhibited a potentiated action.

Depending on reduction rates, the tested programs could be arranged ascendingly as follows : program A, D, B, E, F and C, respectively. Similar arrangement had achieved in evaluation of these programs against ***P. gossypiella*** small larvae. The efficiency of the tested programs were evaluated during 1994 and 1996 seasons, the obtained data were statistically analysed by analysis of variance, and presented in **Table (27)**. Results showed that there were no significant differences between programs A, B and untreated check in means of ***E. insulana*** first instar larvae. contrarily, these values in case of the chemical insecticides program "C" were significantly lower than untreated check. The recorded reduction values were amounted 11.11, 4.9 and 31.11% for programs A, B and C, respectively. This result indicates that the chemical program was the most effective one in reducing SBW small larvae, followed by

Table (27) : Average numbers of small *E. insulana* larvae on cotton bolls as affected by certain control programs during 1994 & 1996 cotton seasons.

Programs	Average No. of *E. insulana* 1st instar larvae per replicate at various inspections							Reduction (%)
	1st	*2nd*	*3rd*	*4th*	*5th*	*6th*	Mean	
Program "A"	1.16	2.16	1.66	1.33	1.66	4.0	2.00 a	11.11
Program "B"	1.5	1.5	1.5	1.0	2.66	4.66	2.14 a	4.9
Program "C"	1.0	1.66	2.16	1.0	1.33	2.16	1.55 b	31.11
Untreated	1.33	1.83	2.17	1.33	3.0	3.83	2.25 a	-
"F" value							3.18*	
L.S.D.							0.387	

- Means followed by the same letter did not differ significantly.

Dipel-2X, while the binary mixture was the least effective. This result is in harmony with that of **El-Gemeiy (1992)** who mentioned that combinations of *B.t.* with chemical insecticides were less effective than the insecticides alone.

Average numbers of small larvae of ***E. insulana*** in every inspection date throughout cotton season 1995 as affected by Xentari (program D), binary mixtures of Xentari and a sequence of chemical insecticides (program E) and a sequence of chemical insecticides (Cyanophos, Cutabron and Bollduck at the recommended rate) (*i.e.* program F) and the corresponding values of ***E. insulana*** larvae during 1996 season were subjected to combined analysis of variance to determine the most effective control program against small ***E. insulana*** larvae.

Results presented in **Table (28)** revealed slight decrease in ***E. insulana*** 1*st* instar larval numbers in the three control programs as compared with untreated check. But this decline was not significant. The reduction values of small SBW larvae were 3.38 %, 14.97 %, and 27.53 % for programs, D, E and F, respectively, indicating that the chemical control program was more effective than programs D and E.

IV.4- Effect of Certain Control Programs on suppression of All SBW Larvae in Cotton Bolls :

Data presented in **Table (29 & 30)** show average numbers of SBW larvae obtained during 1994, 1995 and 1996 cotton seasons after applying different control programs.

IV.5.1- Season 1994 :

Data illustrated in **Table (29)** clearly show that one week after the first application (24*th* July) of all tested programs larval populations of SBW were reduced.

Larval populations ranged from 0.00 and 1.33 for 1*st* - 4*th* inspection week, whereas 3 sprays were applied. One more spray was conducted for the bio- insecticide program at 16*th* August.

Table (28) : Average numbers of small *E. insulana* larvae on cotton bolls as affected by certain control programs during 1995 & 1996 cotton seasons.

Programs	Average No. of *E. insulana* 1*st* instar larvae per replicate at various inspections								Reduction (%)
	1*st*	2*nd*	3*rd*	4*th*	5*th*	6*th*	7*th*	Mean	
Program "D"	1.0	1.5	2.83	1.16	2.33	4.0	1.16	2.00 a	3.38
Program "E"	1.0	2.83	1.83	2.0	1.83	2.0	0.83	1.76 a	14.97
Program "F"	1.16	2.33	1.16	1.5	1.33	1.83	1.16	1.50 a	27.53
Untreated	1.33	2.16	2.16	1.83	2.5	3.16	1.33	2.07 a	-
"F" value								2.58	
L.S.D.								N.S.	

- Means followed by the same letter did not differ significantly.

- N.S. : not significant

Table (29) : Average numbers of all counted larvae and (%) reduction of *E. insulana* in cotton bolls after treatments by certain control programs during 1994 & 1996 seasons.

Program	Average number of all counted larvae of SBW/replicate/inspection																	
	1994									1996								
	Weeks of inspection							Mean	% Reduction	Weeks of inspection							Mean	% Reduction
	1st	2nd	3rd	4th	5th	6th	7th			1st	2nd	3rd	4th	5th	6th	7th		
A	0.00	0.66	1.33	1.33	2.66	9.00	-	2.5 abc	6.36	0.50	3.25	2.75	4.50	3.75	8.25	11.00	4.86 bc	41.34
B	0.33	1.00	0.00	0.00	5.66	8.66	-	2.61 ac	2.25	0.25	2.00	4.50	3.75	3.50	10.25	9.00	4.75 bc	42.63
C	0.00	0.00	0.00	0.00	2.66	6.66	-	1.56 bc	41.57	0.25	2.25	3.75	2.75	2.25	10.75	3.75	2.39 c	71.13
Untreated check	0.00	0.33	0.66	0.33	6.66	8.00	-	2.67 a	-	1.25	4.75	5.00	4.75	5.75	15.75	18.70	8.28 a	-
Relative co-toxicity																		+40.21
"F" value								7.93**									4.79**	
L.S.D.								1.07									2.637	

- Means followed by the same letter are not differ significantly

Table (30) : Average numbers of all counted larvae and (%) reduction of SBW *E. insulana* in cotton bolls after treatments by certain control programs during 1995 & 1996 seasons.

Program	Average number of all counted larvae of PBW/replicate/inspection																	
	1995									1996								
	Weeks of inspection							Mean	% Reduction	Weeks of inspection							Mean	% Reduction
	1st	2nd	3rd	4th	5th	6th	7th			1st	2nd	3rd	4th	5th	6th	7th		
D	0.00	1.66	2.66	2.00	5.23	6.33	6.66	3.52 b	41.71	0.25	3.25	5.75	3.00	2.50	10.75	11.50	5.29 b	36.16
E	1.00	3.00	1.33	4.66	6.00	7.66	4.66	4.05 b	33.05	0.25	3.25	4.50	4.75	2.00	5.00	4.25	3.43 bc	58.59
F	0.00	3.00	2.00	4.33	5.66	6.66	9.00	4.38 b	27.6	0.25	3.00	4.25	3.75	1.50	2.50	3.00	2.61 c	68.48
Untreated check	1.00	2.00	2.66	3.33	5.00	12.66	15.66	6.05 a	-	1.25	4.75	5.00	4.75	5.75	15.75	18.70	8.25 a	-
Relative co-toxicity									20.9									+14.4
"F" value								7.84**									4.79**	
L.S.D.								1.35									2.637	

- Means followed by the same letter are not differ significantly

The SBW populations increased through the *5th* and *6th* inspection. After 3 applications of the different programs, the chemical program "C" gave moderate efficacy against all counted SBW larvae, whereby the reduction value was 41.57 %. While the reduction values of Dipel-2X alone or in mixture with the inscctieides were very low (6.36 % and 2.25 %).

IV.5.2- Season 1995 :

During this season, 3-4 sprays were applied. According to the mean reduction values of SBW larval population (**Table, 30**). Xentari alone or in a mixture with the recommended insecticides were highly effective against SBW larvae after spraying with 4 sprays. All tested programs reduced significantly ***E. insulana*** larval numbers during 1995 season as compared to untreated check. Statistical analysis of the data did not show any difference between the various programs in reducing all counted larvae of SBW.

IV.5.3- 1996 season : Season 1996

Results of experiments directed through this season are presented in Tables (29 & 30). Experiments were carried out to evaluate efficacy of microbial insecticides Dipel-2X and Xentari alone and in mixtures with half dose of the recommended insecticides. Seven inspections were undertaken on samples of bolls. Three-four times treatments of the tested programs were applied.

Analysis of variance of the obtained data proved that there were significant differences between the tested programs and untreated check. The six programs proved to be effective in reducing larval populations of ***E. insulana***.

The tested compounds could be arranged in the following descending order up to reduction percentages in larval populations : Program "C" (71.13 %), program "F" (68.48 %), program "E" (58.59 %), program "B" (42.63 %), program "A" (41.34 %) and program "D" (36.16 %).

It is obvious that when combinations of (Xentari) + (chemical insecticides), and/or (Dipel-2X) + (chemical insecticides) reduction of SBW larvae increased, whereas the relative co-toxicity of the two mixtures reached +14.4 and 40.21, respectively, indicating that mixtures of Xentari + chemical insecticide had shown an additive effect while in case of Dipel-2X + chemical insecticides, it was a potentiated action.

According this result, the tested programs could be grouped as follows :

1- Highly effective compounds (includes programs "C" and "F").
2- Moderate effective compounds (includes programs "E" and "B").
3- Least effective compounds (includes programs "A" and "D").

Combination of numbers of counted SBW larvae post- treatment/ replicate/treatment through inspection weeks in 1994 and 1996 seasons for the same directed programs were calculated to evaluate the efficiency of the tested programs through the two seasons.

Data illustrated in **Table (31)** clearly show that all tested programs reduced the numbers of SBW significantly as compared with untreated check. Furthermore, program "C" differ significantly from program "A" (Dipel 2X alone) and/or program "B" (mixture of Dipel-2X and half dose of recommended insecticides).

In conclusion, the insecticides program was more effective (60.3 %) than programs "A", or "B" (32.54 % and 34.92 %) in reducing SBW larvae in cotton bolls during the whole two seasons.

Combined analysis of variance of the counted SBW larvae during the whole cotton seasons of 1995 and 1996 presented in **Table (32)**, revealed that all tested programs reduced significantly numbers of SBW larvae as compared to untreated check.

Accordingly, the chemical program "F" was the most effective 50.43%) followed by the binary mixture (program "E") (45.29 %), while the bio-insecticide (program "D") was the least effective (34.43 %).

Table (31) : Average numbers of all counted *E. insulana* larvae on cotton bolls as affected by certain control programs during 1994 & 1996 cotton seasons.

Programs	Average No. of *E. insulana* larvae per replicate at various inspections							Reduction (%)
	1st	*2nd*	*3rd*	*4th*	*5th*	*6th*	Mean	
Program "A"	0.33	2.5	1.33	2.83	3.5	8.16	3.11 b	32.54
Program "B"	0.33	1.16	1.83	1.66	4.33	8.66	3.00 b	34.92
Program "C"	0.166	1.33	2.0	1.0	2.33	4.16	1.83 c	60.3
Untreated	0.83	2.16	2.83	2.33	7.0	12.5	4.61 a	-
"F" value							9.75**	
L.S.D.							0.92	

- Means followed by the same letter did not differ significantly.

Table (32) : Average numbers of all counted *E. insulana* larvae on cotton bolls as affected by certain control programs during 1995 & 1996 cotton seasons.

Programs	Average No. of *E. insulana* larvae per replicate at various inspections								Reduction (%)
	1st	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*	Mean	
Program "D"	0.167	2.66	3.5	2.66	4.16	9.5	9.5	4.59 b	34.43
Program "E"	0.667	3.5	2.5	4.5	4.33	6.33	5.0	3.83 bc	45.29
Program "F"	0.167	2.83	2.66	3.83	3.66	5.0	6.16	3.47 c	50.43
Untreated	1.33	3.0	3.83	3.83	6.16	14.83	16.0	7.00 a	-
"F" value								21.79**	
L.S.D.								0.955	

- Means followed by the same letter did not differ significantly.

IV.6- Effect of Certain Control Programs on Larval Populations of Bollworms (*P. gossypiella* and *E. insulana*) :

Data illustrated in Table (33) clearly show the following :

One week after the first application (24*th* July), all tested programs gave the same effectiveness on total larval populations of PBW and SBW. Average numbers of bollworms larvae/replicate/treatment were significantly lower than untreated check. Inspection after the 2*nd* spray show that the chemical insecticides program was the most effective on average numbers of both bollworms, while the bio-insecticide (Dipel-2X) was the least effective. After the third treatment (16*th* August) there were no significant differences between all tested programs and untreated check in spite of the reduction of larval populations of bollworms. Although the experimental plots treated by the bio-insecticide program needed one more spray than binary mixtures program and/or chemical program, it still the least effective against bollworms populations until the end of the season. Analysis of variance of the obtained data revealed that there were highly significant differences between all tested programs and untreated check, and also between the tested programs itself, most of the whole season.

At the end of the season (after all applications), chemical insecticides program was the most effective on bollworms populations followed by binary mixture resulting in 64.83 % and 56.39 % reduction, respectively. Relative co-toxicity value of the combinations of Dipel-2X plus chemical insecticides was +13.01. This value indicates that addition of the insecticide to Dipel-2X in mixtures showed an additive effect. The least effective was the bio-insecticide, whereas its reduction value was 13.93 %.

Contrarily, data collected during 1995 season revealed that there were no differences between counted numbers of bollworms between the tested programs in all the inspections (Table, 34).

Table (33) : Average numbers of larvae and (%) reduction of bollworms (*P. gossypiella* and *E. insulana*) in cotton bolls after treatments by certain control programs during 1994 & 1996 seasons.

Program	Average number of *P. gossypiella* and *E. insulana*/replicate at various inspections																	
	1994									1996								
	Weeks of inspection							Mean	% Reduction	Weeks of inspection							Mean	% Reduction
	1st	2nd	3rd	4th	5th	6th	7th			1st	2nd	3rd	4th	5th	6th	7th		
A	9.66	17.66	11.66	17.00	21.00	48.66	-	20.94 b	13.93	5.00	10.75	9.50	10.25	12.50	15.50	18.00	11.64bc	37.3
B	5.66	9.66	7.66	4.00	11.33	25.33	-	10.61 c	56.39	5.75	7.00	8.50	12.00	11.00	19.20	21.25	12.2bc	34.3
C	5.66	8.00	6.33	4.00	9.00	18.33	-	8.56 d	64.83	4.25	8.75	8.75	8.00	12.00	9.75	11.25	8.96 d	51.75
Untreated check	17.00	20.66	11.66	20.00	33.30	43.30	-	24.30 a	-	10.75	14.25	14.00	15.50	20.75	25.00	29.75	18.57 a	-
Relative co-toxicity									+13.01									+37.7
"F" value								18.83**									11.05**	
L.S.D.								1.679									2.81	

- Means followed by the same letter are not differ significantly

Table (34) : Average numbers of larvae and (%) reduction of bollworms (*P. gossypiella* and *E. insulana*) in cotton bolls after treatments by certain control programs during 1995 & 1996 seasons.

Program	Average number of *P. gossypiella* and *E. insulana*/replicate at various inspections																	
	1995									1996								
	Weeks of inspection							Mean	% Reduction	Weeks of inspection							Mean	% Reduction
	1st	2nd	3rd	4th	5th	6th	7th			1st	2nd	3rd	4th	5th	6th	7th		
D	2.66	3.00	6.33	6.33	12.00	19.00	19.00	9.76 b	36.7	6.50	8.75	11.00	10.25	13.25	18.75	18.75	12.46 b	32.9
E	5.66	5.66	4.00	9.66	15.66	16.33	18.66	10.81 b	29.9	3.50	8.25	9.75	12.25	10.00	12.50	12.00	9.75 bc	47.5
F	3.66	4.66	5.66	7.66	20.33	22.33	28.33	13.23 a	14.2	6.25	7.00	13.25	9.00	10.50	11.00	9.75	9.54 cd	48.6
Untreated check	4.00	2.33	5.00	13.30	20.33	26.66	36.33	15.42 a	-	10.75	14.25	14.00	15.50	20.75	25.00	29.75	18.57 a	-
Relative co-toxicity									+18.53									+2.26
"F" value								9.01**									11.05**	
L.S.D.								2.246									2.81	

- Means followed by the same letter are not differ significantly

At the end of the season, mean numbers of bollworms larvae differ in two categories : the first was the bio-insecticide alone/or in mixtures with the insecticides and the second was the chemical insecticides and untreated check. As to their effects on reduction of larval populations of bollworms, the tested compounds could be arranged in descending order as follows : Xentari (36.7 %), Xentari in binary mixture (29.9 %) and chemical insecticide (14.2 %).

The calculated relative co-toxicity value for the combination of Xentari plus chemical insecticides was +18.53, indicating an additive effect.

During 1996 season, all programs applied during 1994 and 1995 seasons were repeated again to evaluate their efficacy against larval populations of bollworms.

Analysis of variance of data indicated that, there were significant differences between counted numbers of bollworms within the treatments (programs) and untreated check in all inspections during this season.

According to mean reduction values of pink and spiny bollworms larval populations (Tables, 33 & 34), program "C" (Dursban, Cutabron and Bollduck at recommended dose) was the most effective, followed by program "F" (Cyanox, Cutabron and Bollduck), program "E" (binary mixture of Xentari and chemical insecticides), program "A" (Dipel-2X) and program "B" (binary mixture of Dipel-2X with chemical insecticides). The least effective was program "D" (Xentari alone).

Co-toxicity values for mixtures of Xentari plus chemical insecticides, and Dipel-2X plus chemical insecticides were +2.26 and 33.7, respectively. These values indicate that the first combination exhibited an additive effect, while the second mixture resulted in a potentiated effect.

Combination of numbers of counted bollworms larvae/replicate/ treatment through inspection weeks during 1994/1996 seasons for the same directed programs were calculated to evaluate its efficacy.

As shown in **Table (35),** all tested programs reduced the numbers of bollworms significantly as compared with untreated check. Programs "B" and "C" reduced the populations significantly than program "A".

In conclusion, combinations of Dipel-2X plus half dose of insecticides were effective in reducing larval populations of bollworms and also the chemical insecticide program (program "C") resulting in 49.34 % and 56.9 % reduction, respectively. The bio-insecticide program "A" was the least effective (22.14 % reduction). These results coincide with the data obtained during evaluation of these programs against PBW and SBW larvae separately.

Average numbers and reduction as well as combined analysis of variance of the counted bollworms larvae during 1995/1996 seasons are presented in **Table (36).** Results showed that, all tested programs reduced the counted larvae significantly as compared to untreated check. Reduction values were 31.02 %, 37.60 % and 32.14 % for the bio-insecticide program "D", binary mixture program "E" and the chemical insecticides program "F", respectively.

IV.7- Effect of Certain Control Programs on Percentages of Infested Cotton Bolls With *P. gossypiella* :

Evaluation of PBW different control programs on basis of percent infested bolls was studied during 1994, 1995 and 1996 cotton seasons.

IV.7.1- Season 1994 :

Tables (37 & 38) includes percentages, mean numbers and reduction percentages of infested cotton bolls during 1994 season. Data clearly show that, one week after the first application (on August 1*st*) the chemical insecticides and their combination with Dipel-2X were moderately effective in reducing rates of infested bolls with PBW reaching values of 52.96 and 50.0 % reduction. Dipel-2X was the lowest one (29.4 % reduction). **(Table, 38).**

After the second and third application, infestation rate and reduction continued with the same trend. The bio-insecticides plots received a 4*th* spray

Table (35) : Average numbers and reduction (%) in cotton bollworms (*P. gossypiella* and *E. insulana*) larvae in cotton bolls as affected by certain control programs during 1994 & 1996 cotton seasons.

Programs	Average No. of bollworms larvae per replicate at various inspections							Reduction (%)
	1st	*2nd*	*3rd*	*4th*	*5th*	*6th*	Mean	
Program "A"	7.66	15.16	10.66	13.5	17.66	31.33	16.00 b	22.14
Program "B"	5.5	8.0	7.83	8.16	11.0	22.0	10.41 c	49.34
Program "C"	5.66	9.0	7.5	5.5	11.16	14.33	8.858 c	56.9
Untreated	14.16	17.5	13.5	17.0	26.83	34.33	20.55 a	-
"F" value							43.84**	
L.S.D.							2.117	

- Means followed by the same letter did not differ significantly.

Table (36) : Average numbers and reduction (%) in bollworms (*P. gossypiella* and *E. insulana*) larvae in cotton bolls as affected by certain control programs during 1995 & 1996 cotton seasons.

Programs	Average No. of bollworms larvae per replicate at various inspections								Reduction (%)
	1st	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*	Mean	
Program "D"	5.0	6.33	8.33	9.16	13.16	20.5	19.66	11.74 b	31.02
Program "E"	5.16	7.66	6.0	11.0	13.66	15.0	15.83	10.62 b	37.60
Program "F"	5.33	6.16	9.0	8.0	16.16	17.16	19.0	11.55 b	32.14
Untreated	7.66	8.33	10.16	13.66	20.33	26.0	33.0	17.02 a	-
"F" value								26**	
L.S.D.								1.5887	

- Means followed by the same letter did not differ significantly.

Table (37) : Percentage of infested bolls with pink bollworm (*P. gossypiella*) during cotton season of 1994.

Programs	Percentages of infested bolls with *P. gossypiella* at various inspections							Mean of infested bolls	
	Before spray	After spray						Mean No.	Mean %
		*1st**	*2nd***	*3rd****	*4th*	*5th*	*6th*		
Program "A"@	28	32	46.64	28	40	54.64 ****	77.32	11.61b	46.4
Program "B"	22.66	22.64	33.32	18.64	16.0	20.0	46.64	6.55c	26.2
Program "C"	28	21.32	28	24	16.0	22.64	29.32	5.88c	23.52
Untreated	32	45.32	56.0	37.32	53.32	68	76	14.0a	56.0
F-value								13.9*	
L.S.D.								1.208	

@ : Only program "A" include 4 sprays (after *4th* spray)

* After 1*st* spray

** After 2*nd* spray

*** After 3*rd* spray

Table (38) : Reduction percentages of infested cotton bolls with pink bollworm (*P. gossypiella*) during cotton season of 1994.

Programs	Before spray	% Reduction of infested bolls with *P. gossypiella* at various inspections after sprays						Reduction (%)
		*1st**	*2nd***	*3rd****	*4th*	*5th*	*6th*	
Program "A"	-	29.39	16.71	24.97	24.98	11.01 ****	-1.7	17.07
Program "B"	-	50.00	40.50	50.10	70.00	83.54	38.63	53.20
Program "C"	-	52.96	50.00	35.70	70.00	81.34	61.40	58.00
Untreated	-	-	-	-	-	-	-	-

* After 1*st* spray

** After 2*nd* spray

*** After 3*rd* spray

- Only program "A" include 4 sprays (after 4*th* spray) with the tested preparation. After this application, no reduction obtained until the end of the season (-1.72 % reduction).

However, analysis of variance revealed that all tested control programs reduced significantly numbers of infested cotton bolls with PBW and there were significant differences between them and untreated check. Also, effectiveness of binary mixture and chemical insecticides in reducing bolls infestation was approximately similar but differed significantly from the bio-insecticide (Dipel-2X). **(Table, 37).**

In addition, when the experimental design of 1994 repeated during 1996, similar results were obtained **(Table, 39),** after combined analysis of variance of obtained data during both seasons.

IV.7.2- Season 1995 :

Data illustrated in **Tables (40 & 41),** revealed that 3 weeks after the first application percentages of infestation with PBW decreased in cotton bolls as compared with initial infestation at pre-spray in all tested programs. However, reduction percentage of infested bolls in most tested programs were negative along the first three inspections.

Percentages of infestation increased gradually until the end of the season in spite of the continuous application of the tested programs, which depends on the correlation co-efficient between numbers of small larvae and total counted larvae of bollworms during inspection intervals.

According to the obtained reduction values, the tested programs could be arranged in descending order as follows : Xentari (28.57 % reduction), binary mixture (20.4 % reduction) and chemical insecticide the least effective (9.57 % reduction).

When a combined analysis of variance was done for data on basis of mean numbers of infested bolls as affected with the different programs of 1995 and 1996. Results **(Table, 39)** showed that all tested programs reduced the number of infested cotton bolls with PBW and differed significantly from

Table (39) : Average number, percentage infestation and (%) reduction in infestation with *P. gossypiella* as affected by certain programs during 1994/1996 and 1995/1996 cotton seasons.

Programs	Seasons					
	1994/1996			1995/1996		
	Mean No. infested bolls	Mean % infestation	% Reduction	Mean No. infested bolls	Mean % infestation	% Reduction
A	8.63 b	17.26	22.88	-	-	-
B	6.16 c	12.32	44.95	-	-	-
C	6.28 c	12.56	43.88	-	-	-
D	-	-	-	5.85 b	11.70	25.28
E	-	-	-	5.71 b	11.42	27.07
F	-	-	-	6.21 b	12.42	20.69
Untreated check	11.19 a			7.83 a		
"F" value	42.3**			9.47**		
L.S.D.0.05	1.09			0.89		

- Means followed by the same letter did not differ significantly.

(-) : Programs are not tested.

Table (40) : Percentage of infested bolls with pink bollworm (*P. gossypiella*) during cotton season of 1995.

Programs	Percentages of infested bolls with *P. gossypiella* at various inspections								Mean of infested bolls	
	Before spray	After spray							Mean No.	Mean %
		1st*	2nd	3rd	4th**	5th	6th	7th		
Program "D"	40.0	9.32	4.0	13.32	14.64	24.0 ***	33.3 ****	41.32	5.0	2.0
Program "E"	36.0	16.0	10.64	10.64	20.0	28.0 ***	33.3 ****	37.3	5.57	22.28
Program "F"	32.0	14.64	6.64	12.0	10.64	38.64 **	41.32 ***	53.3	6.33	25.3
Untreated	16.0	10.64	8.0	8.0	30.64	38.64	41.32	58.6	7.0	28.0
F-value									2.4	
L.S.D.									non seg	

* After 1*st* spray
** After 2*nd* spray
*** After 3*rd* spray
**** After 4*th* spray (Program "A")
- Program "F" include only 3 sprays

Table (41) : Reduction percentages of infested cotton bolls with pink bollworm (*P. gossypiella*) during cotton season of 1995.

Programs	Before spray	% Reduction of infested bolls with *P. gossypiella* at various inspections after sprays							Reduction (%)
		*1st**	*2nd*	*3rd*	*4th**	*5th*	*6th*	*7th*	
Program "D"	-	1.24	50.0	-66.5	52.2	37.9 ***	19.36 ****	29.53	28.57
Program "E"	-	-50.4	-24.81	-24.81	34.72	27.53 ***	19.36 ****	36.36	20.4
Program "F"	-	-37.6	17.0	-50.0	65.27	0.0 **	0.0 ***	9.07	9.57
Untreated	-	-	-	-	-	-	-	-	-

* After 1*st* spray

** After 2*nd* spray

*** After 3*rd* spray

**** After 4th spray (Program A)

- Program "F" include only 3 sprays.

untreated check. On the other hand, differences between all control programs were not significant. Reduction values were 25.28, 27.07 and 20.69 % for programs D, E and F, respectively.

IV.7.3- Season 1996 :

The six tested programs directed during 1994 and 1995 were evaluated again during 1996 season. Concerning percentages of infested bolls with PBW, the obtained results are given in **Table (42).** Results indicate that, all tested programs differ significantly from untreated check except program "C". In addition, all programs showed approximately similar effect on percentages of infested bolls after using 3, 4 or 5 applications, except program "C", in which the obtained ratio did not differ significantly from control.

Comparing the effectiveness of the six tested programs on basis of mean percentages of reduction in infested bolls **(Table, 43),** the tested programs could be grouped into :

Group 1 : Programs A, C and E with reduction values around 36 %.

Group 2 : Programs B, D and F with reduction values of around 29 %.

IV.8- Effect of Certain Control Programs on Percentages of Infested Cotton Bolls With *E. insulana* :

During 1994, 1995 and 1996 cotton seasons, evaluation of different programs applied against SBW were studied on basis of bolls infestation rates.

IV.8.1- Season 1994 :

Tables (44 & 45) include percentages, mean numbers and percent reduction of infested cotton bolls during 1994 season. Data show that percent infested bolls with SBW ranged 1.33-2.66 in all tested programs before spray.

After the first application (on August 1*st*), percentages were nil in all programs except program "B" (1.32%). Then these values fluctuated in all programs until the end of the season.

However, analysis of variance revealed that there were significant differences between program "A", "B" and untreated check and program "C".

Table (42) : Percentage of infested bolls with pink bollworm (*P. gossypiella*) during cotton season of 1996.

Programs	Percentages of infested bolls with *P. gossypiella* at various inspections								Mean of infested bolls	
	Before spray	After spray							Mean No.	Mean %
		*1st**	*2nd*	*3rd*	*4th***	*5th*	*6th*	*7th*		
Program "A"	15	18 *	21 *	19 **	21 ***	26 ****	24	23.0 *****	5.36b	21.43
Program "B"	15	19 *	16 *	14 *	29 **	28 **	30 **	31 ***	5.96bc	23.84
Program "C"	18	14 *	23 *	18 *	18 **	33 ***	29	29	8.86a	35.43
Program "D"	23	21 *	19 *	13 *	26 **	37 **	27 **	24 ***	5.96bc	23.84
Program "E"	18	14 *	18 *	18 *	26 **	24 ***	25 ***	27 ****	5.43cd	21.72
Program "F"	22	18 *	16 *	32 *	21 **	27 ***	30 ***	23 ***	5.96c	23.84
Untreated	21	34	31	28	37	42	30	34	8.43a	33.79
F-value									6.51**	
L.S.D.									1.17	

* After *1st* spray
** After *2nd* spray
*** After *3rd* spray
**** After *4th* spray
***** After *5th* spray (Program "A")
- Means followed by the same letter did not differ significantly

Table (43) : Reduction percentages of infested cotton bolls with pink bollworm (*P. gossypiella*) during cotton season of 1996.

Programs	Before spray	% Reduction of infested bolls with *P. gossypiella* at various inspections after sprays							Reduction (%)
		1st	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*	
Program "A"	-	52.9 *	32.25 *	53.6 **	43.2 ***	38.1 ****	20.0 *****	32.35	36.4
Program "B"	-	44.1 *	48.4 *	50.0 *	21.62 **	33.3 **	0.0 ***	8.8 ***	29.3
Program "C"	-	58.8 *	25.8 *	35.7 *	51.35 **	21.43 ***	3.3 ***	14.7 ***	35.6
Program "D"	-	38.2 *	38.7 *	53.6 *	29.73 **	11.9 **	10.0 ***	29.4 ***	29.3
Program "E"	-	58.8 *	41.9 *	35.71 *	29.73 **	42.8 ***	16.66 ****	20.66 ****	35.6
Program "F"	-	47.05 *	48.39 *	-14.3 *	43.24 **	35.7 ***	0.0 ***	32.35 ***	29.3
Untreated	-	-	-	-	-	-	-	-	-

* After 1*st* spray
** After 2*nd* spray
*** After 3*rd* spray
**** After 4*th* spray
***** After 5th spray (Program A)

Table (44) : Percentage of infested bolls with spiny bollworm (*E. insulana*) during cotton season of 1994.

Programs	Percentages of infested bolls with *E. insulana* at various inspections							Mean of infested bolls	
	Before spray	After spray						Mean No.	Mean %
		*1st**	*2nd***	*3rd****	*4th*	*5th*	*6th*		
Program "A"@	1.33	0.0	2.64	5.32	5.32	9.32 ****	14.66	2.17a	8.69
Program "B"	1.33	1.32	4.0	0.0	0.0	22.64	32.00	2.5a	10.0
Program "C"	2.66	0.0	0.0	0.0	0.0	9.32	24.0	1.39b	5.56
Untreated	2.66	0.0	3.32	2.64	4.32	21.32	29.32	2.33a	9.32
F-value								9.83**	
L.S.D.								0.97	

* After 1*st* spray

** After 2*nd* spray

*** After 3*rd* spray

**** After 4*th* spray (Program "A")

- Means followed by the same letter did not differ significantly

Table (45) : Reduction percentages of infested cotton bolls with spiny bollworm (*E. insulana*) during cotton season of 1994.

Programs	Before spray	% Reduction of infested bolls with *E. insulana* at various inspections after sprays						Reduction (%)
		*1st**	*2nd***	*3rd****	*4th*	*5th*	*6th*	
Program "A"	-	0.0	25.76	-1.015	-303.0	56.28 ****	0.0	7.0
Program "B"	-	-100	-20.48	100.0	100.0	-6.19	-9.14	0.0
Program "C"	-	0.0	100	100.0	100.0	56.28	18.14	21.1
Untreated	-	-	-	-	-	-	-	-

* After 1*st* spray

** After 2*nd* spray

*** After 3*rd* spray

**** After 4th spray (Program A))

Data in **Table (46)** clearly show that the bio-insecticide (Dipel-2X) alone or in mixture with the insecticides were not effective in reducing bolls infestation with SBW. Contrarily, the chemical insecticides program "C" reduced the boll infestation with SBW by 21.1 %.

When the experimental design of 1994 repeated during 1996 season, the analyzed data **(Table, 46)** showed higher reduction values (19.69 %, 27.60 % and 56.01 % for programs A, B and C, respectively).

IV.8.2- Season 1995 :

Data in **Tables (47 & 48)** show that, one week after the first application (on August 1*st*), the bio-insecticide (Xentari) and the chemical insecticide (Cyanox) were effective in reducing the bolls infestation rates with SBW, while binary mixture was not effective. Percentages of infested bolls increased gradually in all experimental plots until the second application (8.00 % and 14.64 %) for the bio-insecticide alone/or in mixture with insecticide, it was 14.64% for the chemical insecticides and then increased sharply until the end of the season inspite of applying the 3*rd* and 4*th* applications of the tested programs. However, at the last week of inspections, reduction values amounted 60.98, 65.89 and 41.40 % for program D, E and F, respectively. At the end of the season, it was obvious that Xentari was the most effective against SBW resulted in 49.3 % reduction followed by the binary mixture (32.57 %) and chemical insecticides (28.37 %). Contrarily, when a combined analysis of variance on basis of mean numbers of infested bolls, using the same tested materials during 1995 and repeated in 1996, data in **Table (46)** indicated that the chemical program was the most effective against SBW inducing 45.76 % reduction followed by binary mixture (39.76 %) and the least effective was the bio- insecticide (Xentari) resulting in 29.95 % reduction.

IV.8.3- Season 1996 :

Concerning the percentages of infested bolls with SBW during 1996 season, results obtained **(Table, 49)** revealed that, the chemical programs (C and F) were the most effective against SBW (inspite of the different

Table (46) : Average number, percentage infestation and (%) reduction in infestation with *E. insulana* as affected by certain programs during 1994/1996 and 1995/1996 cotton seasons.

Programs	Seasons					
	1994/1996			1995/1996		
	Mean No. infested bolls	Mean % infestation	% Reduction	Mean No. infested bolls	Mean % infestation	% Reduction
A	3.14 b	6.28	19.69	-	-	-
B	2.83 b	5.66	27.60	-	-	-
C	1.72 c	3.44	56.01	-	-	-
D	-	-	-	4.21 b	8.42	29.95
E	-	-	-	3.62 bc	7.24	39.76
F	-	-	-	3.26 c	6.52	45.76
Untreated check	3.91 a	-	-	6.01 a	-	-
"F" value	8.81**			23.86**		
L.S.D.	0.71			0.726		

- Means followed by the same letter did not differ significantly.

(-) : Programs are not tested.

Table (47) : Percentage of infested cotton bolls with spiny bollworm (*E. insulana*) during cotton season of 1995.

Programs	Percentages of infested bolls with *E. insulana* at various inspections								Mean of infested bolls	
	Before spray	After spray							Mean No.	Mean %
		*1st**	*2nd*	*3rd*	*4th***	*5th*	*6th*	*7th*		
Program "D"	2.66	0.0	6.64	8.0	8.0	18.64 ***	25.32 ****	21.32	3.14b	12.56
Program "E"	2.66	4.0	12.0	5.32	14.64	22.64 ***	30.64 ****	18.64	3.85b	15.4
Program "F"	1.33	0.0	12.0	8.0	14.64	22.64 **	25.32 ***	32.0	4.16b	16.36
Untreated	4.0	4.0	8.0	10.64	12.0	20.0	50.64	54.6	5.71a	22.84
F-value									10.04**	
L.S.D.									1.027	

* After 1*st* spray

** After 2*nd* spray

*** After 3*rd* spray

**** After 4*th* spray

- Program "F" include only 3 sprays
- Means followed by the same letter did not differ significantly

Table (48) : Reduction percentages of infested cotton bolls with spiny bollworm (*E. insulana*) during cotton season of 1995.

Programs	Before spray	% Reduction of infested bolls with *E. insulana* at various inspections after sprays							Reduction (%)
		1st*	2nd	3rd	4th**	5th	6th	7th	
Program "D"	-	100	17.0	24.8	33.3	6.8 ***	50.0 ****	60.98	49.3
Program "E"	-	0.0	-50.0	50.0	-22.0	-13.2 ***	39.5 ****	65.89	32.57
Program "F"	-	100	-50.0	24.8	-22.0	-13.2 **	50.0 ***	41.4	28.37
Untreated	-	-	-	-	-	-	-	-	-

* After 1*st* spray

** After 2*nd* spray

*** After 3*rd* spray

**** After 4th spray

- Program "F" include only 3 sprays.

Table (49) : Percentage of infested cotton bolls with spiny bollworm (*E. insulana*) during cotton season of 1996.

Programs	Percentages of infested bolls with *E. insulana* at various inspections								Mean of infested bolls	
	Before spray	After spray							Mean No.	Mean %
		1st	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*		
Program "A"	1.33	2.0 *	13.0 *	11.0 **	13.0 ***	26.0 ****	25.0	40.0 *****	4.93ab	19.72
Program "B"	1.33	1.0 *	7.0 *	17.0 *	14.0 **	14.0 **	34.0	36.0 ***	4.39bc	17.56
Program "C"	5.33	1.0 *	9.0 *	15.0 *	11.0 **	9.0 ***	6.0	11.0	2.21d	8.84
Program "D"	1.33	1.0 *	12.0 *	23.0 *	12.0 **	10.0 **	39.0	39.0 ***	4.86ab	19.44
Program "E"	1.33	1.0 *	13.0 *	19.0 *	17.0 **	7.0 ***	18.0	16.0 ****	3.25bc	13.0
Program "F"	2.66	1.0 *	11.0 *	15.0 *	14.0 **	6.0 ***	9.0	11.0	2.39cd	9.56
Untreated	0.0	5.0	18.0	20.0	19.0	30.0	44.0	58	6.93a	27.7
F-value									5.08**	
L.S.D.									2.11	

* After *1st* spray
** After *2nd* spray
*** After *3rd* spray
**** After *4th* spray
***** After *5th* spray (Program "A")
- Means followed by the same letter did not differ significantly

compounds and doses), followed by binary mixtures (Dipel-2X and Xentari), while the bio- insecticides (Dipel-2X and Xentari) were the least effective compounds.

Comparing the effectiveness of the six tested programs on basis of percent reduction, the tested programs could be arranged in descending order as follows program "C" (68.1 %), program "F" (65.5 %), program "E" (53.1 %), program "B" (36.65 %), program "D" (29.9 %), and program "A" (28.98 %). **(Table, 50).**

IV.9- Effect of Certain Control Programs on Percentages of PBW and SBW Infestation :

IV.9.1- Season 1994 :

Before spraying (on July 24*th*) bollworms infestation rates ranged from 29.3-40.0 %. **(Table, 51).**

At the end of the experiment, the highest infestation rate was 88 % in the untreated plots. Average infestation rates during the whole season are presented in **Table (51).** Analysis of variance of the obtained data revealed that, there were highly significant differences between the tested programs and untreated check. Concerning the reduction rates of the infested cotton bolls with bollworms, it is obvious that program "C" was the most effective in reducing infestation (53.73 %), followed by program "B" (44.00 %), and the least effective was program "A" (18.13 %), **(Table, 52).**

Similar result was obtained when a combined analysis of variance on basis of mean numbers of infested bolls was conducted for data of applied programs during 1994 and their repetition at 1996 season. reduction percentages of bolls infestation with bollworms. were 45.47 %, 38.76 % and 23.21 % for the various programs, respectively **(Table, 53).**

Table (52) : Reduction percentages of infested cotton bolls with bollworms (*P. gossypiella* and *E. insulana*) during cotton season of 1994.

Programs	Before spray	% Reduction of infested bolls with bollworms (PBW & SBW) at various inspections after sprays						Reduction (%)
		*1st**	*2nd***	*3rd****	*4th*	*5th*	*6th*	
Program "A"	-	29.39	13.78	23.4	24.38	24.97 ****	3.04	18.13
Program "B"	-	47.04	37.06	53.4	70.7	46.41	24.27	44.00
Program "C"	-	52.96	51.05	40.0	70.7	62.49	43.95	53.73
Untreated	-	-	-	-	-	-	-	-

* After 1*st* spray

** After 2*nd* spray

*** After 3*rd* spray

**** After 4th spray (Program A))

Table (53) : Average number, percentage infestation and (%) reduction in infestation with bollworms (*P. gossypiella* and *E. insulana*) as affected by certain programs during 1994/1996 and 1995/1996 cotton seasons.

Programs	Seasons					
	1994/1996			1995/1996		
	Mean No. infested bolls	Mean % infestation	% Reduction	Mean No. infested bolls	Mean % infestation	% Reduction
A	10.52 b	21.04	23.21	-	-	-
B	8.39 c	16.78	38.76	-	-	-
C	7.47 c	14.94	45.47	-	-	-
D	-	-	-	9.14 b	18.28	25.4
E	-	-	-	9.12 b	18.21	25.6
F	-	-	-	8.95 b	17.90	27.0
Untreated check	13.7 a	27.4	-	12.26 a	24.52	-
"F" value	44.52**			20.25**		
L.S.D.0.05	1.12			0.9986		

- Means followed by the same letter did not differ significantly.

(-) : Programs are not tested.

IV.9.2- Season 1995 :

Table (54) show that percentages of infested cotton bolls with bollworms (PBW and SBW) before spraying on August 1*st* 1995 were from 9.33-16.0%. these values reached 49.3-86.6% at the end of the season.

Analysis of variance depending on numbers of infested bolls with bollworms showed that all treatments reduced significantly mean numbers of infested bolls in comparison to untreated check. In addition, program "D" was the most effective in reducing numbers of infested bolls with bollworms, while programs of chemical insecticides and binary mixtures were approximately equal in their effectiveness **(Table, 54)**. According to reduction percentages, programs could be arranged in descending order as follows : Program "D" (30.87 %), program "E" (15.62 %) and program "F" (13.10 %), **(Table, 55)**.

Table (53) summarized the results when the same programs were evaluated again during 1996. results indicate that, the chemical program "F" had a slightly lower effect in reducing infested cotton bolls (27.0 %) than programs "D" and "E" where redaction percentage were 25.4 % and 25.6 %, respectively.

IV.9.3- Season 1996 :

During 1996 season, the previous six programs were tested, percentages of infested bolls with bollworms (PBW and SBW) before spray ranged (16-25%) in the treated plots **(Table, 56)**.

Untreated check showed the highest percent of infestations all over the experiment. Percentages of infestation ranged from 33-84 % at the end of the season in the various treatments and untreated check. Treated plots with the different control programs received 3-5 sprays during the season. Analysis of variance on criterion of numbers of infested bolls with bollworms, to determine the efficacy of various programs, revealed that there were significant differences between the tested programs and untreated check.

Table (54) : Percentage of infested bolls with cotton bollworms (*P. gossypiella* and *E. insulana*) during cotton season of 1995.

Programs	Percentages of infested bolls with (PBW & SBW) at various inspections								Mean of infested bolls	
	Before spray	After spray							Mean No.	Mean %
		*1st**	*2nd*	*3rd*	*4th***	*5th*	*6th*	*7th*		
Program "D"	16.0	9.3	10.64	20.0	22.64	40.0 ***	56 ****	53.3	7.57c	30.3
Program "E"	14.66	20	20	29.3	32	48 ***	60 ****	49.3	9.24b	36.96
Program "F"	12.0	14.64	18.64	20	25.3	57.32 **	61.3 ***	69.3	9.52b	38.1
Untreated	9.33	14.64	14.64	17.3	40	52	81.3	86.6	10.95a	43.8
F-value									8.8**	
L.S.D.									1.41	

* After *1st* spray

** After *2nd* spray

*** After *3rd* spray

**** After *4th* spray

- Program "F" include only 3 sprays
- Means followed by the same letter did not differ significantly

Table (55) : Reduction percentages of infested cotton bolls with bollworms (*P. gossypiella* and *E. insulana*) during cotton season of 1995.

Programs	Before spray	% Reduction of infested bolls with bollworms (*P. gossypiella* and *E. insulana*) at various inspections after sprays							Reduction (%)
		*1st**	*2nd*	*3rd*	*4th***	*5th*	*6th*	*7th*	
Program "D"	-	36.34	27.3	-15.5	43.4	23.1 ***	31.1 ****	38.46	30.87
Program "E"	-	-36.6	-36.6	-69.28	20.0	7.7 ***	26.2 ****	43.1	15.62
Program "F"	-	0.0	-27.3	-15.47	36.7	-10.2 **	24.6 ***	20.0	13.1
Untreated	-	-	-	-	-	-	-	-	-

* After 1*st* spray

** After 2*nd* spray

*** After 3*rd* spray

**** After 4th spray

- Program "F" include only 3 sprays.

Table (56) : Percentage of infested bolls with cotton bollworms (*P. gossypiella* and *E. insulana*) during cotton season of 1996.

Programs	Percentages of infested bolls with (PBW & SBW) at various inspections								Mean of infested bolls	
	Before spray	After spray							Mean No.	Mean %
		1st*	2nd	3rd	4th**	5th	6th	7th		
Program "A"	16	18 *	33 *	29 **	34 ***	36 ****	49 ****	55 *****	9.03bc	36.12
Program "B"	16	20 *	22 *	28 *	41 **	42 **	56 **	59 ***	9.53bc	38.12
Program "C"	22	15 *	29 *	32 *	28 **	42 ***	35 ***	40 ***	7.84c	31.56
Program "D"	25	22 *	28 *	36 *	35 **	43 **	57 **	52 ***	9.75b	39.0
Program "E"	19	15 *	30 *	34 *	40 **	32 ***	42 ***	43 ****	8.43bc	33.72
Program "F"	24	19 *	26 *	46 *	34 **	33 ***	38 ***	33 ***	8.18bc	32.72
Untreated	21	38	43	43	54	62	59	84	13.68a	54.72
F-value									9.78**	
L.S.D.									1.8	

* After *1st* spray
** After *2nd* spray
*** After *3rd* spray
**** After *4th* spray
***** After *5th* spray (Program "A")
- Means followed by the same letter did not differ significantly

Accordingly, the six tested programs could be classified in two groups according to their efficacy in reducing mean numbers of infested bolls as follows:

Group 1 : includes programs "A", "B" and "D", were less effective than group 2 which includes programs "C", E" and "F". Meanwhile values ranged from 29-34% and 38-42% for the first and second group, respectively, **(Table, 57).**

IV.10. GENERAL CONCLUSION :

1- Determination of the most effective control program against cotton bollworms :

Control programs of cotton bollworms are essentially because of their protective nature. Therefore, determination of the most effective control program based on reduction percentages of 1*st* instar larvae of bollworms (PBW and/or SBW) and the infested bolls is important.

2- Determination of the most effective control program against PBW :

Data presented in **Table (58)** show that the tested control programs could be arranged descendingly according to its efficacy in reducing small PBW larvae as follows :

Chemical control program (Dursban in 1*st* spray), Xentari, Xentari + chemical insecticides, Dipel + chemical insecticides, chemical control program (Cyanox in 1*st* spray and Dipel-2X where % reduction were 61.9%, 56.9%, 52.3%, 48.3%, 36.3% and 26.6%, respectively. On the other hand, according to reduction rate of infested bolls the tested programs could be arranged descendingly in three ranks as follows :

First rank : Dipel-2X + chemical insecticides (44.95% reduction in boll infestation).

Chemical control (when Dursban in the 1*st* spray 34.88%.

Second rank : Xentari alone (25.28%) or mixed with chemical insecticides (27.07%).

Third rank : Dipel-2X (22.83%).

Table (57) : Reduction percentages of infested cotton bolls with bollworms (PBW & SBW) during cotton season of 1996.

Programs	Before spray	% Reduction of infested bolls with bollworms (*P. gossypiella* and *E. insulana*) at various inspections after sprays							Reduction (%)
		1st	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*	
Program "A"	-	52.63 *	23.26 *	32.56 **	37.0 ***	43.55 ****	16.95 *****	34.52 *****	33.98
Program "B"	-	47.37 *	48.84 *	34.9 *	24.1 **	33.87	5.1 ***	29.76 ***	30.29
Program "C"	-	60.53 *	35.58 *	25.58 *	48.15 **	32.26 ***	40.7 ***	52.38 ***	42.3
Program "D"	-	42.1 *	34.88 *	16.28 *	35.2 **	30.6 **	3.39 ***	38.1 ***	28.71
Program "E"	-	60.53 *	30.23 *	20.91 *	25.9 **	48.4 ***	28.8 ****	48.81 ****	38.38
Program "F"	-	50 *	39.53 *	6.98 *	37.0 **	46.8 ***	35.6 ***	60.71 ***	40.21
Untreated	-	-	-	-	-	-	-	-	-

* After *1st* spray
** After *2nd* spray
*** After *3rd* spray
**** After *4th* spray
***** After *5th* spray (only program A).

Chemical control (when Cyanox used in 1*st* spray) (20.69%).

It could be concluded that : the chemical control program (Dursban EC 45% lt 1 l/fed. in the 1*st* spray, and Cutabron EC 50% at 750 ml/fed. in the 2*nd* spray, and Bulldock at 165 ml/fed. in the 3*rd* spray) was the most effective control program. However, the beginning of chemical sequence with Dursban seem to be important to increase the efficiency of control. In contrary, beginning with Cyanox lead to decreasing the efficiency. These results are in agreement with the findings of **Watson *et al.* (1986)** who found that, the sequence of Dursban-fenpropathrin-Cyanox yielded 90 % reduction of larval content of PBW and superior of the sequence of synthetic pyrethroid; although many studies confirmed the superiority of the synthetic pyrethroid for bollworms control.

The second conclusion in the present study, the bio-insecticide Xentari (*B.t.* subsp. *aizawai*) was more effective against *P. gossypiella* than *E. insulana*.

Moreover, efficiency of Xentari against small PBW larvae was higher than that of a sequence of the chemical insecticides (Cyanox-Cutabron-Bulldock). This result is in agreement with that of **Abul-Nasr *et al.* (1979)** who reported that, the use of certain microbial insecticides in the field may be even more effective in controlling bollworms than some of commonly used insecticides and microbial pesticides may be an important factor in an integrated control program of bollworms.

The third conclusion, the program including Dipel-2X (WP) in a mixture with (Dursban-Cutabron-Bulldock) had higher potential protective against bollworms than both of the two bio-insecticides Dipel-2X and Xentari.

El-Gemeiy (1992) reported an increase in the efficiency by mixing *B.t.* with Polytrin (chemical insecticide) and mentioned that this increase could only referred to the strong toxic effect of Polytrin even in its very low concentration used (0.075 l.).

Therefore, the obtained results indicated that the most effective control program against PBW was as a sequence of 3 chemical insecticides where Dursban EC 45 % (1 L/fed.) in 1*st* spray, Cutabron EC 50 % (750 ml/fed.) in 2*nd* spray, and Bulldock EC 15 % (165 ml/fed.) in 3*rd* spray.

Although, a sequence of 4 sprays with Xentari (500 g/fed.) resulted in 56.9 % reduction of small PBW larvae and 25.28 % in boll infestation, the sequence of 3 binary mixtures of Dipel-2X (400 g/fed.) with half dosage of the chemical insecticide sequence is considered the most effective where it induced 48.3 % reduction of small PBW larvae and 44.95 % in boll infestation.

3- **Determination of the most effective control program against SBW :**

Data in **Table (58)** show the most effective control program according to reduction percentages of small larvae of ***E. insulana***.

The control program of 3 sprays with chemical insecticides (Dursban in the 1*st* spray, Cutabron in the 2*nd* and Bulldock in the 3*rd* spray) had a moderate effect followed by a sequence of 3 sprays of chemical insecticides (Cyanox in the 1*st* spray, Cutabron in the 2*nd* and Bulldock in the 3*rd* spray).

Programs of 4 sprays with binary mixture of Xentari + chemical insecticide and 4-5 sprays of Dipel-2X had low effect on reduction rates of SBW small larvae (14.97% and 11.11%, respectively). The least effective programs against SBW small larvae were of 3 applications of Dipel-2X + chemical sequence (4.9% reduction) and 3-4 sprays of Xentari (3.38% reduction).

Moreover, the calculated reduction rates of small spiny bollworm larvae revealed that, efficiency of all programs was less than of the pink bollworm. This conclusion is in agreement with **Joyce (1956)** who reported that some widely used insecticides are ineffective against ***E. insulana*** in the sprayed fields; this may have been connected with preferable oviposition on the sprayed plants, which developed vigorous secondary growth.

As far to reduction percentages of infested bolls with spiny bollworm the programs could be arranged as follows :
Chemical program (began with Dursban (56%), chemical program (began with Cyanox) (45.76%), program of binary mixtures of Xentari + chemical insecticides (39.76%), program of Xentari alone (29.95%), program of binary mixtures of Dipel-2X + chemical insecticides (27.6%) and program of Dipel-2X alone (16.69%). This result indicates slight increase in efficiency of all control programs against boll infestation with the spin bollworm.

Table (58) : Effect of certain control programs against pink bollworm (PBW), spiny bollworm (SBW) and their complex (BWS) based on combined analysis for two experimental seasons.

Group	Programs	Reduction % of 1*st* instar larvae		Reduction % of infested bolls with		
		PBW	SBW	PBW	SBW	P.& S BWS
1*st*	Dipel-2X	26.6	11.11	22.83	16.69	23.27
	Dipel + chemical	48.3	4.9	44.95	27.62	38.88
	Chemical (Dursban in 1*st* spray)	61.9	31.11	43.88	56.01	45.51
2*nd*	Xentari	56.9	3.38	25.28	29.95	25.49
	Xentari + Chemical	52.3	14.97	27.07	39.76	25.62
	Chemical (Cyanofos in 1*st* spray)	36.3	27.53	20.69	45.76	27.0

4- Determination of the most effective control program against bollworms complex :

As shown in **Table (58)** and based on reduction percentages of the infested bolls with bollworms complex (***P. gossypiella*** and ***E. insulana***), the most effective control program was of a sequence of 3 sprays of insecticides (Dursban in the *1st* spray, Cutabron in the *2nd* and Bulldock in the *3rd*) had a moderate effect where it yielded 45.5% reduction on infested bolls; followed by a sequence of 3 sprays of binary mixtures of Dipel-2X (WP) 500 g/fed. with the former sequence (at half rate/fed.) where it resulted in 38.88% reduction of infested bolls.

The sequence of 3 sprays of insecticides (Cyanox, Cutabron and Bulldock), binary mixture of Xentari + former insecticides, Xentari alone and Dipel-2X caused low effect on reduction rates of boll infestation with bollworms whereby percentages reduction were 27.00%, 25.62 %, 25.49% and 23.27%, respectively.